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Punctuated Equilibria, Rates of Change, and Large-Scale Entities in Evolutionary Systems

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Archaeology and paleontology, often confused in the public's mind, share more than a common source of data in the earth beneath our feet. Both are charged with documenting the actual results of history, be it the history of the evolutionary process as preserved in the sequence of faunas and floras in the fossil record or the history of human socio-cultural evolution as preserved in the archaeological record. In this chapter I seek a still deeper analogy between the two disciplines. As I see it, both archaeology and paleontology are poised and ready to enter the ranks of what, for want of a better term, we might call "functional" science, conferring an alternate status to the traditional perception of them as purely "historical" sciences.

Asked what is unique and potentially powerful about their data, both archaeologists and paleontologists generally respond with the simple word "time." As skimpy and scantily incomplete as their data generally are, both disciplines are unique within their larger fields of evolutionary and sociocultural inquiry in providing the exact temporal backdrop against which the actual course of historical events has been played out. Yet, until recently, relatively few contributions to an understanding of evolutionary mechanisms (or simply processes of history) have been forthcoming from these disciplines. This is because the actual processes of change (or of that vastly more common pattern, stasis, meaning stability or virtual lack of change) are commonly held to be understood solely in the short-term phenomena of currently functioning systems.

This epistemological assertion—that we can understand processes of stasis and change in both biological and sociocultural systems only by

studying the structure and function of currently existing systems (see, e.g., Dobzhansky, 1937, and Carson, 1981, for evolutionary biology)—is usually not distinguished from the ontological claim that those processes and phenomena observed in the short term are both necessary and entirely sufficient to account for all historically observed phenomena, including those of the paleontological and archaeological records. Thus the role of archaeology as well as of paleontology has been simply to document the actual events of history, leaving to evolutionary biologists (mainly, in the past fifty years, geneticists) and sociocultural theorists working with various aspects of human behavior and sociocultural organization the task of elucidating the mechanisms of stasis and change in those systems.

Science seeks to explain phenomena (classes of events, in particular) in terms of causal interactions among entities. Thus in evolutionary biology, physical attributes of organisms are held to undergo adaptive modification according to the differential reproductive success of organisms that vary with respect to that trait within a breeding population—the principle of natural selection. It is my central contention here that in restricting analysis to those entities and interactive processes that are easily accessible to human observers over a few minutes, days, months, or years (a procedure easily defended on epistemological grounds) automatically and arbitrarily limits the range of entities, hence of interactive processes, that are admitted to causal theories of stasis and change. And such excluded entities and processes may well prove to be important to a full theory of history in both biological and sociocultural systems.

In particular, I argue that it is the main legacy of the evolutionary biological theory of punctuated equilibria, which came out of paleontology, that large-scale, interactive biotic entities of which organisms are parts do in fact exist; that their natures can be specified; and that their causal interactions can thus be elucidated. In setting out the argument, I focus first and most intensely on such large-scale biological entities simply because those are the systems with which I am familiar. I then argue that much the same approach can be taken with large-scale sociocultural entities, thus bringing archaeology more directly into the business of elaborating genuine causal scientific theory. My goal is to show that these two “historical sciences” have not been taking full advantage of their gift of time in not recognizing the nature, or even the existence, of large-scale systems. I am emphatically not seeking to forge any unified theory of biological and cultural evolution because I believe that humans are organisms and have evolved biologically; but I am also con-

vinced (for the usual reasons, especially differences in modes of hereditary transmission of traits) that cultural and biological aspects of human existence are largely decoupled (see, for example, Bock, 1980, on the incommensurability of biological and cultural patterns of variation within *Homo sapiens*).

PUNCTUATED EQUILIBRIA: THEMES AND CONTENT

The notion of punctuated equilibria arose in an attempt to bring evolutionary theory more closely in line with general patterns of evolutionary history that are manifest in the fossil record (Eldredge, 1971; Eldredge and Gould, 1972—in which the term was coined; see Eldredge, 1985a, for a general account of the history and content of the concept). The paleontologists who reviewed the first edition of Darwin's (1859) *On the Origin of Species* (see Hull, 1973, for a compendium of reviews) all expressed some degree of surprise that Darwin failed to mention the marked degree of nonchange (or stasis, as it is now generally termed; Eldredge and Gould, 1972) that is characteristic of most species after their earliest appearance in the fossil record. Thus it was known in Darwin's day that the bulk of a species' history was spent in relative stability, a fact that Darwin interwove into his narrative by the sixth edition (Darwin, 1872). Yet evolutionary biology since Darwin's time has unquestionably seen evolution as a matter of slow, steady, and progressive transformation of the adaptive features of organisms. Punctuated equilibria, as its central empirical facet, sought an explanation for the overlooked phenomenon of marked stability, responding to a pattern in which adaptive evolutionary change seems to be concentrated in (relatively) brief episodes, "punctuating" vastly longer intervals when little or no change occurs.

Darwin's central task had been to demonstrate that life has in fact had a history—that all living forms are descended from a remote common ancestor, that there has been "descent with modification," as he put it, in the intervening eons. His success derived in no small part from his description of a powerful engine of evolutionary change—natural selection. Natural selection, Darwin's direct, natural analogue of the artificial selection of breeders, stood as the materialistic substitute for a supernatural Creator as the molder of design in the organic world. And Darwin's depiction of that organic world as a scene of constant struggle and competition over both resources and mates made the corollary

seem overwhelmingly inevitable: those variations that give an edge will tend to be disproportionately passed along to succeeding generations. Even if environments do not change, variants will always appear that play the game of life better than ever, and thus improvement can be expected. But environments do change, and with great regularity. Thus it seemed (to Darwin and his successors, e.g. Simpson, 1944; see Eldredge, 1985b) wholly inevitable that the history of life would be one of constant modification of organismic properties shifting to keep pace with an ever-fickle environment. Adaptive change has seemed ineluctable and inevitable in the Darwinian tradition.

Such a view, handed down intact to the present time as the central picture of both evolutionary change and evolutionary history, has infused all branches of evolutionary biology from population genetics to paleontology. To be sure, dampening effects—constraints—are known in all fields; opposing forces (e.g., of selection and mutation) as well as simple genetic recombination have been seen as conservative factors in population genetics, and the intricate delicacy of developmental systems ensures that reduced viability is the common result of substantial alteration of developmental pathways.

In paleontology, exceptions to the expectation that evolutionary history should ordinarily be recorded as progressive series of gradually transmogrified organisms have generally been explained in another fashion altogether: as the natural outcome of faulty data. Darwin himself helped found the modern discipline of taphonomy (the study of the formation of the fossil record) in partial answer to the riddle of the disturbing lack of many examples of progressive change through the rock record. The fossil record does indeed have gaps, and, for the most part, paleontologists have ever been willing to explain the discrepancy between expected and observed evolutionary patterns as the simple effect of the haphazard way organisms die, become preserved, survive in fossilized form for as many as hundreds of millions of years, are discovered, taken to the laboratory, and analyzed.

Yet stasis stands out as a bald fact of the fossil record; most species that have been recorded over a significant interval of time (for marine invertebrate organisms, typically in the few, but up to 10 or 15, millions of years; for terrestrial vertebrates, more on the order of hundreds of thousands up to a few millions of years), little change is observed. More precisely, the differences observed between (interpreted) ancestral and descendant species generally involve characters that are not observed to vary, let alone change in the direction of the descendant, within the

ancestral species before the appearance of its presumed descendant (see Eldredge and Cracraft, 1980:285ff.). The same pattern has been noted in the modern-day biota as well: patterns of variation within species often do not correspond to the differences observed between closely related species. Thus, though a species may display geographic variation to some degree, and some (generally oscillatory) change might occur throughout the history of a species, the differences observed between species in an ancestral-descendant lineage do not usually arise as a simple outgrowth of variation and evolutionary transformation within species.

It is the central goal of punctuated equilibria to explain these observations by bringing to bear a subset of evolutionary theory quite distinct from the general expectation of patterns of gradual adaptive change through time. For though the differences between species in the main involve functional characteristics of organisms and appear to have arisen in the manner envisioned by Darwin—through natural selection—the first question to be asked is, Why is adaptive change seemingly concentrated into brief episodes? The answer still preferred by many evolutionary biologists is simply that everyone knows that evolutionary rates vary and that peculiar concatenations of ecological and historical factors will conspire at some times to foster change and at others to induce stability (see, e.g., Hecht and Hoffmann, 1986).

Yet a more general theory that can be applied to the common patterns of stasis and punctuation in evolutionary history is the theory of speciation: species are understood to be (sexual) reproductive communities, with reproduction going on within the community and with little (and, usually, no) reproduction going on with members of other such reproductive communities. Speciation, in this sense, is the origin of one or more descendant reproductive communities from an ancestral reproductive community. This is in stark contrast to the alternative, and still very general, conceptualization of species as collections of anatomically similar organisms. Thus, to Darwin, the evolution of species is a matter of the transformation of anatomical properties of organisms to the point at which an identifiably new group of similar organisms has emerged; hence the title of his book, which dealt with “species” strictly as ephemeral collections of similar organisms—arbitrarily designated subdivisions of lineages that were undergoing regular and progressive, if not utterly constant, transformation through time. This is the sense in which most paleontologists to this day use the term “species.”

In the late 1930s and early 1940s, when the Modern Synthesis was in

the throes of formulation, the geneticist Theodosius Dobzhansky and the systematist Ernst Mayr each wrote books on evolutionary theory. Both were concerned to add one item to the general Darwinian picture of intergradational transformation of the adaptive properties of organisms. For both men realized that *discontinuity* ranks equally with adaptive *diversity* as a phenomenon to be explained by evolutionary theory. There is a panoply of organic form in biotic nature, and it seemed to them (as it does to me and to virtually every other evolutionary biologist) that natural selection, working on a groundmass of variation whose ultimate source is genetic mutation, is the effective agent underlying the production of such diversity. Yet that diversity is not smoothly continuous in the living world (though both men expected that it would be so were the fossil record complete); rather, diversity seems to come in packages—in “species.” Thus species, both as clusters of discontinuity in the spectrum of adaptive diversity and as communities of reproductive interaction, required explanation.

Because natural selection produces adaptive change gradationally, as a continuum of change, Mayr and Dobzhansky both argued that discontinuity must arise through disruption of reproduction. That is why both men defined species as reproductive communities, eschewing any reference to general organismic similarity in form. Dobzhansky (1937) in particular was concerned to develop the notion of isolating mechanisms, a theme elaborated on by Mayr (1942); both zoologists argued that the most common initial source of reproductive isolation derived from physical (i.e., geographic) isolation, with subsequent divergence. Their views continue to serve as the basis of the modern understanding of the process of speciation. Recently H. E. H. Paterson (1985 and references therein) has further clarified the matter, pointing out that all sexually reproducing organisms have species-specific-mate recognition systems that allow conspecifics to recognize one another for mating purposes (either simple chemical recognition of sperm and egg in seawater or complex bits of behavior that more literally involve recognition).

The point of Paterson’s contribution is that isolation may lead to divergence in the specific mate-recognition system (SMRS), which is the minimal requirement for speciation to occur. Such a change may be accompanied by no, little, or a great deal of change in the vastly larger set of organismic adaptations—those pertaining to the soma, the economic adaptations of organisms. But though no economic change may accompany SMRS change, the pattern to be explained by punctuated equilibria says that economic change in general is not to be expected

unless as an accompaniment to SMRS change. Thus the original statement of punctuated equilibria took the theory of allopatric (geographic) speciation and, as Mayr and Dobzhansky argue, saw the onset of “reproductive isolation” (now best understood as Paterson’s SMRS disruption) as causally implicated, not only in the disruption of the spectrum of adaptively generated diversity but in the instigation and preservation of adaptive change. Precisely how and why economic change, when it occurs at all, generally accompanies SMRS disruption remains an unresolved and somewhat contentious problem.

IMPLICATIONS OF PUNCTUATED EQUILIBRIA: LARGE-SCALE BIOTIC SYSTEMS

Allopatric speciation is a theory of species birth—how new species arise from old. Fragmentation of an ancestral species into two descendants may amount to a roughly 50-50 division; perhaps more commonly, new species arise as relatively small, peripheral populations become geographically isolated and reproductively and (generally) economically disjunct from the parental population. Both extreme possibilities have analogues in the asexual reproductive activities of various organisms: single-celled organisms commonly reproduce by simple division, whereas the polyps of the aquatic coelenterate *Hydra* reproduce by budding tiny descendants that grow and eventually detach. In either case, there are two individual organisms where once there had been one—precisely the case in speciation. Ancestral species rarely become extinct in the process of giving rise to descendants.

Likewise, it is clear that all species eventually suffer extinction—just as all organisms eventually die. Thus species are spatiotemporally bounded entities; like organisms, they have births, histories, and deaths. Organisms are parts of species, and because organismic traits tend to remain conservative during the vast bulk of a species’ history, species tend to remain recognizably discrete from one another throughout their entire histories. In other words, there are some intriguing parallels between organisms and species. In particular, specific instances of both categories—organisms and species—deserve to be called *individuals*.

Just such a suggestion was made by Michael Ghiselin (1974), who argued that species, which have names, are defined ostensively. Thus they are more analogous to a corporation, such as General Motors, than to a substance such as gold, which is, at least theoretically, a spa-

tiotemporally unrestricted class. Though the class "gold" is defined with reference to certain atomic properties (i.e., any atom with atomic weight 79 is ipso facto an atom of gold), each particular atom of gold is a spatiotemporally restricted individual, having had a beginning, a history, and, eventually, a demise. We do not name individual atoms of gold because no one has as yet conceived of a useful purpose or practicable way for doing so.

As with gold, so with species. The Linnaean category "species" is indeed a class: any community of reproductively interacting (sexual) organisms, with reproductive adaptations (SMRS) unique to that community, belongs to the class "species." Each particular species, each with its own SMRS, is an individual instance, a taxon of species rank that is named, viz. *Homo sapiens*.

Particular species have long been considered to be classes (like gold): collections of adaptively similar organisms, for example, any extant hominid with a cranial capacity greater than, say, 1,200 cc would be an organism of the class *Homo sapiens*. The difference between the two ontological conceptualizations of species is critical: if we see particular species as groups of similar organisms, species have no particular ontological status; we are free to accept an evolutionary theory that sees the entire history of life as no more than a matter of stochastic and (especially) deterministic (i.e., natural selection) processes that form, maintain, and modify the phenotypic and underlying genotypic properties of organisms.

If, however, species are spatiotemporally bounded entities, with births, histories, and deaths, factors influencing their births and deaths would obviously have to be taken into account in any evolutionary theory. Moreover, through specifying the nature of such entities—species and other large-scale biotic entities that might be recognized—the roles played by such entities, plus any interactive processes in which they might be engaged, could also be specified. When species are viewed as classes, evolutionary dynamics are seen only in terms of the interactions of smaller-scale entities (individuals), such as organisms and genes—and disciplines that deal with species and monophyletic taxa of higher Linnaean rank (i.e., systematics and paleontology) are perforce entirely "historical," constrained as they are merely to record the results of the evolutionary process, the events that are the outcomes of interactions among lower-level entities.

The original formulation of punctuated equilibria, elaborated independently of Ghiselin's formal argument on the individuality of species, offers a case in point. For if species characteristically remain stable

through the bulk of their histories, how do we explain directional change throughout a lineage of ancestral-descendant species? Traditionally, such directionality was seen as a simple accumulation of directional natural selection: small amounts of change accrue in relatively brief intervals; over the vaster stretches of geological time, truly large-scale, directional change can accrue, the reflection of so-called orthoselection. Yet the prevalence of stasis means that such a simple model cannot be an accurate description of a process underlying the production of admitted examples of long-term directional change in evolution—as in the increase in hominid brain size over the past 4 or 5 million years.

Originally, we (Eldredge and Gould, 1972) simply suggested that trends likely reflect a pattern of differential species survival superimposed over a pattern of speciation in which adaptive changes occur under the aegis of natural selection. Steven M. Stanley (1975) and many subsequent authors since generalized this notion of species selection to embrace a host of theoretical models that would systematically bias births or deaths—speciations or extinctions—of component species within a lineage. Given the diversity of mechanisms available, Elisabeth Vrba and I (1984) suggested that the preferable, neutral term for the general phenomenon would be “species sorting.” For present purposes, the important point is that long-term directional changes within lineages through evolutionary time are now almost universally considered by theorists to involve differential comings and goings of species interpreted as entire entities, as well as selection-mediated adaptive change of the phenotypic properties of organisms.

Thus, in barest outlines, is the general nature of a change in paleontology—from a position of chronicler of the major events in life's evolution, to one of active contributor, to a consideration of causal processes effective during that evolutionary history. The job of writing the theory that is implicit in this newly perceived structure has barely begun. The question for the rest of this chapter is, To what extent are these changes in paleontological thinking relevant to a consideration of the histories and evolution of social systems in general and to the study of human history and archaeology in particular?

WHAT ARE SOCIAL SYSTEMS?

My consideration of the nature of social systems stems explicitly from my background as an evolutionary biologist and paleontologist. Socio-

biology, of course, has recently been widely touted in biological circles as an achievement of a general scientific—and explicitly evolutionary—approach to social behavior and social systems. In general, sociobiology represents a relatively straightforward application of contemporary versions of neo-Darwinism: social behavior is generally interpreted in adaptive terms, and specifiable traits are thought to be developed, retained, and modified according to their contribution to the probabilities of reproductive success of the organisms (or their close kin), in accord with the standard form of ultra-Darwinism to be found, for example, in the works of Richard Dawkins (e.g., 1976, 1982, 1987).

The view that behavioral traits, like any phenotypic trait, can be understood fundamentally as devices for reproductive success amounts to an elision in an evolutionary theory of causal processes underlying the origin, maintenance, and modification of adaptations. We observe, for example, that sharp teeth, a fusiform body, and a capacity (including behavioral repertoire) for remaining motionless, then darting rapidly from ambush to seize prey, is characteristic of the general feeding adaptations of the redbfin pickerel, *Esox americanus americanus*. We can assume, in this instance, that the behaviors and morphologies functioning in the observed manner were evolved for the purpose we see them fulfill—in other words, they are adaptations for feeding. To claim that such feeding adaptations are actually devices for spreading the genes underlying such morphologies and behaviors is consistent with Dawkins's notion of "selfish genes" but is not the best possible description of nature. The sharp teeth, fusiform body, and so on are for efficient capture of prey; they are not for enhancing reproductive success. Yet it is, of course, true, as Darwin and Wallace taught us long ago, that fish that eat more efficiently will tend on average to leave more offspring—bearing the qualities of their parents—than will those less well endowed. Natural selection is a matter of differential economic success biasing reproductive success. To elide the statement and claim that (economic) adaptations arise for the enhancement of reproductive success—instead of seeing selection as a side effect of relative economic success—is to provide a distorted description of the origin and (worse) the present-moment functioning of a phenotypic trait complex. Not least among the difficulties arising from such a worldview is that the genetically based instructions for building such systems somehow emerge as of greater importance than the systems they build—a general difficulty with the ultra-Darwinian notion of selfish genes.

Sociobiologists, as I have pointed out elsewhere (Eldredge, 1987),

tend to describe social systems as if they arise and are maintained by a competitive struggle among organisms to pass on their genetic information. G. F. Oster and E. O. Wilson (1978) provide a refreshing counter-tendency; in their monograph of hymenopteran caste evolution, these authors devote the greater amount of their attention to what they call "ergonomics," that is, the economic behavior(s) of castes within insect colonies. Such behavior (which amounts to the growth, differentiation, and maintenance of the soma of all organisms, plus additional aspects in social organisms) typically dominates the vast bulk of any organism's life. Relatively few organisms spend a disproportionate amount of their time (and economically based energy) on reproductive matters—queens in hymenopteran colonies being an obvious exception.

In nonsocial organisms, there is an increasing distinction between soma and germ line—between anatomical areas devoted to the two great classes of biological process involving matter-energy transfer and replication and transmission of genetic information (reproduction)—as the skein of organismic complexity, from prokaryotic bacteria through multicellular eukaryotic organisms (plants, fungi, and animals) is surveyed. As I and colleagues have argued elsewhere (Eldredge and Salthe, 1984; Eldredge, 1985b, 1986), the dichotomy between the two classes of biological process becomes even more pronounced when we look at larger-scale biological entities. Organisms are simultaneously parts of two very different hierarchically arrayed systems. On the one hand, organisms are parts of local populations (of conspecifics), which are in turn parts of local economic systems (ecosystems); local ecosystems are parts of larger, interconnected regional economic systems—and so on, until the entire biosphere of the earth is considered.

On the other hand, organisms are parts of species, which in turn are parts of monophyletic taxa. These are the entities of traditional interest to evolutionists. They are historical entities and, on a moment-by-moment functional basis, are best seen as packages of genetic information that stock the economic arena—the ecosystems in which the moment-by-moment business of life is conducted. I have argued (especially Eldredge, 1985b, 1986) that evolutionary theory in general has been based on a faulty appreciation of the nature of these large-scale entities. In particular, there has been a strong tendency to confound the two sets of processes and hierarchical systems. Cross-genealogical economic systems (ecosystems) are all but completely absent from standard evolutionary discourse, and, instead, species and monophyletic taxa are depicted as economic entities, occupying "niches" and "adaptive zones."

The point of all this biological ontology is simple. If there truly is a formal dichotomy between large-scale biotic entities, if economic and genealogical systems above the level of organisms are indeed separate, all social systems emerge as reintegrations of the reproductive and economic activities of organisms. From this perspective, social systems are very much hybrid affairs—stable entities arising from a complex comingling of reproductive and economic organismic activities. And as would perhaps be expected, the form assumed by such a reintegration varies greatly. In most hymenopteran colonies, division of labor remains strict, with particular castes assigned particular economic or reproductive roles. The blending of the twin themes arises because all bees of a colony share the same mother, and the economic activities of non-reproducing castes are extended in part in procuring energy sources for reproductive activities.

Mammalian social systems as a rule follow a strikingly different course of economic and reproductive integration. In human societies, family units are economic and reproductive cooperatives, with male(s) and female(s) performing purely economic tasks (however much these tasks may be the same or differ) as well as (different) reproductive functions and a variety of economic activities directly pertaining to reproduction, as in care of offspring.

Yet even within human society, there is a tendency to segregate reproductive activities from economic ones.¹ Thus complex and generally hierarchically interested entities are rife in the economic sector of any complex society. An individual *Homo sapiens* typically belongs to some form of family, but also, in complex societies, may be part of a department within a division of a company within a multinational corporation—the prime source of economic input to the individual's life. There are myriad other categories of "economic" organizations, most of which are also hierarchically structured, to which that same individual may belong—fraternal organizations, sports teams, religious and political groups, and others. To a hierarchically minded biologist, human social organization offers the clearest examples of hierarchically structured systems to which organisms can belong.

Thus, beyond the simple example of families, human social organiza-

1. "Economic" pertains to all processes of matter-energy transfer in organisms used for the differentiation, growth, and maintenance of the soma; used this way, "economics" is a more general concept than the usual meaning of the term in the social sciences.

tion in general clearly reveals the duality of organismic existence in general, reflecting the clear and obvious distinction between economic and reproductive activity to be drawn. Even the hierarchical associations of families reflect this dichotomy. Families are hierarchically structured in at least two separate ways: they are genealogically structured into hierarchies of relationships, and they are cross-genealogically economically structured, as when clusters of (generally) cross-genealogical (unrelated) families form villages, towns, and similar communities of varying degrees of geopolitical integrity. Such associations of families are obviously of economic, rather than reproductive, importance.

And yet, in human society, there is far greater interplay between the economic and reproductive activities of component organisms than in nonsocial organisms. A coral spends much of its time respiring and, when favorable conditions prevail, with tentacles fully extended, acting as a sort of microcarnivore, removing tiny (and, in some species, even larger) organisms from the seawater. Occasionally, provided there is enough energy beyond the needs simply to maintain body tissues, the coral will reproduce. (Organisms in general do not reproduce unless they have an excess of energy—reproduction being a physiological luxury not needed for an organism's survival.) In humans and other mammalian social organisms, the situation is far more complex; not only do normal Darwinian considerations—namely, that relative economic success impinges on probability of reproductive success—obtain as in all sexual organisms, but reproductive success may have an equally direct impact on economic success. For example (and as I have discussed in Eldredge, 1987), evolutionists and eugenicists have often decried the propensity for members of disadvantaged socioeconomic classes to produce more children than members of higher classes—an apparent contradiction in the eyes of many early biologists (see Kevles, 1985). The work of another Victorian—Karl Marx—supplied the answer to the puzzle: reproductive proclivity is a source of labor, thus of direct economic import to the family as a potential source of wealth.

Thus social systems introduce a complexity to the causal network of interaction between the economic and reproductive activities of organisms. Not only does economic success determine (stochastically) reproductive success, but reproductive success (measured in means other than pure numbers—as in “quality” as well) has many potential economic ramifications. One son playing shortstop for the New York Yankees may well mean more to the old-age economic welfare of parents than five whose own economic fates are far less grand. Such considerations

are unimportant in a biological evolutionary context because older people are generally past the age of reproduction, but from the standpoint of the fabric and stability of a social system, they may be very relevant indeed.

STABILITY AND CHANGE IN SOCIAL SYSTEMS

There is an epistemological bind in the recognition of long-term, large-scale systems as entities. Although it is by no means a logical, formal requirement, it is obviously helpful to their recognition if such entities remain stable, thus recognizably more or less the same for extended periods of time. Thus stasis greatly aids in the recognition of a species over intervals of millions of years in the fossil record. Such stability is also of importance in recognizing long-term social entities, such as the "Anasazi" culture of the American Southwest (Berry, 1982).

Yet stability is not *prima facie* evidence that what is involved is a large-scale entity. Stasis in biological systems involves the anatomical (or phenotypic in general) properties of organisms; evolutionary non-change in such features no more ensures that species are "individuals" than does stasis in cultural traits imply that nation-states are spatiotemporally bounded entities. Yet if there is independent evidence and reason supporting interpretations that large-scale systems such as species and nation-states are spatiotemporally bounded entities, it becomes abundantly clear that stability in phenotypic and cultural traits (respectively) is of enormous practical utility in recognizing such systems.

Once the possibility that such systems are large-scale entities is entertained, however, their existence affects interpretations of stasis and change in biological or cultural traits. Just as we ask how speciation and species extinction affect patterns of stasis and change in organismic adaptations, we also must ask, What are the general patterns of stasis and change in the histories of cultural traits? What governs stability? What prompts change? What forms of interactions between large-scale sociocultural entities act to promote either stasis or change of cultural traits?

The work of historian F. J. Teggart (esp. 1925) provides some insight into how such a line of inquiry can be developed. Teggart noted parallel problems between biological and social theories of evolution.² Teggart claimed that there are three main patterns underlying stasis and change

2. For example, Teggart (1925) said he turned to Darwin to provide a model for

in historical cultural systems. First and foremost, is stability, governed by custom and other factors; the strongest signal of history is simply nonchange.

Second, there is a tendency for long-term change gradually to accrue within a sociocultural system. Teggart's example involves language—the drift in linguistic usage that happens so rapidly as to be detectable within the span of a single human lifetime. R. Lande (1976) has discussed seemingly comparable, albeit proportionately even slower, patterns of morphological drift through time within species in the fossil record.

But such gradual change (contrary to the basic models of both biological and cultural evolution) does not seem to be the stuff of “real” evolutionary (or historical) change. New species (even genera and families) may come and go, all the while some lineages are slowly accruing gradual change through time; and the differences between closely related (or ancestral-descendant) species often do not seem to arise as a smooth function of patterns of variation (of gradual, protracted, directional change) within the ancestral species. And so it is, Teggart writes, with cultural change: new traits often appear abruptly and generally are not the outgrowth of slow, steady change through time.

Teggart's view of how substantial cultural change is effected in history is particularly instructive, for Teggart saw most substantial change concentrated into historical events, which result from interactions between large-scale sociocultural systems. Egyptian society, for example, was profoundly altered with the introduction of horse-drawn chariots when the Hyksos dominated the Egyptians for a while during the interregnum between the Middle and New Kingdoms.

I cite Teggart's theories of patterns and process of historical change only to illustrate the potential value of recognizing the existence of large-scale entities and the downward causal influence that their presence and interactions may have on stasis and change of cultural traits. Teggart clearly sees sociocultural systems embedded hierarchically within larger (regionally organized) entities, and he sees interactions (largely but not exclusively portrayed as collisions) between like entities (e.g., nation-states) as the source of the events that account for patterns

evolutionary thought only to be dismayed that Darwin argued that adaptive change is perforce a matter of gradual and progressive change—in spite of abundant evidence to the contrary. Teggart recognized much the same rhetoric underlying what little cultural evolutionary theory existed.

of abrupt change that interrupt vastly longer sequences of internal stability and gradual accrual of generally negligible amounts of change.

M. S. Berry's (1982) work on the sequence of cultures in the North American Southwest offers a similar example. Rather than interpreting the pattern as a linear history, in which change sometimes occurred rapidly and at other times at a more leisurely pace, Berry argues that the patterns of stasis interrupted by brief spurts of rather profound cultural change do not represent linear evolution, but rather a sequence of habitation and replacement. The Anasazi are a historical whole, as regionally diverse and temporally modified as they were. They were replaced by another cultural system, not as a smooth evolutionary outgrowth but because the Anasazi were eventually (and rather abruptly) no longer able to occupy their territory. The point is not that all sociocultural change should now be seen to come in brief spurts interrupting vastly longer periods of stasis—as a direct analogue to patterns of stasis and change commonly encountered in the biological evolutionary realm. Nor, certainly, is my aim to call for some sort of megatheory of stasis and change that permeates both biological and sociocultural systems. Rather, the point is to explore the possibility that social systems may profitably be viewed as hierarchically arrayed stable entities—large-scale spatiotemporally bounded entities. If so, then it must be true that a theory of evolution, even one that focuses exclusively on biological or cultural traits of organisms, cannot be complete if it addresses only mechanisms of stasis and change of such traits on a generation-by-generation basis. Human sociocultural systems—because they are complex amalgams of the economic and reproductive behaviors of *Homo sapiens* organisms—automatically have the capacity for interaction (as do all biological economic systems); some anthropologists have already treated the capacity of social units to split—to give rise to other such entities. Thus the further intriguing possibility emerges that such social entities may themselves be susceptible to a form of selection directly analogous to large-scale natural selection—something of an irony because neither cultural selection (because the probability of reproductive success is unaffected by variance in the distribution of cultural traits) nor species selection (because species cannot be economic interactors) are themselves wholly legitimate analogues of true natural selection.

Events that stem from the interactions and behaviors of large-scale entities in both the biological and sociocultural realms constitute biological and sociocultural history—evolution. Births and deaths of such large-scale systems are important in themselves; the possibility that