The transition from quantity to quality: A neglected causal mechanism in accounting for social evolution

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Students of social evolution are concerned not only with the general course it has followed, but also with the mechanisms that have brought it about. One such mechanism comes into play when the quantitative increase in some entity, usually population, reaching a certain threshold, gives rise to a qualitative change in the structure of a society. This mechanism, first recognized by Hegel, was seized on by Marx and Engels. However, neither they nor their current followers among anthropologists have made much use of it in attempting to explain social evolution. But as this paper attempts to show, in those few instances when the mechanism has been invoked, it has heightened our understanding of the process of social evolution. And, it is argued, if the mechanism were more widely applied, further understanding of the course of evolution could be expected to result.

In his book *Science of Logic*, Georg Friedrich Hegel remarked: "It is said that there are no sudden changes in nature, and the common view has it that when we speak of a growth or a destruction, we always imagine a gradual growth or disappearance. Yet we have seen cases in which the alteration of existence involves not only a transition from one proportion to another, but also a transition, by a sudden leap, into a . . . qualitatively different thing; an interruption of a gradual process, differing qualitatively from the preceding, the former state" (1).

The significance of this transition from quantity to quality, which Hegel was perhaps the first to point out, was one of several ways of explaining change that Karl Marx and Frederick Engels borrowed from Hegel in their search for the mechanisms of social transformation. It was not, however, part of Hegel's famous "dialectic," with its mantra of "thesis, antithesis, and synthesis," and its "the negation of the negation," which Marx and Engels also borrowed from him.

In my own attempts to understand the changes that occur in social evolution, while I have failed to find the latter two mechanisms of much use, I nevertheless have found the first—the transition from quantity to quality—enormously useful. Yet, curiously enough, Marxists themselves, including modern-day Marxist anthropologists, have made virtually no use of it. In this paper I propose to explore the operation of this mechanism in some detail and to show how in repeated instances it helps make much more intelligible those structural transformations undergone by evolving societies.

Marx himself seems to have made only limited use of the explanatory power of the transition from quantity to quality. For example, in *Capital,* he noted "the correctness of the law discovered by Hegel . . . that merely quantitative differences beyond a certain point pass into qualitative changes," and illustrated this process in the economic sphere by speaking of "the minimum of the sum of value that the individual possessor of money . . . must command to metamorphose himself into a capitalist . . ." (2).

It was Engels, rather than Marx, who made much of this principle. In *Anti-Duehring* (3) and *The Dialectics of Nature* (4) he discussed it more fully than Marx and gave several examples of its operation, especially in the field of physical science. Engels began by citing the most obvious and best-known example of this process, the transformation undergone by water as the amount of heat applied to it is increased or decreased: ". . . water . . . at 0°C changes from a liquid to a solid and at 100°C from liquid to gaseous, . . . thus at both of these points of departure a mere quantitative change in temperature produces a qualitative change in the water" (ref. 3, p. 156).

Engels gave other instances of "Hegel's Law," drawing especially from chemistry. Thus he cited the series: formic acid (CH_2O_2), acetic acid ($C_2H_4O_2$), propionic acid ($C_3H_6O_2$), butyric acid ($C_4H_8O_2$), and valerianic acid ($C_5H_{10}O_2$), whose members vary in chemical characteristics through the successive addition of a CH− radical (ref. 4, p. 157). He also cites the series in which methane (CH_4) becomes ethane (C_2H_6) by the addition of more carbon and hydrogen atoms to the molecule. And while the three lowest members of this series are gases, the highest member, hexadecane ($C_{16}H_{34}$) is a solid (ref. 4, p. 31). Thus, once again Engels showed that a quantitative increase in the number of its atoms gave rise to a qualitative change in a chemical substance.

More than half a century after Engels, J. D. Bernal, a chemist as well as a Marxist, generalized the underlying physico-chemical relationship between quantity and quality in the following way: "We are learning more and more that specific qualitative properties of bodies depend on the number of certain of their internal components. If an atom can only link with one other atom, the result is a gas. If it can link with two or three, the result will be a solid of fibrous or platy character. If with four, a hard crystalline solid like diamond. If with more than four, a metal" (5).

In addition to the examples cited above, Engels gave a somewhat different illustration of the transformation of quantity into quality:

"We know that 'the chemical properties of elements are a periodic function of their atomic weights' . . . and that, therefore, their quality is determined by the quantity of their atomic weight. And the test of this has been brilliantly carried out. Mendeleyev proved that various gaps occur in the series of related elements arranged according to atomic weights indicating that here new elements remain to be discovered. He described in advance the general chemical properties of one of these unknown elements, which he termed eka-aluminium, because it followed after aluminium in the series beginning with the latter, and he predicted its approximate specific and atomic weight . . . A few years later, Lecoq de Boisbaudran actually discovered this element, and Mendeleyev's predictions fitted with only very slight discrepancies" (ref. 4, p. 33).

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Engels concluded that: "By means of the—unconscious—application of Hegel's law of the transformation of quantity into quality, Mendeleyev achieved a scientific feat which it is not too bold to put on a par with Leverrier in calculating the orbit of the still unknown planet Neptune" (ref. 4, p. 33).

In looking for examples of quantitative changes leading to a change in quality, Engels did not restrict himself to the physical world. He illustrated its application to the social realm by citing a curious example of it put forward by none other than Napoleon Bonaparte, who had had occasion to witness the equestrian prowess of Mameluke cavalrymen during his Egyptian campaign. According to Engels, Napoleon ". . . describes the conflicts between the French cavalry, bad riders but disciplined, with the Mamelukes who, as regards single combat were better horsemen but undisciplined, as follows—Two Mamelukes were a match for three Frenchmen, 100 Mamelukes were equal to 100 Frenchmen, 300 Frenchmen could beat 300 Mamelukes, and 1,000 Frenchmen invariably defeated 1,500 Mamelukes" (ref. 3, pp. 158–159).

Since the time of Marx and Engels, scientists have come to recognize the validity and utility of the notion that, during the course of changes in nature, a quantitative increase in substance, once it reaches a critical threshold, results in a qualitative transformation of state. The physicist David Bohm, for example, wrote as follows:

"We see, then, that quantitative changes in the mean kinetic energy of molecular motion lead to a series of qualitative changes in the properties of matter in bulk. These qualitative changes are generally foreshadowed as one approaches a critical temperature. As one passes such a critical temperature, however, two things happen. First, conditions are created in which completely different qualities come into being (e.g., the tendency in the case of the liquid phase to occupy a definite volume). Secondly, even those properties (such as specific heat, density, etc.), which are common to both phases, show discontinuities in their quantitative behavior as one passes through a transition point" (6).

As another example from the field of physics, one can cite the process undergone by fissionable uranium in an atomic bomb. As long as the uranium is kept below a critical mass, it will not detonate. However, as soon as several pieces of uranium of subcritical mass are rammed together, so as to exceed the critical mass, an explosion of catastrophic proportions spontaneously occurs.

In the field of biology, the passing from one qualitative state to another with an increase in the magnitude of some quantity also has been pointed out. For example, in discussing what happens in the human eye during the perception of color, Julian Huxley wrote:

"We know that our different color sensations depend on quantitative differences in the wavelength of the light received on our retina. We also know that in the optic nerve these different wavelength stimuli are translated in qualitatively different sets of electrical impulses" (7).

In my own professional field—anthropology—the transition from quantity to quality has received only limited recognition. Its application has been chiefly in attempts to explain how, during the course of hominid evolution, the human brain became able to engage in the symboling behavior underlying the production of speech, and with that, to be able to generate culture.

No structure is known in the human brain that is not also found (if on a reduced scale) in the brain of other higher primates. Nor is the cellular makeup of humans' brains in any way unique. The neurologist Anton J. Carlson, for example, observed that "man has no new kinds of brain cells or brain cell connections" (8). The emergence of the symbolic faculty, then, may well represent a case of the brain having steadily increased in size until it reached a "critical mass," which allowed the human species to cross the Rubicon, giving rise thereby to both language and culture.

Leslie A. White was perhaps the first anthropologist to suggest this as the most plausible explanation for the origin of the capacity for culture:

"Now in many situations we know that quantitative changes give rise to qualitative differences. Water is transformed into steam by additional quantities of heat. Additional power and speed lift the taxiing airplane from the ground and transform terrestrial locomotion into flight. The difference between wood alcohol and grain alcohol is a qualitative expression in the proportion of carbon and hydrogen. Thus a marked growth in size of the brain in man may have brought forth a new kind of function" (8).

Seeking as well to account for the symbolic faculty, Mischa Titiev, another anthropologist, used the same argument: " . . . it may be that a primate brain, which is normally less than 900 cc, stands for a mentality that is incapable of true symbolization; . . . [but] any normal Primate brain above 1,000 cc is probably fully capable of using symbolic speech and other features of algebraic mentality" (9).

And this explanation, first proposed more than half a century ago, continues to be the one most favored by modern-day students of the origin of the language faculty. In his book, *The Biology and Evolution of Language,* for example, Philip Lieberman writes: "A functional branch-point theory for evolution by means of natural selection claims that a process of gradual anatomical change can at certain points yield 'sudden' functional advantages that will lead to qualitatively different patterns of behavior in a species" (10).

When it comes to accounting for categorical changes in social evolution, however, the transition from quantity to quality is rarely invoked. Yet it has long seemed to me that this mechanism has considerable power in explaining many of the striking changes that have occurred during the development of human society. In the remainder of this article I would like to offer various examples of this mechanism in action.

We may begin by asking, What is it whose numerical increase can most readily bring about qualitative transformations in social structure? And the answer is: population. An increase in the sheer number of persons in a society, whether we're dealing with a village or a state, can, when that increase exceeds a certain threshold, give rise to new forms of organization. The geneticist J. B. S. Haldane once remarked that, from the standpoint of organic evolution, "comparative anatomy is largely the story of the struggle to increase surface in proportion to volume" (11). Similarly, we can say that social evolution is largely the struggle to increase structure in proportion to size.

Let us explore this relationship further by means of several illustrations.

The first example to consider of the structural effects of population growth is, in a sense, a negative one. It has to do with the consequences that the pressure of growing human numbers has on an autonomous village. With no overarching political controls to hold it together in the face of augmenting strains and stresses, an autonomous village, having reached a critical size, will split. The integrative social mechanisms that did exist were no longer able to accommodate or resolve quarrels that erupted, so now there are two villages where before there was one. Virtually every ethnography of an autonomous village with any time depth reports an occasion, some time in the past, when the village had fissioned.

This fissioning, which is all but universal in the history of autonomous villages, may manifest an underlying regularity not at first apparent. Indeed, there may even be a mathematical relationship between the size of an autonomous village and its tendency to split. Elsewhere, I have suggested that a village's tendency to fission may be proportional, not to the first power

of its population, as one might at first surmise, but to the square of its population. The reasoning behind this conjecture is simple. Because it takes two to quarrel, the probability of an autonomous village splitting really depends on the number of pairs of individuals—all potential quarrelers—living in the village. Now the number of pairs of individuals in a village is given by the formula $n^2 - n/2$, where n is the number of inhabitants of a village. And this number works out to be nearly proportional to the square of the population. While this relationship was proposed on purely theoretical grounds, elsewhere I have suggested a procedure for testing it empirically (12).

Although no dramatic change may occur in the status of a village until the moment it actually divides, there may nonetheless be signs and portents of the impending split just before it happens. Just as water, shortly before it starts to boil, becomes agitated and its surface can be seen to be rapidly in motion, so a village may reveal clear evidence of internal turmoil as tensions mount within it as it inexorably approaches fissioning. Examples of this internal stress can be cited from among Amazonian Indian villages, such as those of the Yanomamö and the Kayapó. Within villages of these two groups the increasing number of duels fought between disputants may signal an impending breakup. It is when these duels are no longer capable of defusing quarrels and reducing tensions that a village split becomes unavoidable.

A dozen different reasons may be offered by the villagers for these quarrels, and at a superficial level they may all be quite valid. But in many cases the underlying factor generating and exacerbating these quarrels is the increase in human numbers.

Earlier I labeled this effect of population growth negative. I did so because it leads a village to break apart rather than to elaborate its social structure in an effort to lessen and control internal friction. Splitting, however, is not the only alternative open to a growing village. There are also positive structural responses to population growth, responses in which the village in question gives rise to new social segments as it seeks to maintain its integrity. Such social-structural innovations are, of course, much more germane to the process of social evolution than is fissioning. Indeed, they are the very stuff of social evolution.

The most common response we find among autonomous villages to an increase in population, if fissioning is not to occur, is the development of new social segments such as clans and moieties, which apportion individuals to identifiable subunits of the society. In giving rise to clans and moieties, a village generally makes use of the principle of unilineal kinship in assigning persons to one social segment or another. Whether membership in these social units is assigned patrilineally or matrilineally is of little consequence here. It is only the existence of these newly formed segments that matters.

With social units like clans and moieties in existence, village residents no longer form part of an undifferentiated mass, but are assigned to one (or more) segments of the society. Instead of leaving it an amorphous aggregate, then, clans and moieties impart to a society a kind of cellular structure that makes it more resistant to the shearing forces, which steadily increase as a village grows larger, and which threaten its existence.

Clans and moieties operate in several ways to counter the divisive forces in a growing village. For one thing, being generally exogamous units, they require an individual to rely on a different clan or moiety than his own in seeking a marriage partner. In this way, it keeps clans and moieties in a dependent and cooperative, rather than in an antagonistic, relationship toward each other.

In this connection, let us look specifically at moieties. Because they are often complementary and reciprocal in their functions, moieties are particularly effective at counteracting the fissive tendency of large villages by artificially creating a dependence of the members of one moiety on those of the opposite one.

As an example, consider the moiety system found among the Kayapó Indians of central Brazil, whose villages often numbered as many as 600 or 800 persons. The Kayapó have several sets of moieties, membership in which may be determined not only by unilineal kinship, but also by such considerations as which half of the village (east or west) one was born in, or whether he was born during the rainy season or the dry season. Any dichotomous criterion will do. Opposing moieties among the Kayapó not only provide teams for such competitive sports as log racing, but also bury each other's dead. Now, it is perfectly clear that a moiety is fully capable of burying its own dead, but by assigning this function to the opposite moiety, a dependence is created between the moieties that helps bind together the members of a large Kayapó village.

It is instructive to compare the Kayapó and the Yanomamö with regard to village size and structural complexity. Both societies were similar in being heavily involved in warfare, an activity in which having a large village conveys a distinct advantage. Yet Yanomamö villages rarely exceed 200 in size, and on those occasions when they do, usually fission not long afterward. Kayapó villages, on the other hand, as we have already seen, often attained a population of 600 or 800, and yet successfully resisted the tendency to split at levels which Yanomamö villages could not even approach.

What accounts for this difference? Structurally, a Yanomamö village had only a few simple patrilineages, whereas Kayapó villages had developed a fairly complex social segmentation consisting of clans, moieties, and age grades. It would appear, then, that the quantitative increase in human numbers, which led the Kayapó, at certain thresholds, to elaborate their social structure, did not have the same effect among the Yanomamö. (One is free to speculate, of course, that in time it would have.)

The virtual absence of such social segments as clans, moieties, and age grades among small bands, and their very wide occurrence among large villages, shows how readily this form of organization tends to emerge among human societies as they grow in size.

A striking example of how larger population aggregates can bring about an abrupt elaboration in social structure is provided by the Indians of the North American Plains. For most of the year, the members of a Plains tribe lived in small bands of 50 or so. During this time their social structure was exceedingly simple. There was a band headman, but he had little power and few duties. A band that size needed little more. However, when the two dozen or so bands of a typical Plains tribe came together for the summer buffalo hunt, everything changed. A tribal council of band leaders was formed which elected one of their number as tribal chief, and in that capacity he enjoyed greatly expanded powers. He organized and directed all tribal activities, being assisted by the men's societies, which sprang into being as soon as the whole tribe assembled. One of these societies acted as a police force and was charged with keeping order during the buffalo hunt and the Sun Dance ceremony that followed.

"That the emergence of these structural features was a response to the organizational problems posed by supraband aggregation is shown by the fact that every one of them—the tribal chief, the council, the men's societies, the police force, the sun dance organization—lapsed when the tribe broke up into its constituent units in the fall" (13).

A more general demonstration of the fact that as successive thresholds are crossed, increases in population bring about new structural features is provided by a study I carried out a number of years ago. In this study of 46 autonomous villages, the number of structural features of each society was plotted against its size. The graph revealed that autonomous villages develop new structural elements at a rate roughly proportional to the 2/3 power of their population (13, 14). Here again we have a demonstration of a quantitative increase giving rise to a qualitative change, a relationship that in this case is expressible in fairly precise mathematical terms.

Another expression of this relationship can be found in the sphere of economic life. For example, full-time craft specialists come into being only when the aggregate demand for their products has reached a certain threshold. And when the quantity of goods of these specialists reaches an even greater magnitude, their exchange is no longer carried out informally and sporadically. Instead, markets tend to arise where buyers and sellers gather on some regular basis to transact their business. At first, these markets take place only on designated occasions, perhaps every 5 days, but as the number of persons who attend, and the volume of goods bought and sold, increases even more, markets begin to take place daily, and their location becomes fixed.

And when the volume of exchange reaches a certain magnitude, structural features arise to ensure that markets will function in an efficient and orderly way. The great Aztec market of Tlatelolco in Tenochtitlán, vividly described by eyewitnesses such as Hernán Cortés and Bernal Díaz del Castillo, furnishes a prime example of this. The Spaniards were struck by the huge throngs of people buying and selling there, a number Cortés estimated at 60,000 (15). Bernal Díaz was especially impressed by the amount and variety of merchandise displayed in the market and went on to itemize many of the products he saw for sale—gold, feathers, embroideries, slaves, rope, shoes, animal skins, pottery ("made in a thousand shapes"), honey, firewood, smoking pipes, stone knives, gourd cups, and on and on. "I wish I could get through with telling all of the things they sold there, but only to finish looking and inquiring about everything in that great square filled with people would have taken two days, and then you wouldn't have seen everything." Indeed, Bernal Díaz affirmed that in the great Aztec market "one could see every sort of goods that is to be found in all of New Spain . . . ."

At the same time that he was overwhelmed by the number of people and the bewildering variety of goods to be found in the market of Tlatelolco, Bernal Díaz was impressed with the orderly way in which the market was run, speaking of "the efficiency and administration of everything" (16). Cortés was struck by this as well:

"A very fine building in the great square [where the market was held] serves as a kind of audience chamber where ten or a dozen persons are always seated, as judges, who deliberate on all cases arising in the market and pass sentence on evildoers" (15).

But before they could be tried, these "evildoers" had to be caught at some malfeasance. And there was a mechanism for doing so as well. Cortés observed:

"In the square itself there are officials who continually walk amongst the people inspecting goods exposed for sale and the measures by which they are sold, and on certain occasions I have seen them destroy measures which were false" (15).

In similar words, it was said of these market officials that "they kept peace and order in the marketplace, adjudicating differences between market vendors, and inspected the merchandise and prices," seeing to it "that customers were not overcharged or cheated" (17).

And should an altercation break out among the marketgoers, there were men charged with apprehending those who had caused the trouble. "Passing through the crowd were warriors who acted as police and, should a disagreement arise, hailed disputants into . . . court . . ." (18).

We see, then, that the smooth and efficient functioning of so large a market could not be left to private individuals. Various sets of officials were in place whose function it was to oversee the conduct of business, ensuring that transactions were fair and that the behavior of the marketgoers was orderly.

Once again we encounter an instance in which some quantity—in this case, the number of persons and the volume of trade in a market–had grown so great that qualitative changes had been required in the structure of the market to allow for its proper functioning. A hierarchy of overseers had arisen with the power to enforce the law and punish violators.

It is not, however, merely an increase in the sheer number of persons involved in some activity that gives rise to new structural forms. Often it is the density of the population involved that is the critical factor. Population density, of course, is a ratio of the human numbers participating in some activity to the amount of land in which that activity is carried out. (I will discuss the effect of density of population shortly when I consider the origin of chiefdoms and states.)

Along with density, it should be noted that an increase in the frequency or intensity of some activity also may have a transforming effect on a society, without the necessity of there being a corresponding increase in the number of persons involved. Consider, for example, the effect that a heightened participation in war had on the Kayapó of central Brazil and the Masai of East Africa. Both societies, as a way of enhancing their fighting prowess, had developed, independently of each other, certain parallel forms of military organization. Most conspicuous among these was the division of the society's male population into age grades, with the grade that included younger able-bodied males forming a sort of warrior caste. While still young, boys were arranged into cohorts and segregated from the women by being expected to live together in a men's house. There they underwent rigorous training, every effort being made to instill in them the courage and hardihood needed by a warrior, at the same time that they were acquiring skill in the use of weapons and military tactics.

On a much larger scale we have the example of ancient Sparta, a society, which, beyond any other in the classical world, was geared for war. Indeed, virtually every aspect of a Spartan's life was subordinated to it. The system of dividing males into age grades, so effectively used by the Kayapó and the Masai, also was used by Sparta. From the age of 8, boys were removed from the company of females and were brought up under the stern tutelage of a magistrate called a paedoinomus. During their early years, boys were subjected to a most stringent regimen aimed at turning them into redoubtable warriors who would become effective tools of Sparta's aggressive politics (19).

Of Sparta's success in this regard, Xenophon noted: "Now once it had struck me that Sparta, despite having one of the lowest populations, had nonetheless clearly become the most powerful . . . state in Greece, I wondered how this had ever happened. But I stopped wondering once I had pondered the Spartiates' institutions . . ." (20).

The heightened incidence of warfare among human societies had, in time, very profound consequences. Indeed, it led to a wholesale transformation in the socio-political structure of societies around the globe. As far as we can tell, throughout the Paleolithic and early Neolithic periods, all societies existed as autonomous political communities, first as bands and then as villages. No overarching political superstructure existed above them. In political affairs, then, each band and each village was a sovereign unit. The first major threshold that had to be crossed in the political evolution of the human race was the transcending of local autonomy and the creation of multivillage polities. And given the universal reluctance of bands or villages to surrender their sovereignty, the only way this could be achieved was through the instrumentality of war.

If we judge it by its effects, war can be divided into two types, dispersive and aggregative. Until the late Neolithic, all war was dispersive in nature. By a process of fight and flight, its net effect was to drive villages farther apart rather than to bring them closer together. Aggregative war began only after steadily increasing human numbers created acute shortages of arable land. War now took a decisive turn. Not only did it become more frequent and more intense, it came to have different objectives.

Instead of fighting to avenge murder or wife stealing or witchcraft, as before, villages now fought, first, to obtain land to be able to feed an increasing population, and next, to incorporate enemy villages themselves, exacting labor and tribute from their inhabitants.

And it was warfare that led directly to the transcending of village autonomy and the formation of multivillage aggregates, the polities known as chiefdoms. Then, as warfare continued to be waged with increased intensity, chiefdoms gradually grew in size through the conquest and amalgamation of weaker chiefdoms by stronger ones. As chiefdoms thus grew larger, the need arose for them to elaborate their socio-political structure to coordinate and integrate the greater number of persons now subject to their control. And as their size and structure continued to grow, some chiefdoms attained a scale warranting their being called states.

The strong association between growing population density and state formation is now generally accepted. But it was not always so. In *African Political Systems,* for example, Meyer Fortes and E. E. Evans-Pritchard, two distinguished British anthropologists, explicitly denied it (21). And their pronouncement on this subject stood virtually unchallenged until 1968 when Robert F. Stevenson devoted an entire volume, *Population and Political Systems in Tropical Africa,* to examining and refuting it. Stevenson began by stating, "there is impressive empirical evidence from other continental areas [than Africa] of a positive relationship between high population density and state formation." And after an extensive survey of some 34 African societies he concluded, contrary to Fortes and Evans-Pritchard, that "the picture of tropical Africa as a whole . . . shows a pronounced general conjunction between state formation and higher population density" (22).

On a much larger scale, this association between population density and political evolution has been tested by Michael J. Harner in a global cross-cultural study. Harner began with the conviction that "population pressure is a major determinant of social evolution" and set about to test it. He did so by first specifying the mechanism by which he thought the process had unfolded, beginning with agriculture. "[T]he innovation of agriculture," he wrote, "results in population growth; and as population pressure increases, subsistence resource land will become scarcer, . . . leading to a competition for its control. Competition for scarcer subsistence resources will, in turn, lead to ever-larger local and interlocal cooperative social units to ensure success in holding and acquiring scarce resources" (23).

Moreover, Harner argued, "Continuing growth of population pressure will lead to greater land subsistence resource scarcity, with consequently intensified competition for its control." This competition, which occurs "particularly . . . in the form of war," culminates, under favorable conditions in the emergence of the state (23).

In an elaborate and ingenious manner, Harner proceeded to subject this hypothesis to a test, using a worldwide sample of 838 societies, and found at the end of his study that the hypothesis had been confirmed. The thrust of Harner's study, then, was to show once again the transforming effect on socio-political organization of a steady increase in human numbers and the role of competition and warfare in bringing about this key transformation in human society.

Before concluding this paper there is an aspect of the relationship between quantitative and qualitative changes not hitherto alluded to which nevertheless deserves examination. This is the close analogy between changes of state in physical bodies and social bodies—changes of a kind that are best understood by applying the concept of elastic limits. I can illustrate this concept in the following way. If the deflecting force applied to a metal rod does not bend it beyond a certain point, then, when the force is released, the rod will return to its original position. However, if the rod is bent beyond that point—beyond its elastic limits—it will not return to its original position, but will take a permanent set.

An analogous situation can be said to hold among social systems. If a certain dislocation of the normal workings of a society does not exceed a certain point, the ordinary operation of the existing institutions of that society eventually will restore it to its former state, with no permanent change in its structure having occurred. But if the disturbance is of sufficient magnitude, the social system will no longer be able to return to its previous condition, but will be permanently modified, as the society seeks new ways to accommodate itself to its drastically altered circumstances.

This principle can be seen in operation by comparing two depressions in American economic history. The depression of 1922 was moderate in strength and short in duration. Its effects were ephemeral and were overcome by the normal functioning of market forces. No extraordinary legislative initiatives were required. Thus, after the depression of 1922 was over, the American economic system remained essentially unchanged.

However, the depression that began with the stock market crash of 1929 was of a vastly different order. Its magnitude was both profound and prolonged. And when it finally became obvious that normal market forces were insufficient to reestablish the previous equilibrium, a series of legislative measures were enacted creating new structural features designed to restore the national economy—indeed the whole society—to a semblance of its former self. The New Deal legislation of the 1930s established such new entities as the Reconstruction Finance Corporation, the Agricultural Adjustment Administration, the Securities and Exchange Commission, the Federal Deposit Insurance Corporation, the National Labor Relations Board, Unemployment Insurance, the Public Works Administration, and the Social Security Administration.

To put the matter in more general terms, the depression of the 1930s was so severe that it exceeded the elastic limits of the existing American society. The quantitative changes in the economy were so great that they called for and engendered qualitative changes of a permanent sort. By contrast, the depression of 1922 was so moderate that it did not exceed the elastic limits of the society, and thus failed to produce any significant or enduring changes in the socio-economic system (24).

In summary, the notion of a build-up of quantitative changes until they reach a certain magnitude, at which point they give rise to qualitative changes, has repeatedly proved of value in accounting for structural changes in human societies. Surprisingly, in explaining the mechanisms underlying social evolution, the small group of anthropologists for whom this principle is part of their Marxist heritage have made virtually no use of it. But then again neither have those non-Marxist anthropologists who are likewise interested in exploring how societies evolve. Yet, shorn of its political associations, the principle of quantitative changes leading to qualitative changes stands as a sound and powerful tool in the armamentarium of evolutionary interpretations. In the relatively few applications it has thus far received it has shed great light on important social changes. Put to work on a larger scale, it holds the promise of yielding even greater results in our quest to understand how societies evolve.

I thank Joyce Marcus from whose broad perspective and wise counsel this paper has greatly benefited.

1. Bukharin, N. (1925) *Historical Materialism* (International Publishers, New York), pp. 79–80.
2. Marx, K. (1906) *Capital* (Charles H. Kerr & Company, Chicago), pp. 337–338.
3. Engels, F. (1907) *Landmarks of Scientific Socialism ("Anti-Duehring")* (Charles H. Kerr & Company, Chicago).
4. Engels, F. (1940) *Dialectics of Nature* (International Publishers, New York).
5. Bernal, J. D. (1949) *The Freedom of Necessity* (Routledge & Kegan Paul, London), pp. 353–354.
6. Bohm, D. (1961) *Causality and Chance in Modern Physics* (Harper & Brothers, New York), p. 53.
7. Huxley, J. (1962) *J. R. College Surgeons Edinburgh* **7,** 163–179.
8. White, L. A. (1949) *The Science of Culture* (Farrar, Straus, and Company, New York), pp. 32–33.
9. Titiev, M. (1954) *The Science of Man* (Henry Holt, New York), p. 160.
10. Lieberman, P. (1984) *The Biology and Evolution of Language* (Harvard Univ. Press, Cambridge), p. 256.
11. Haldane, J. B. S. (1954) in *A Treasury of Science*, eds. Shapley, H., Raport, S. & Wright, H. (Harper and Brothers, New York), p. 323.
12. Carneiro, R. L. (1987) in *Themes in Ethnology and Culture History,* ed. Donald, L. (Folklore Institute by Archana, Meerut, India), pp. 100–101.
13. Carneiro, R. L. (1967) *Southwestern J. Anthropol.* **23,** 234–243.
14. Carneiro, R. L. (1987) *Int. J. Comp. Sociol.* **28,** 111–128.
15. Smith, M. E. (1998) *The Aztecs* (Blackwell, Oxford), p. 116.
16. Díaz del Castillo, B. (1957) *The Bernal Díaz Chronicles: The True Story of the Conquest of Mexico,* ed. Idell, A. (Doubleday, Garden City, NY), p. 156.
17. van Zantwijk, R. (1985) *The Aztec Arrangement* (Univ. of Oklahoma Press, Norman), p. 143.
18. Vaillant, G. C. (1962) *Aztecs of Mexico,* rev. Vaillant, S. B. (Doubleday, Garden City, NY), p. 193.
19. Jones, A. H. M. (1967) *Sparta* (Basil Blackwell & Mott, London), pp. 34–39.
20. Plutarch (1988) *Plutarch on Sparta* (Penguin, London), p. 166.
21. Fortes, M. & Evans-Pritchard, E. E. (1940) *African Political Systems* (Oxford Univ. Press, London), pp. 7–8.
22. Stevenson, R. F. (1968) *Population and Political Systems in Tropical Africa* (Columbia Univ. Press, New York), pp. 9, 232.
23. Harner, M. J. (1970) *Southwestern J. Anthropol.* **26,** 67–86.
24. Carneiro, R. L. (1982) in *Self-Organization and Dissipative Structures,* eds. Schieve, W. C. & Allen, P. M. (Univ. of Texas Press, Austin), pp. 113–114.