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Organizational Structure and Scalar Stress

GREGORY A. JOHNSON

INTRODUCTION

It is a common observation in anthropology that larger societies tend to be more complex than smaller ones, and both size and complexity are normally considered to be major axes of variability in social evolution. Indeed, various measures of social-system size and organizational complexity are highly correlated. Naroll (1956), for example, reports strong positive relationships between the population size of the largest settlement in a society ($N = 25$) and both degree of craft specialization and a measure of organizational ramification. Carneiro (1967) notes a similar relationship between population size and organizational complexity in a sample of 46 single-community cases, while Ember (1963) reports strong relationships between the number of types of political officials (both formal and informal) in a society ($N = 24$) and both population of the largest community and population of the largest territorial unit on behalf of which government activities are initiated. The relationships reported in these studies are linear in logarithmic transformation.

Figure 21.1 uses Ember's data to illustrate the relationship between types of political officials and population sizes of the largest organizational (territorial) unit. Twenty-three of Ember's 24 cases are used here, giving a correlation between the variables examined of .828. One case (Thai: types of political officials = 100+, largest organizational unit = 20 million) was deleted as an

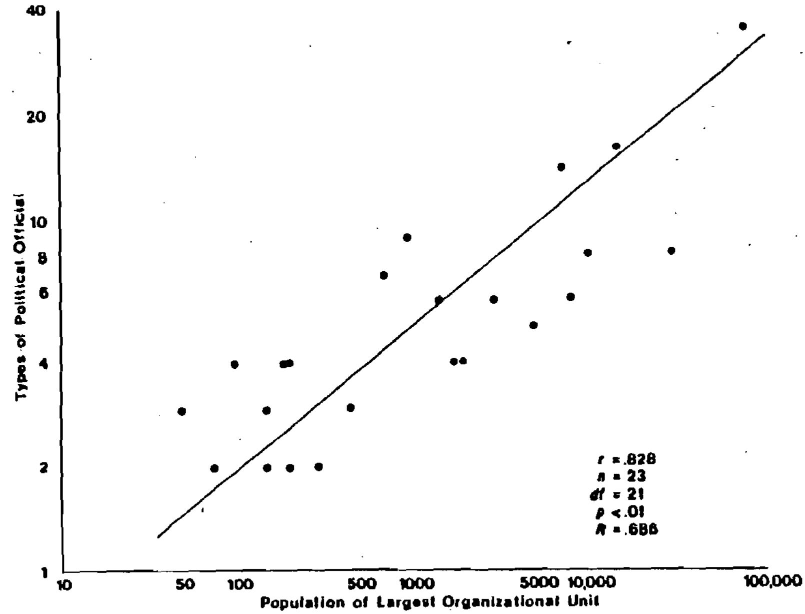

Figure 21.1. Societal scale and political complexity.

extreme value outlyer. If it were included in the analysis, the correlation would be increased to .905.

In any case, the relationship between system scale and organization evidenced in these studies is striking. As Carneiro (1967, 239) has put the matter: " . . . if a society does increase significantly in size, and if at the same time it remains unified and integrated, it must elaborate its organization."

A common reaction to this scale–complexity relationship has been to account for increasing complexity of social organization through population growth. Population–resource imbalance (population pressure) is often evoked as the source of stress to which organizational change is a response (Carneiro 1970, M. N. Cohen 1977, Harner 1970, Sanders, Parsons, and Santley 1979, Smith and Young 1972). Although subsistence stress may well have been a critical factor in particular cases, it is unlikely to have been a universal source of stress leading to increasing social complexity (Cowgill 1975, Hassan 1979).

Hassan (1975, 38), for example, makes an important distinction between hunter–gatherer population density and hunter–gatherer group size that is too often ignored. He notes that, in general, there is much less variability in group size than in environmental conditions. This would suggest that the linkage between resource availability and hunter–gatherer organization is looser than has often been assumed.

The difficulty of relating complexity of organization to population size through subsistence stress does not, however, eliminate the problem of accounting for the relationship between population size and organizational complexity that has been demonstrated so often. Perhaps one problem is that the relationship between population size and complexity is itself fairly loose, and it is most evident only when systems that differ considerably in size are compared.

Ember's (1963) data (illustrated in Figure 21.1) are instructive on this point. Examination of this plot of types of political officials on population of largest organizational unit suggests the presence of a differentiated cluster of data points at population size 50–500. Within this range, there is no correlation between population and number of political officials ($r = -.019$). Even in a second possible cluster of points incorporating a much greater population range (700–30,000), the correlation between size and complexity is only .431 ($p >$ 0.5). If these two ranges are combined, however, the size–complexity correlation is raised to .781 ($N = 22$, $p < .01$, R or $r^2 = .610$).

Table 21.1 summarizes these data on the effect of expanding the population-size range considered on the size–complexity correlation. This table incorporates data on Thailand originally considered by Ember, but deleted in Figure 21.1. Few would dispute the evolutionary importance of the relationship between social-system population size and social-system complexity, and it is tempting to argue simply that population growth generates complexity. Unfortunately, scale–complexity relationships are apparently more complicated than this.

The problem is that a very strong scale–complexity relationship is observable only when a very large range of system scale is examined. The relationship is weaker, if extant at all, when narrower ranges of variability are considered. This suggests that while there is an underlying process that governs the scale–complexity relationship, this process is subject to significant "local" variation.

I will try to deal with some of this local variation by suggesting that while scale is a critical factor in social change, population is not necessarily the best

TABLE 21.1
Effects of Population Range on Population–Complexity Correlations[a] (Variables in Logarithmic Transformation)

Population range	N	r	R
50–500	10	−.019	.000
50–1000	12	.612	.375
50–5000	17	.626	.392
50–10,000	20	.738	.545
50–75,000	23	.828	.686
50–20,000,000	24	.905	.819

[a]Data are from Ember 1963.

measure of scale. Many other measures of scale are possible, and I will focus here on what might be called "organizational scale."

The term *organization* has appeared several times in this chapter, and anthropologists are increasingly looking at societies as kinds of organizations (Claessen 1978, Flannery 1972, Johnson 1978, Peebles and Kus 1977, Service 1975, Synenki and Braun 1980, Wright 1977).

Viewing social systems as organizations has the salubrious effect of making a large body of literature outside anthropology relevant to the problems at hand. Varieties of organizations have been studied by sociologists, social psychologists, administrative scientists, and others. I will try to suggest that the insight gained by these studies may be very helpful in the investigation of ethnographic and archaeological cases of organizational change.

SMALL-GROUP STUDIES

Although organizations of very different sizes have been studied, it might be well to consider very small and simple groups first. Study of such minimal social organizations is the province of "small-group dynamics."

These organizations are composed of a very limited number of people and the groups of interest here are "task-oriented" (Mayhew and Levinger 1976, 1023). A variety of experimental studies have been undertaken in which group size ranges from about 2 to 20 or so, and group tasks involve problem solution (decision making). Two questions about such groups are of interest here. What are the effects of group size (number of individuals) on group performance, and what is the relationship between group size and group organization?

Figure 21.2 illustrates the results of a series of such studies (Cummings, Huber, and Arendt 1974) relative to a plot of group size against the number of possible pairs of individuals within groups of different sizes. The idea here is that potential exchange of information in group decision making should be a function of maximum potential group interaction, and maximum interaction is defined as a situation in which each group member interacts with every other group member on a one-to-one basis. The number of potential pair relationships within a group is thus taken as an index of potential information exchange.

Note that the number of pair relationships, $(n^2 - n)/2$ where n = group size, is nonlinearly related to group size (Dubin 1959). Increase in group size thus generates a disproportionately greater increase in potential information exchange. This power relationship between group size and number of group-member pairs is approximately linear in logarithmic transformation.

The data in Figure 21.2 suggest that there is some kind of organizational threshold (indicated by a dashed line) in groups of approximately six individuals. Note that:

1. The development of within-group leadership (hierarchical organization) appears to be most common in groups of six individuals.

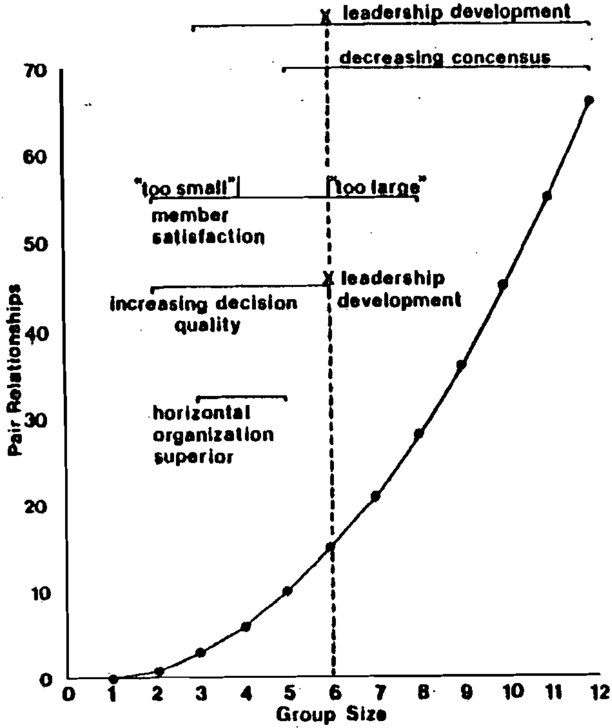

Figure 21.2. Scalar stress in small groups.

2. Horizontally organized (nonhierarchical) groups of greater than six members appear to be under some kind of stress as evidenced by decreasing concensus in decision making and decreasing member satisfaction with group performance.
3. In groups of less than six members, not only does decision quality increase with group size, but horizontally organized groups may exhibit superior performance in comparison to hierarchically organized ones. (See also Bridges, Doyle and Mahan 1968).

Increased interaction apparently facilitates problem solution, at least up to a point. Hierarchical organization at group sizes 5 and less would effectively decrease potential interaction.

If hierarchy development is related to some kind of scalar stress, why should it occur at around group size 6? Unfortunately this question is much more easily asked than answered.

One direction of inquiry involves examination of the capacity of an individual to monitor and process information. People do have a finite capacity for this activity, and experimental studies of both individuals and small groups reveal a general pattern of performance in which performance increases with demand to a level constrained by capacity, and then declines as capacity is exceeded and decision errors increase. The resulting performance curve has an "inverted-U" shape (Meier 1972). Miller (1956, 86) suggests that people have a span of absolute judgment of unidimensional stimuli that is limited by the amount of information (in bits) that must be processed, and a span of immediate memory limited by the number of items (information chunks) that can be simultaneously retained. Both spans are fairly narrow, and average about 7.

It is possible then, that the "scalar" stress evident in the small-group studies discussed earlier may be identifiable as "communications" stress occasioned by information-processing workloads exceeding individual capacities. Certainly, communications stress has been shown to produce various physiological changes, anxiety, and performance reduction in individuals (Meier 1972, 298) that would be consistent with the decreasing concensus and member satisfaction observed in small groups of greater than 6 members.

Figure 21.3 illustrates possible relationships among group size, communications load, and decision performance that might be expected if individual information-processing capacity is a limiting factor on nonhierarchical task-group size. Again,the number of pair relationships within groups of different sizes is used as an index of communications load. An approximate information-processing capacity (indicated by a dashed line) is set as equal to the communications load generated in a group of 6 members [load = $(6^2 - 6)/2 = 15$]. Below capacity, decision performance is here calculated as communications load as a proportion of capacity (e.g., when group size = 4, communications load = 6, and performance = load/capacity = 6/15 = .40). At and above capacity, performance is calculated as capacity as a proportion of communications load (e.g., when group size = 10, load = 45, and performance = capacity/load = 15/45 = .33). The resulting performance curve, if "rounded out" to some extent, approximates the "inverted-U" performance curves obtained from experimental studies on individuals and small groups.

Performance can be expected to increase with information-processing demand until approximate capacity is reached. It does not completely collapse after capacity has been exceeded, but degrades. The point at which some kind of organizational change is to be expected in response to stress is thus dependent not only on group size, but on "acceptable" performance levels. Acceptable decision quality can be expected to vary from one task situation to the next, and thus maximal possible group size may be expected to vary accordingly. Operation of this source of variability would give the performance curve illustrated in Figure 21.3 more of an inverted-U shape.

There appear, then, to be rather severe limits on the maximum size of task-oriented groups that are organized horizontally (nonhierarchically), and these limits may be related to individual information-processing capacity. A wide variety of studies suggests that an effective limit on group size is somewhere around six group members. This apparent constraint on operational task-group

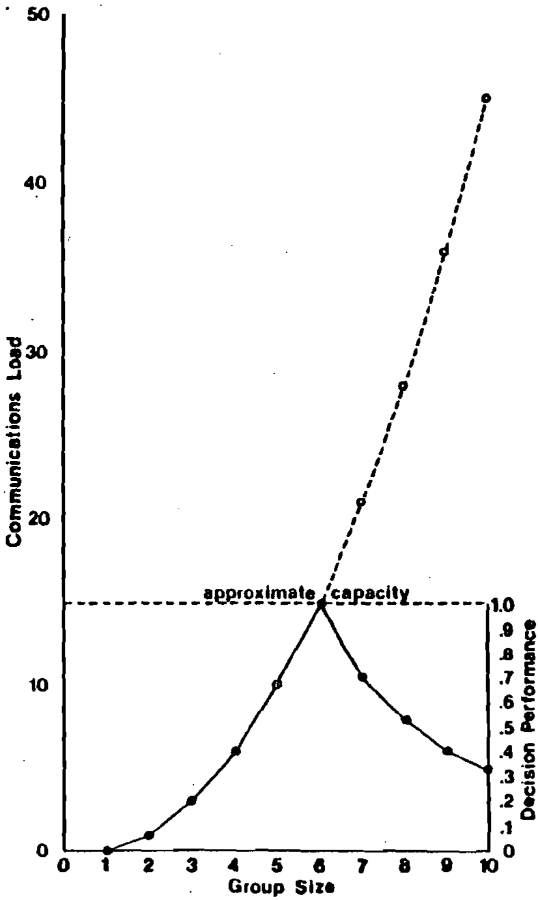

Figure 21.3. Scalar-Communications stress and decision performance.

size poses a theoretical problem when more traditional anthropological data are considered.

Human groups with little or no evidence of internal hierarchy are very common in the ethnographic and archaeological record. Not only are they common, but group sizes among egalitarian hunters and gatherers, for example, obviously far exceed the figure of six group members discussed here. A portion of this variability may be due to the fact that such groups are not in continual "face-to-face" interaction that is characteristic of the small-group studies discussed earlier. Group decision making in such societies is, however, based on consensus (Reynolds and Zeigler 1979), and achieving consensus requires such face-to-face interaction. Given the evidence discussed here on small-group dynamics, such egalitarian societies must have some mechanism to overcome the scalar-communications stress problem that does not involve what we would normally recognize as hierarchical organization.

SEQUENTIAL HIERARCHIES: AN EGALITARIAN ALTERNATIVE

I attempted to show in a previous publication (Johnson 1978) how increase in the number of information sources contained within an integrated system increases the probability of either system collapse or the development of hierarchical organization. These "information sources" were defined on a very general level as minimal relevant organizational units that might be territorial, population, residence, activity units, etc.

The structures developed in that model might be termed "simultaneous" hierarchies. These are hierarchies of the familiar sort in which system integration is achieved through the exercise of control and regulatory functions by a relatively small proportion of the population. Such functions may be exercised simultaneously at a number of hierarchically structured levels of control. As such, the entire control hierarchy "exists" at any given time.

System disruption or simultaneous hierarchy development may not, however, be the only alternatives available to deal with scalar-communications stress. If a problem is being generated by the presence of too many units in the system, it might be possible to make the operational size of these units (kinship groups, residence units, etc.) larger, and thus the number of units in the system smaller. Perhaps some illustrative ethnographic material would be useful here.

Ethnographic Cases

Two kinds of data are required for looking at egalitarian groups in terms of scaler stress:

1. Data on group organization involving kinds of social groups present and their sizes are required.
2. If an increase in operational unit size is to be analyzed in relation to scalar stress, data on scalar stress at different group sizes are also required. (The latter are, unfortunately, very difficult to find.)

The !Kung San, or žu/õasi as they call themselves, (Wilmsen 1980) of southern Africa are at least one group for whom both organization and stress data are available. Several different potential organizational units can be defined for the !Kung (Yellen 1977). All of these units can be observed "on the ground" in !Kung camps.

Large dry-season camps exhibit extended families made up of nuclear

TABLE 21.2
!Kung Groups and Organizational Units

Group	Organizational units	Units per group	
		Range	Mean
Dobe: Dry-season camps, $N = 2$ (Yellen 1977, 70–71)	Extended families	3–4	3.50
	Nuclear families	9–12	10.50
	Social units	12–15	13.50
	Adults	22–28	25.00
	Population	35–45	40.00
Extended families, $N = 7$ (Yellen 1977, 70–71)	Nuclear families	1–5	3.00
	Social units	1–7	3.86
	Adults	2–12	7.14
	Population	2–22	11.43
Rainy-season camps,[a] $N = 24$ (Yellen 1977, 147–236)	Nuclear families	2–6	3.08
	Social units	2–8	3.08
	Adults	3–15	7.13
	Population	7–24	14.83
Nuclear families, $N = 21$ (Yellen 1977, 70–71)	Adults	2–3	2.10
	Population	3–6	3.43
Social units, $N = 27$ (Yellen 1977, 70–71)	Adults	1–3	1.86
	Population	1–6	2.96

[a]Some camps had more than one occupation. These figures are based on individual occupations.

families, or social units, that in turn consist of individuals. (A "social unit" can be either a nuclear family or an individual occupying a separate hut.) Small rainy-season camps are made up of nuclear families, or social units, and their constituent individuals. Table 21.2 presents data on the sizes of these various organizational units derived from Yellen (1977).

Note that data reported from the large dry-season camp at Dobe represent upper-limit figures as, "Any !Kung with a hut at the camp was included, whether he was present most of the time or not. [Yellen 1977, 69]." Camp size

TABLE 21.3
!Kung Group Organization (Basal Units)

Group	Basal unit	Units per group		Mean group population
		Range	Mean	
Dry-season camp	Extended family	3–4	3.50	40.00
Rainy-season camp	Nuclear family	2–6	3.08	14.83
Extended family	Nuclear family	1–5	3.00	11.43
Nuclear family	Adult	2–3	2.10	3.43
Social unit	Adult	1–3	1.86	2.96

can vary considerably over time. Lee (1969, 66), for example, provides data on the number of people present at Dobe over a 28-day period from July 6 to August 4, 1964. While the average camp size was 30.9 people, the range over the 28 days was 22–40 (SD = 5.4).

Table 21.3 presents possible !Kung organization in simplified form. Social groups are viewed here as being composed of "basal units." As children contribute little to food supplies (Lee 1979, 67), adults are considered to be the basal units of nuclear families and social units. Nuclear families are the basal units of both rainy-season camps and extended families, while extended families are the basal units of large dry-season camps.

Note that although the mean population of social groups increases from the social unit to the dry-season camp (2.96–40.00), the mean number of basal units per larger social group is fairly constant at around 3 (mean = 2.71, range = 1.86–3.50). Note also that the range (1–6) of basal units that constitute a larger social group is very restricted and does not exceed 6.

I suggest that these data are consistent with those discussed earlier on small-group dynamics. Larger numbers of people can be accommodated with a horizontally organized social group by expanding the size of the basal units of which the group is composed. In the case of the !Kung, extended families appear in large dry-season camps where their constituent nuclear families occupy huts adjacent to one another.

The proposition that expanded basal unit size is a mechanism allowing larger !Kung aggregations can be partially evaluated with available data on serious disputes in !Kung camps. These disputes appear to reflect problems in the organization of the economic system, in that they most commonly involve "Accusations of improper meat distribution, improper gift exchange (hxaro), laziness, and stinginess. . . [Lee 1979, 372]." I suggest that these disputes minimally represent failures to reach consensus, which in a consensus-based decision-making system reflect degraded decision performance.

Quality of decision performance should be inversely related to scalar-communications stress (among other things), and !Kung dispute frequency is apparently scale dependent. Lee (1979, 366) reports that while at camps like Dobe and Mahopa (population 40–60) serious disputes occur at a rate of only three or four a year, dispute frequency is about one every two weeks at a much larger camp like /Xai/xai (population 100–150).

Consider the following propositions:

1. If dispute frequency among the !Kung is the product of scalar stress, then some measure of group size should predict dispute frequency.
2. If extended families are operationally the basal units of organization in large camps, then number of extended families should predict dispute frequency more accurately than other possible group-size measures such as gross population, etc. Data allowing evaluation of these propositions is presented in Table 21.4.

TABLE 21.4
Estimating Scalar Stress in !Kung Camps

	Population = 100		Population = 150	
Camp: /Xai/xai	Unit frequency	Scalar stress	Unit frequency	Scalar stress
Basal units				
Extended families	8.7	33.5	13.1	79.2
Nuclear families	29.2	411.7	43.7	933.0
Social units	33.8	554.3	50.7	1259.9
Adults (.63)	63.0	1953.0	94.5	4417.9
Adults (.71)	71.0	2485.0	106.5	5617.9
Population	100.0	4950.0	150.0	11,175.0
	Population = 40		Population = 60	
Camps: Dobe and Mahopa	Unit frequency	Scalar stress	Unit frequency	Scalar stress
Basal units				
Extended families	3.5	4.4	5.2	10.9
Nuclear families	11.7	62.6	17.4	142.7
Social units	13.5	84.4	20.3	195.9
Adults (.63)	25.2	304.9	37.8	695.5
Adults (.71)	28.4	389.1	42.6	886.1
Population	40.0	780.0	60.0	1770.0

The goal here is not to predict absolute dispute frequency, but relati frequency by camp size. Six possible measures of camp size are used: number extended families, nuclear families, social units, adults (two estimates), ar population. Two estimates of the number of adults are used, because while L (1979, 46) notes that children constitute some 29% of the population in tl Dobe area (adults = 71%), Yellen's data indicate a figure closer to 37% (adul = 63%).

Smaller and larger estimates of scalar stress are made because Lee gives h camp-size data relative to disputes in ranges (Dobe and Mahopa 40–60 peopl /Xai/xai 100–150 people). The number of different possible organization units (extended families, nuclear families, etc.) likely to be present in camps these sizes was calculated from the mean units-per-group data in Table 21. Given, for example, a camp-population size of 100 and an average extend family size of 11.43, that camp is estimated to contain 8.7 extended famili Similarly, one would expect 13.1 extended families in a camp of 150 peopl

These smaller and larger frequency estimates were then converted into scal stress indices using the formula $(n^2 - n)/2$ where n = the basal-unit frequen estimate. For example, an estimate of 8.7 extended families in a camp of 1 people would be associated with a scalar-stress index of 33.5. The formula used here is the same as that for number of "pair relationships" or "communications stress" used previously in Figures 21.2 and 21.3.

Finally, these calculations were made separately for the population ranges reported at Dobe and Mahopa, and /Xai/xai. The result is a series of scalar-stress indices based on different basal-unit scale measures for the two relevant population ranges.

Table 21.5 uses these indices and the dispute data to evaluate the propositions stated earlier. When standardized to yearly estimates, Lee's dispute data can be expressed as a ratio range of 1 dispute per year of occupation at a smaller camp (Dobe or Mahopa) to 6.50–8.67 disputes per year at a larger camp (/Xai/xai). An average figure would be 1 dispute at a smaller camp to 7.59 disputes at a larger one.

The scalar-stress indices over six scale measures for the smaller and larger camp population ranges cited by Lee were then used to calculate expected dispute ratios between smaller and larger camp sizes. Calculation of expected dispute ratios can be illustrated with the following example.

Note from Table 21.4 that the smaller population size of a larger camp (/Xai/xai) is 100. A camp of 100 individuals is expected to contain (on the average) 8.7 extended families. The scalar-stress index associated with 8.7 extended families is 33.5. Similarly, the smaller population size of a smaller camp (Dobe or Mahopa) is 40. A camp of 40 is expected to contain approximately 3.5 extended families, and the scalar-stress index associated with this figure is 4.4. The expected dispute ratio between the smaller and larger

TABLE 21.5
!Kung Camps: Observed and Expected Ratios of Serious Disputes

	Smaller estimate[a]	Larger estimate[b]	Average estimate
Observed disputes	1:8.67	1:6.50	1:7.59
Expected disputes	Smaller estimate[c]	Larger estimate[d]	Average estimate
Basal units			
Extended families	1:7.61	1:7.27	1:7.44
Nuclear families	1:6.58	1:6.54	1:6.56
Social units	1:6.57	1:6.43	1:6.50
Adults (.61)	1:6.41	1:6.35	1:6.38
Adults (.71)	1:6.39	1:6.34	1:6.37
Population	1:6.35	1:6.31	1:6.33

NOTES:
[a]Assumes three disputes per year at Dobe or Mahopa.
[b]Assumes four disputes per year at Dobe or Mahopa.
[c]Based on lower end of camp size ranges.
[d]Based on upper end of camp size ranges.

camp sizes is taken as the ratio of their associated scalar-stress indices—4.4:33.5 or 1:7.61.

This process is then repeated for the larger population-size figures of both th smaller and larger camps. For a larger camp, population = 150, expecte extended families = 13.1, and associated scalar stress = 79.2. For a smalle camp, population = 60, expected extended families = 5.2, and associate scalar stress = 10.9. The expected dispute ratio is then 10.9:79.2 or 1:7.27.

Now we have two expected dispute ratios based on the number of extende families as a scale measure. The first ratio (1:7.61) was calculated from th smaller population figures of 100 and 40. The second ratio (1:7.27) wa calculated from the larger population figures of 150 and 60. The final expecte dispute ratio is taken as the average of the smaller and larger estimates. In thi case, it is the average of 1:7.61 and 1:7.27, and thus = 1:7.44. These ratio appear in Table 21.5 along with those based on the remaining five possible scal measures.

Note again that the average expected dispute ratio based on extended familie is 1:7.44, reasonably close to the average observed figure of 1:7.59. Note als that the other possible scale measures are consistently poorer estimators c disputes, and that the poorest of these is group population. (The error associate with the extended-family-based estimate is 2%, while that associated with th estimate based on gross population is 17%.)

The primary results of this analysis are that first, the number of extende families is the best (and quite accurate) predictor of relative dispute frequenc Second, an exponential function of this scale measure is required for accura prediction. (Recall that it was scalar-stress indices that were used to calcula expected dispute ratios. Untransformed frequency estimates yield quite di ferent results. The predicted average dispute ratio based on simple extende family frequency would be 1:2.50, the same figure as that based on u transformed population size. The error associated with these estimates would t 67%.)

I would draw three conclusions from these results. First, dispute frequency a function of scalar–communications stress. Second, this stress is an e ponential function of organizational scale. Third, organizational scale is be measured in terms of number of basal organizational units, which may or m not be equivalent to the number of individuals. These conclusions ha implications for the organization of smaller !Kung aggregates.

If the dispute frequency at /Xai/xai, where the extended family is apparent the basal organizational unit, is taken as indicative of "high stress," at wh point would similar stress levels be reached under other organizational mod (such as the adult or the nuclear family) as the basal organizational unit? T question is investigated in Figure 21.4, where three scalar-stress curves a given, based on number of adults, nuclear families, and extended families.

These curves were constructed using the mean nuclear- and extended-fam sizes from Table 21.3, and considering adults to constitute 71% of t

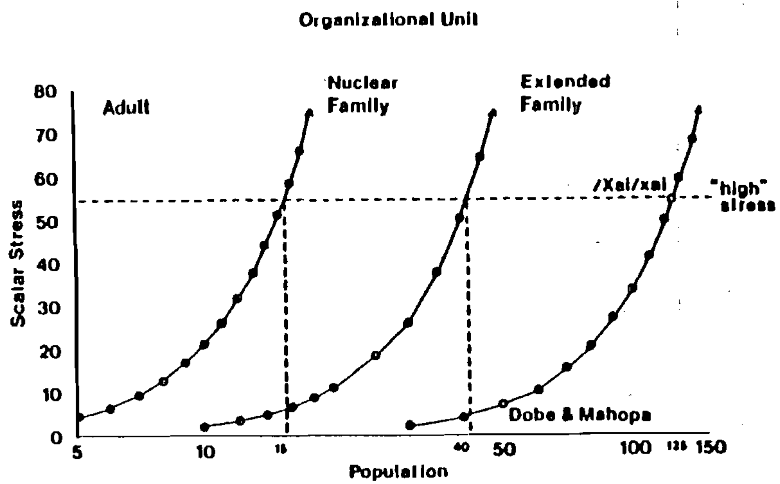

Figure 21.4. Scalar stress and !Kung organization.

population (Lee 1979, 46). The number of adults, nuclear and extended families expected in populations of different sizes were transformed into scalar-stress indices following the procedure discussed earlier, and then plotted against population size. The positions of /Xai/xai and Dobe and Mahopa on the extended-family scalar-stress curve are indicated by open circles.

Note that the "high-stress" line at /Xai/xai (average size 125 people, extended families = 10.9, scalar stress = 54.) intersects the nuclear-family scalar-stress curve at just over population size 40. This would suggest that an organizational transition from nuclear to extended families could be expected at about this population size. Yellen's data (Table 21.2) shows extended families at camp population size 35–45.

The same "high-stress" line intersects that adult stress curve in Figure 21.4 at just over 15 people, suggesting that nuclear families should be the basic organizational unit for groups of approximately this size. Recall that nuclear families are the basal units of rainy-season camps and that these camps have an average size of 14.83 people.

Groups of adults in rainy-season camps would appear to be under similar constraints as groups of nuclear families in dry-season camps. In the former case, groups of adults are combined into nuclear families. In the latter case, groups of nuclear families are combined into extended families.

The available data, even if limited, suggest that !Kung organization incorporates an operational hierarchy. This is apparently not the kind of simultaneous hierarchy with which we are so familiar, but something that might be called "sequential" hierarchy.

Introduction of new terms such as this normally should be avoided, but i seems necessary in this case. The problem is one of describing the hierarchica organization of a nonhierarchically organized group. Evidently something in ou anthropological concept of hierarchy is lacking.

I mentioned before that normal (what I have called "simultaneous") hierarchies imply the exercise of integrative and control functions by a minorit over the majority of a population. It does not seem useful to describe th consensus-based !Kung in these terms. I find it difficult, however, to characterize sequential hierarchy. While the "hierarchic" organization of the !Kun seems reasonably clear in light of the material presented previously, I do no know how it works.

One possibility may involve sequential decision making. If concensus wer achieved first within nuclear families, then within extended families, a grou decision would only require concensus among extended families. Discussion a the extended-family level, however, might often require a new concensus to b reached at lower levels, and the whole process is likely to be often length Sequential achievement of concensus should imply sequential suppression c disputes, and one might expect dispute frequency to be directly related t kinship distance (Sahlins 1972, 196).

Such sequential decision making might be observed in the field simply i terms of individual interaction rates that are inversely related to kinshi distance. In this case, operational-unit boundaries would also function a information filters reducing what would otherwise be a very high-stress con munications load on individuals.

If the specific mechanism(s) of sequential hierarchy is unclear, so are tl limits of its ability to integrate increasingly larger social groups. While groups 125 !Kung are under high scalar stress given !Kung organization, group size egalitarian societies may be considerably higher. What if, for example, larg social aggregates such as clans were basic operational units?

Table 21.6 presents data on clan organization in highland New Guin derived from Brown and Podolefsky (1976). While New Guinea groups a egalitarian in social organization, they do incorporate so-called "big-men" wl exercise hierarchically differentiated integrative and control functions. Lead ship in big-man societies is, however, typically a temporary affair (Sahli 1963) and does not represent a well-established simultaneous hierarchy.

Note in Table 21.6 that while size of the local exogamous clan and size of t largest political unit of which they are a part show a great deal of variation, t mean number of such clans per political unit has very little variability. T range in these data is from 1.24 to 7.50 exogamous clans per largest politi unit, with a mean of 4.22. Operational clan groups in New Guinea would tl seem to be under very similar scalar constraints as !Kung extended-fam aggregations. These scalar constraints are not in terms of population, but terms of number of operational units per larger aggregation.

Given the presence of emergent simultaneous hierarchy in New Guir

TABLE 21.6
Clan Organization in Highland New Guinea[a]

Group	Mean population of local exogamous clan	Mean population of largest political unit	Mean number of clans per unit
Gahuku Gama	100	750	7.50
Mae Enga	350	2290	6.54
Maring	40	200	5.00
South Fore	39	180	4.62
Siane	200	840	4.20
Kyaka Enga	200	800	4.00
Bena Bena	188	750	3.99
Raiapu Enga	270	1072	3.97
Chimbu	650	2400	3.69
Kapauku	200	600	3.00
Mt. Hagan	280	820	2.93
Kakoli	383	474	1.24
$N = 12$			
$\bar{X}$	242	875	4.22
S.D.	168	751	1.63
Range	39–650	180–2400	1.24–7.50

[a]Data from Brown and Podolefsky (1976, 218).

represented by big-men, these data may represent the upper range of sequential hierarchy for sedentary groups. Certainly these New Guinea groups are under considerable stress, for, as Brown (1978) notes, the area is characterized by high levels of warfare, and larger tribal or alliance groups are highly unstable.

Increase in sequential hierarchy implies increasing difficulty in the decision process as consensus must be reached at a greater number of operational levels. The complexity of the decision process is related, however, to additional factors beyond organizational scale. One might expect, for example, that decision complexity in the realm of subsistence organization is inversely related to resource predictability. If this is the case, one might further expect that the integrative potential of sequential hierarchy is directly related to resource predictability (other things being equal). Other things are very seldom equal, however, and determinations of the local constraints on potential sequential hierarchy is likely to be a very complex affair.

These problems aside, elaboration of essentially horizontal social organization in sequential hierarchies decreases the complexity of regulating social relationships—a nice example of Ashby's (1968, 135) "law of requisite variety." Given that groups of 6 and more individuals are under increasing scalar stress, and if approximately 25 and 500 represent minimum equilibrium group sizes for hunters and gatherers under specifiable demographic conditions (Wobst 1974), it would appear that sequential hierarchies should be a basic feature of egalitarian societies.

Ritual and Sequential Hierarchies

Elaboration of sequential hierarchy is unlikely to be the only social mechanism allowing large aggregations among egalitarian groups. Ceremony, ritual, or what might be called "generalized feather-waving" is probably another. Scale-dependent ceremonial activity is commonly reported for egalitarian groups (Lee 1979, Gross 1979, Bohannan 1967).

Gross (1979) presents a particularly interesting case from Brazil. Many central Brazilian groups are something of an anthropological problem in that, while politically egalitarian, they exhibit very large aggregations and very complex social and ritual organizations. These groups are fragmented into small, nomadic foraging units for most of the year, but aggregate into villages of up to 1400 people for the horticultural rainy season. The extended family is the smallest nondivisible economic unit, and social organization involves varied mixes of age sets, formal friendships, nondescent "moieties", men's societies, etc. Sequential hierarchy would appear to be the order of the day during these annual agglomerations.

Ceremonial activity is particularly intense in these rainy-season villages. "Several authors report that no sooner has one ceremonial been staged than preparations for another begin, although there apparently is no fixed annual cycle of ceremonials for most groups [Gross 1979, 328]." Both ceremony and elaboration of social organization are scale dependent, in that " . . . little of the social elaborateness reported for village aggregates is present in the small foraging units, and ceremonialism appears to atrophy in villages which become seriously depopulated [Gross 1979, 330]." Gross (1979, 334) argues that both social and ceremonial organization serve integrative functions that allow maintenance of large-group size for the horticultural period of the annual subsistence cycle.

There are a variety of ways in which ceremony might reduce scalar stress. Ceremonial activity typically involves a great deal of stylistic variability ir dress, ritual paraphernalia, etc., and the importance of style as an information transfer device has been emphasized by Wobst (1977) and Conkey (1978) Passive stylistic signaling of individual subgroup affiliation, etc., may reduce th active communications load associated with larger aggregations. Participatio in ceremony that prescribes patterns of behavior and interaction may reduc required integrative decision making, and ceremony may provide a socia context for organizations that have nonceremonial integrative functions (se Plog 1978, 360, on the latter possibility.) Indeed, general arguments fo ritual regulation of important aspects of subsistence and social systems are we known (Rappaport 1968, 1971).

"Feather-waving" may operate in such a manner as to simply reduce th operational size of the social group and thus reduce scalar stress as well. Le (1979) notes, for example, that traditional !Kung aggregations were a time f curing (and other) ceremonies. The more people participating in suc ceremonies. the more efficacious they were thought to be. One result of suc ceremonies was to put the burden of food acquisition on a smaller group of people than would otherwise be the case. Operational group size for coordination of the subsistence system was thus reduced.

This is not the place to get deeply involved in the complex topic of ritual and ritual functions. I think that it is important to note, however, that ritual is often scale dependent, and I suspect that it may often serve to reduce the kind of scalar–communications stress discussed in this chapter. It may be tempting to interpret archaeological evidence of increasing ritual behavior as evidence of particularly "successful" system operation. Upper Paleolithic art in Europe or the Neolithic "shrines" of Catal Hüyük in Turkey (Mellaart 1967) generally have been viewed in this manner. Intensification of ritual, however, may signal a system in trouble rather than one doing particularly well. Conversely, absence of elaborate ritual need not be taken as evidence of a benighted population so occupied with a struggle for subsistence that they have no time for more "intellectual" affairs. (Consider the earlier European Mesolithic, for example.)

Although ritual often appears to be scale dependent, scalar thresholds vary. Other things being equal, I would expect scalar stress to be reflected in ceremonial elaboration at smaller population sizes among groups with smaller basal-unit sizes than for those with larger basal-unit sizes. This, simply, is because a system with a larger basal-unit size can incorporate more people than a system with a smaller basal-unit size at an equivalent scalar-stress level. This appears to be the case in comparing the !Kung with the central Brazilian groups discussed by Gross, and similar patterning should be evidenced archaeologically.

European Bandkeramik settlements, for example, contain little if any artifactual evidence for ceremonial activity. Bylany in Czechoslovakia is one of the better known such settlements, and Soudský and Pavlů (1972, 322) present data on seven occupational phases at the site, suggesting the presence of an average of 16.7 nuclear families grouped into 7.3 extended families per phase (range = 6–9). Many southeastern European neolithic villages are estimated to have had similar population sizes, but nuclear-family residence units. These settlements are also famous for their figurines and other "elaborate" artifacts suggesting intensive ceremonial activity (Milisauskas 1979, Tringham 1971).

Accounting for Organizational Units and Organizational Growth

Egalitarian-group size appears to be constrained by the degree to which sequential hierarchy, and possibly ritual, can mitigate scalar stress. (There are, of course, other constraints on size.) There is, however, considerable variability in degree of sequential hierarchy among egalitarian groups and associated variability in group size. Predicting stress points at which either fission or simultaneous hierarchy development is likely to occur requires knowledge of underlying group organization. Simple knowledge of group-population size is unlikely to be very useful in predicting stress points, because of th organizational reasons discussed earlier.

Accounting for egalitarian group population size will thus, in part, requir accounting for group organization. It seems very unlikely to me the organization is simply a response to scalar stress. We need to know more abo the nonscalar determinants of organizational unit size. Pasternak, Ember, an Ember (1976) have suggested, for example, that the presence of extende family households may be related to activity-scheduling difficulties encounter at a smaller residence unit size. Netting (1974, 29–30) reviews similar studi suggesting that residence unit size is related to labor requirements and form land tenure. Thus while some aspects of social organization, ritual, etc., may l identified as direct responses to scalar stress, others may have develop through different processes but have implications for response to stress.

An equally important problem involves accounting for the system growth th generates scalar stress. It is important, perhaps even vital, to recognize th there is a substantial difference between organizational growth and populati growth. Population on the Susiana Plain of southwestern Iran increased estimated 33% during the immediate period of state formation in the ar Administered population, on the other hand, increased an estimated 118 during the same period (Johnson in press).

When hunters and gatherers aggregate into large camps, organizatio growth has occurred while population growth has not. I suspect that many ca of colonial intervention in indigenous societies have generated simultane population decrease and organizational growth though forced sedentarizatior aggregation.

Expansion of organizational and/or population size probably often is rela to demand for labor (White 1973). As R. Cohen (1978, 42) no "Sedentarization is associated with an increased demand for persons among groups, settlements and domestic units." In is phrase, "person acquisiti becomes increasingly important (see also Bargatzky 1981). Whether or organizational growth involves population growth, sequential hierarchy h limited ability to deal with scalar stress, and either group fission or developn of simultaneous hierarchy is expected.

SIMULTANEOUS HIERARCHIES: THE NONEGALITARIAN IMPERATIVE

Although the integrative functions of simultaneous hierarchy are clear mechanisms of hierarchy development are not. Mayhew and Levinger (1 have formulated a model for the development of a differentiated power stru (differential control by individuals) in small, face-to-face groups. The mo based on individual information-processing constraints, and suggests that in the context of random interaction, the probability of differential domin of interaction increases as a function of group size. Most probable constraint values suggest development of differential control at around group size 7 (Mayhew and Levinger 1976, 1030).

I view their approach as complementary to the persepective presented here. I would suggest that either sequential or simultaneous hierarchy development (or system collapse) are responses to scalar communications stress and degrading decision performance with increasing organizational scale. Mayhew and Levinger would see what I have termed simultaneous hierarchy development as a probabilistic function of increasing group size. Both processes are scale dependent and could operate simultaneously.

Within the limits imposed by the regulatory potential of essentially egalitarian sequential hierarchies, simultaneous hierarchy or group fission is clearly the price of increasing organizational scale. Given the variability in sequencial hierarchies in the ethnographic record, and the very small organizational scale at which either communications stress or the Mayhew–Levinger model operates, we should have evidence of simultaneous hierarchy development at relatively small group sizes—this aside from the evidence on small-group dynamics discussed earlier.

It is now commonplace to suggest that many groups of egalitarian hunters and gatherers were not so egalitarian after all. Differentiated leadership and ascribed-status hierarchies have now been suggested for any number of cases such as the Natufian (G. A. Wright 1978), prehistoric Great Basin (Bettinger 1978), prehistoric central California (King 1978), and perhaps groups of the later northern European Mesolithic (Price 1980).

While these and other cases of simultaneous hierarchy development are being increasingly recognized, it is also apparent that group fission has been a much more common response to scalar stress. R. Cohen (1978, 53) notes that fissioning is characteristic not only of egalitarian groups, but of prestate polities in general. Suppression of fissioning is most often accounted for by some kind of social or environmental circumscription following Carneiro's (1970, 1978) position on the matter. Groups do not fission because the fission products have no place to go.

Scalar increase, however, may have advantages as well as disadvantages. Yellen (1977, 69) notes a positive correlation between !Kung camp size and duration of occupation. He attributes this to advantages of scale. Larger groups can commit more personnel to activities having a low probability of return but potentially high yield, such as hunting. Greater group size in the context of dispersed activities generates increased acquisition of information on resource availability.

There are informational economies of scale, but these are difficult for nonhierarchically organized groups to exploit. Indeed, limitations on nonhierarchal information processing have been suggested recently as effective contraints on the number of hunter–gatherer groups that can exploit a given area (Moore in press), or the size of a region maximally exploitable by a given group (Reynolds and Zeigler 1979). Informational as well as economic advantages of scale (Johnson 1977, 489) suggest that simultaneous hierarchies may well develop as a response to scalar stress, in the absence of fission-inhibiting group circumscription.

Simultaneous Hierarchy and Social-Status Differentiation

I have suggested elsewhere (Johnson 1978) that status ascription and social ranking may be associated with the development of group control-hierarchies. Two operational problems of hierarchical control were identified: decision implementation and decision making. Given the observation that social-status differences are often used to structure or supplement differential influence in hierarchical organizations (Sutherland 1975, 290, Udy 1970, 48), I suggested that the association of leadership functions with high status would facilitate implementation of leader decisions. Status ascription through inheritance would similarly resolve problems of leadership recruitment, training, and continuity that would otherwise inhibit effective decision making in the long term.

The association of status differentials with differential access to resources, which is characteristic of many systems, is a different problem. It seems reasonable to suggest that some degree of control of resources (land, labor, production, etc.) is required for coordination and regulation of their utilization. To the extent (usually considerable) that hierarchical organizatons are engaged in such integrative activity, there should be a positive relationship between position in such a hierarchy and resource access. Higher positions should be associated with greater access to resources than lower positions. If social status is also associated with relative hierarchical position, then status and resource access should covary. The suggestion here is that integrative function, social status, and access to resources may be functionally related to one another. These relationships can, however, be expected to be complicated in complex societies characterized by multiple and overlapping integrative hierarchies.

I might note that this suggestion is very different from that of Davis anc Moore (1945) that has generated so much debate in sociology. (See Abra-hamson 1973, Broom and Cushing 1977 for recent discussion). They sug-gested that social and economic stratification systems represent a differentia system of rewards to ensure performance of functions of differential importance The suggestion here is that differential access to resources is a structura consequence of a hierarchically ordered integrative-control system. (This doe not, by the way, imply the absence of other mechanisms of socioeconomi differentiation.)

A detailed argument for the functional relationship of hierarchical positior status, and wealth would not, of course, necessarily account for the initi development of these differentials. Mayhew and Schollaert (1980) hav developed a model for the development of inequality in status characteristic (wealth, power, prestige, etc.) that generates inequality as the result of a scale-dependent random process. Application of their perspective would require only that the limits of sequential hierarchy had been reached for a given system, and that group fission had been inhibited either by circumscription or by economies of scale.

Whatever the specific processes generating functional, social, and economic hierarchies in particular cases, the resulting organizations are far more similar to those studied by sociologists than are the simple, relatively egalitarian systems discussed thus far. Anthropological study of these more complex systems could well benefit from many of the concepts used in the investigation of variability in complex organizations. *Span of control* is one such basic concept.

Span of Control

Span of control refers to the number of individuals or organizational units directly subordinate to a given individual or organizational unit within a hierarchical structure. Span is said to range from narrow, with few subordinates, to wide, with many. Studies of a wide variety of organizations have produced the empirical generalization that the range of variation in observed span of control is narrow, and that an optimum span may be somewhere around the interesting figure of 6 (Urwick 1956, 41).

To cite a few examples, Pugh *et al.* (1968, 104) report an average span for chief executives of 52 organizations in the area of Birmingham, England, to be 6.08 (range = 2–14, S.D. = 3.08). These organizations ranged in number of employees from 251 to 16,500, and were very diverse. "They include firms making motor cars and chocolate bars, municipal departments repairing roads and teaching arithmatic, large retail stores, small insurance companies and so on" (Pugh *et al.* 1968, 67)

Klatzky (1970, 433) reports, in a study of 53 state and territorial employment agencies in the United States, that the average number of major subdivisions per agency is 6.6 (range 2–13, S.D. 2.5). These agencies varied in number of employees from 50 to 9078 (mean = 1194.7, S.D. = 1675).

Jones (1966, 65) provides data on local communities controlled by subchiefs in the state organization of Basutoland in 1938. Local communities averaged about 183 tax-paying males (range = about 88–253, S.D. = about 46.7), and subchiefs had an average span of control of 5.13 ($N = 8$, range = 2–11, S.D. = 2.75).

Skinner (1977, 305) reports that the average span of control for prefectural level units of the field administration of Late Imperial China was between 5 and 6, with a range of 1 to 24. This large range is interesting, and I will return to it later.

Carzo and Yanouzas (1969) report an experimental study that bears directly on this question. They compared decision performance in two types of organizations, each with 15 members. The first type had a single executive with a span of control of 14. The second type of organization was structured in four levels, with a span of 2 for each but the lowest level. Not surprisingly, the organization with the span of 2 showed significantly higher performance levels than that with a span of 14.

It appears, then, that these complex organizations may be under very similar structural constraints as the egalitarian societies discussed earlier in this chapter. Table 21.7 reviews data presented earlier on !Kung rainy-season camps, highland New Guinea tribal or alliance groups, Basutoland subchief territories, and Klatzky's data on employment agencies. Taken as a group of 97 organizations, organizational population ranges from 7 to 9078. Organizational unit (nuclear family, local exogamous clan, local community, major subdivision) population ranges from 3 to about 698. Horizontal span shows much less variability, from 2 to 13 with means from 3.08–6.60. These figures

TABLE 21.7
Horizontal Spans of Organizations

	Organization population	Basal unit population	Horizontal span
ID	!Kung rainy season camp ($N = 24$)	Nuclear family	
Range	7–24	3–6	2–6
Mean	14.83	3.43	3.08
S.D.	5.16	1.36	1.35
ID	New Guinea tribe or alliance ($N = 12$)	Local exogamous clan	
Range	180–2400	39–650	1.24–7.50
Mean	875	242	4.22
S.D.	751	168	1.63
ID	Basutoland[a] subchief territory ($N = 8$)	Local community	
Range	352–2011	ca. 88–253	2–11
Mean	951.3	ca. 183.0	5.13
S.D.	581.5	ca. 46.7	2.75
ID	Employment agency ($N = 53$)	Major subdivision	
Range	50–9078	ca. 25–698	2–13
Mean	1194.7	ca. 181	6.60
S.D.	1675.7	?	2.50

[a]Population figures = tax-paying males.

are remarkably similar, and are consistent with the experimental results on small-group decision making discussed earlier.

Constraint on span of control has some interesting implications for degree of control in simple hierarchies. Recall that egalitarian organizations incorporating six or more basal units are under increasing scalar stress. Development of simultaneous hierarchy with a single vertical control-unit (chief, etc.) would imply that this single unit would have a span of control of 6+. Such a span could itself be a source of scalar stress on the control unit, and I would expect horizontal differentiation of this unit (multiple chiefs) along territorial or activity lines. Territorial differentiation might simply be reflected in a mosaic of relatively small and "autonomous" groups, each with a single integrative and control unit (see also Johnson 1978, 94).

The high probability of differentiated highest-order control in simple hierarchies suggests that the degree of control exercised by any given unit is structurally limited. Differentiation of second and subsequent levels of hierarchy, however, should allow concentration of power not possible in simpler systems. As Wirsing (1973) has shown with ethnographic data, there is a positive relationship between levels of hierarchy in a society and degree of power exercised by its control mechanism.

Variability in Span of Control

Skinner's (1977) data on span of control for prefectual-level units of Late Imperial China indicate an average span of between 5 and 6, but a wide range of variation from 1 to 24. He notes that wide spans were found in regional core areas where formal administration was concerned almost exclusively with tax collection. Other regulatory functions were exercised through political mechanisms outside the structure of formal field administration (Skinner 1977, 336). Narrow spans were associated with regional peripheries where, along with tax collection, a high degree of social control was required in areas of potential military disruptions (Skinner 1977, 321). Span of control was thus inversely related to the variety of activities for which the field administration was responsible.

This pattern of variability in span of control agrees well with results obtained on other types of organizations in which span width is inversely related to task complexity or scope of unit responsibilities (Blau 1968, 460). Unusually wide spans were possible in regional core areas of China because of the operation of an dual hierarchy, allowing reduction in the scope of responsibilities of the formal adminsitrative system.

Span of control may also vary with degree of control exercised by an organization on its component parts. Variability of this sort should be particularly common in cases of developing complex societies of interest to anthropologists. We might well expect to see a decrease in span of control within such societies as the degree of control exercised by administrative elites increases (see Johnson in press for an archaeological example).

Span of control must be maintained within relatively narrow limits if a relatively high degree of control is to be maintained. System growth, then should often generate an increase in the hierarchical complexity of systen organization. It should be no surprise, therefore, that those who study moden organizations have been interested in the relationship of organizational scal and complexity.

Size and Structure

The literature on organization contains a very wide variety of studies of th relationship between organizational size and various measures of organization complexity (see Scott 1975 for a review). Although results of specific studi are highly variable (probably because organizational population is the mo common measure of size), Blau (1970, 201) concludes that "(1) increasi organizational size generates differentiation along various lines at decelerati rates; and (2) differentiation enlarges the administrative component organizations to effect coordination."

One implication of these empirical generalizations is that while the absol number of administrative personnel increases with organizational size, th relative number generally declines (see also Campbell and Akers 1970). Tl phenomenon may also characterize nonmodern systems.

Although data of this sort are difficult to obtain from the ethnograpl literature, Ember's (1963) material discussed earlier may provide a reasonal approximation of size-controlling component relationships. Recall that Eml provided data on system size (largest political unit) and the number of types political officials for 24 societies. These data can be used here if we assume t the number of types of political officials is proportional to the number political officials.

As in Figure 21.1, Figure 21.5 presents 23 of Ember's 24 cases. If type political officials are transformed into types of officials per 1000 populatio the largest political unit, there is a very clear inverse relationship betw officials per 1000 and the largest organizational unit size ($r = -0.962$, I .925). (Addition of Ember's twenty-fourth case, Thai, increases this correla to −.980.)

These data contain what would appear to be a basic contradiction. If sc stress increases as a function of size, how can an increment in the appa response to stress decrease with increments in size? The size of b organizational units must be increasing, while the size of the system itse increasing. One would expect the basal units in Ember's data to increase example, from the nuclear family to the extended family to the house cluster, clan, village cluster, etc. This unit-size increase with system s

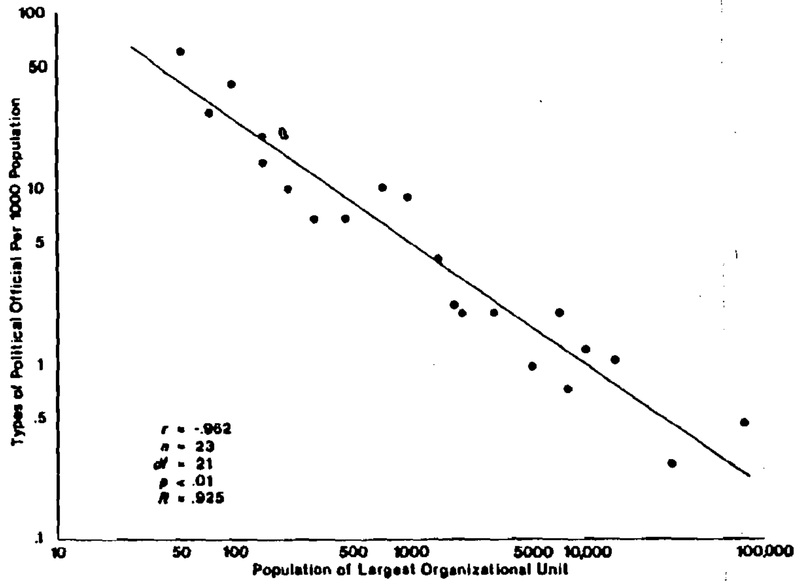

Figure 21.5. Societal size and relative size of controlling component.

occurs in modern organizations (Blau 1970, 207), and suggests that sequential hierarchies may not lose their importance with the development of simultaneous hierarchies.

I suggested earlier that access to resources may be associated with individual position in a control hierarchy. If the relative size of the controlling component of an organization is inversely related to system size, then increasingly fewer people (proportionally) will have access to increasingly greater resources (absolutely). Effective stratification should become increasingly pronounced. As Sahlins (1958, 249) notes in his study of social stratification in Polynesia, "It was suggested, therefore, that stratification is directly related to productivity, [and] productivity was *measured by the number of people embraced in the largest redistributive network* of food and how frequently this overall network was utilized [emphasis added]."

Organizational Limits to Growth?

Are there inherent organizational limits to growth? This is one of those questions to which the answer is both "yes" and, perhaps, "no." Carneiro (1978) looks at the decrease in the number of autonomous political units in the world over time, and the resulting curve is exponential. I suspect that this pattern is probably attributable to the observation that linear increase in level of system hierarchy generates an exponential increase in potential system siz that is constrained by span of control and population size of basal organization units. The population potentially integrated in a hierarchical system is roughl given by the expression $S(C)^L$, where S = basal unit size, C = average span control, and L = number of levels of control.

I mentioned earlier that increasing hierarchical complexity of control appea to be associated with both increasing degree of control and proportional increasing elite access to resources. These, in combination with exponenti increase in potential system size, should help to account for the rapid expansi of many early complex societies. Yet each increase in levels of hierarchy, bas unit size, etc., also represents a stress point that may inhibit further developme

Organizational limits to growth may be observed spatially, beyond sim limits to space (circumscription). Renfrew (1975, 14), for example, describe frequently observed "early state module" consisting of a central place a associated hinterland. These units avered about 1500 km^2 in size and often spaced such that adjacent central places are about 40 km apart. The spat organization of the Susiana Plain of Iran during the period of early st formation (Johnson in press) appears to conform to Renfrew's observatio Administrative control was limited to a radius of about 20 km (a one day rou trip distance) from a given high-order center.

This "spatial" limit apparently represented an organizational constra related to the ability of administrative elites in early complex societies to con rural populations. Such societies are increasingly recognized to have opera with a combination of coersion and consensus (Claessen and Skalník 19 640, Goldelier 1978, 767–768, Service 1975, 266), and this 20-km radius adminstrative influence was probably related to movement costs of r participation in center economies (Johnson in press).

This organizational problem could be resolved through development of additional level of hierarchy such that subordinate centers could be space less than one-day round-trip intervals across the landscape (see Johnson 1 for an example). This solution need not be achieved, however, and an early s system may collapse, as it did in the Susiana case mentioned before.

Other limits to growth may be more technological than strictly organizatio One interesting example has been raised by Williamson (1967). He develop model of "control loss" in which potential control decreases with increase in number of organizational levels due to loss and distortion of informatio transmission from level to level (see also Athanassiades 1973). Pote countermeasures, "anti-distortion control devices" (Williamson 1967, 1 prominently include technical improvements in data processing. Were s cases of the development of writing systems in part a response to problem control loss in increasingly hierarchically organized systems? The answ unclear, but the development of writing systems is increasingly being view terms of the development of information storage, retrieval, and tra technology in the context of developing hierarchical organizations (Green in press, Schmandt-Besserat 1980).

There are limits to growth. Limits may, however, be overcome, at least within the organizational range considered here. These limits represent stress points in organizational development, and increasing our understanding of response to stress will require increasing examination of processes of system collapse as well as those of development (see Yoffee 1979).

Variance and Mean in Organizational Change

Understanding organizational structure and change will require accounting for both the variances and means of critical organizational variables. As I noted earlier, there is considerable variability in the system population size at which simultaneous hierarchies appear in social groups. I suggested that this variability was related to the extent to which sequential hierarchy is, and can be, a response to scalar–communications stress. Comparable variability is common in modern organizations (Reimann 1973) in which alternative structural arrangements are possible to resolve the same underlying problems. In general, trajectories of organizational development will depend in part on response sequence, i.e., the temporal order in which sequential and/or simultaneous hierarchy development or elaboration occurs.

Whatever the response sequence, we can probably expect organizational change under scalar stress to be more discontinuous than continuous. Stress may build slowly, but its resolution in either collapse or development is likely to be much more rapid (see also Flannery 1972, Johnson 1978). Indeed, discontinuous change is increasingly a critical element in theories of change in complex systems (Allen in press, Zeeman 1977).

While there is considerable variability in organizational development, mean values of critical variables such as span of control seem to be heavily constrained. The possible linkage of span of control to underlying human information-processing capacities may contribute to an explanation for this important mean value of organizational structure (see also Mayhew and Levinger 1976, 1038).

CONCLUSIONS

I have essentially argued here for a uniformitarian approach to the study of organizational structure and change. The justification for this approach is that all organizations appear to face certain similar problems, and scalar–communications stress has been emphasized in this chapter as one such important problem. Accounting for change may, however, require a more uniformitarian approach than the one taken here. Hierarchies are not the special province of human organizations, but of structure complex systems in general. They are pervasive in organizations of atoms, molecules, cells, and so on. Hierarchies are so pervasive that understanding why they should exist is not as simple a matter as it might seem (Pattee 1973, 101).

Origin problems aside, studies of the general properties of hierarchical organizations should be of some interest to anthropology and archaeology. Simon (1973, 7) remarks, for example, that degree of hierarchy can be readily related to the rate of system evolution.

Potential system size, degree of control, degree of status differentiation or stratification, degree of elite access to resources, and even rate of system evolution may all be related to general properties of hierarchies. I always wondered why so many things happened so quickly after the Neolithic.

ACKNOWLEDGMENTS

An earlier version of this chapter was presented in a symposium on Morphogenetic Approaches to Sociocultural Change in Complex Societies at the Second Annual Theoretical Archaeology Group Conference in Southampton, December 1980. In addition to the other members of that symposium, I would like to thank Lewis R. Binford, Henri J. M. Claessen, Carol Kramer, Thomas McGovern, and John D. Speth for their helpful comments. Remaining sins of omission and commission are mine. I would also like to express my appreciation for support from the Alexander von Humboldt-Stiftung and the Institut für Vorderasiatische Altertumskunde, Freie Universität Berlin, during the academic year 1980–1981.

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