The various social sciences emerged as distinct modes of inquiry in the latter part of the 19th century. Enlightenment thinking about the inevitable march of human progress was coupled with a metaphorical use of concepts and terms from the other established sciences of physics and biology. The transfer of metaphors between areas of inquiry, back and forth and back again, has characterized scholarly discourse on nature, society, and humans. As this volume seeks to demonstrate, this discourse has entered a new, and potentially revolutionary, phase. Yet in the past, images and concepts that described one phenomenon were borrowed as analogies to describe the other. When the discrepancies between the images of such
analyses and the objects they were supposed to represent, as well as the implicit values attached to them, became apparent, biology and the social sciences diverged. Thus, the question of the role of biological thinking in the social sciences is as old as the social sciences.

However, the past borrowings from biology by the various disciplines and subdisciplines do not afford a unitary interpretation of evolutionary theory, nor do they display uniformity of impact. As is explored in this chapter, the fate of biological ideas in sociology, anthropology, archaeology, economics, and psychology has been uneven: Sometimes they flourished in a discipline, and other times they languished at the margin. In anthropology and sociology, biological arguments greatly influenced the early phases of these disciplines. Indeed, many ideas from the pre- and post-Darwinian period were incorporated into the emerging conceptual cores of sociology and anthropology. But even in these cases, the influence of biology was to wane, even in fields such as anthropology which, in America at least, had kept its biological wing within the discipline. Other social science disciplines, such as economics, political science, and psychology, have all flirted with biological ideas, but have nonetheless kept them somewhat at the margins. Even psychology, which Darwin had entered and in which physiology and neurology have always been components, has not been greatly influenced by biology until recently. Still, there is a new rapprochement with biology in all of the social sciences. If this new spirit of interdisciplinary inquiry is not to falter, as have past periods of interchange, we need to know something of what occurred in the past, where concepts were borrowed back and forth between the social and biological sciences.

However, more than mere historical curiosity guides this review of the history of interchange between the social sciences and biology. If the current receptiveness to true conceptual interchange is to remain on track, it is important to understand where it went wrong in the past and, perhaps equally important, where it was on track, but somehow became sidetracked and pushed to the margins of a discipline. If we do not know what occurred in the past, we are potentially doomed to make the same mistakes as our scholarly forbearers.

There are additional reasons to be concerned with history. One is that current approaches within the social sciences are still subtly influenced by their past connection to biology, although this connection has often been lost as new vocabularies have been adopted within each of the social sciences. Yet another is to document the loss of early insights that have had to be rediscovered in the present era, and hence, to warn against a similar loss in the future. Another reason to examine history is to reveal that the borrowing of ideas from biology was not just one way. Biology borrowed from the social sciences, as is most evident in Darwin's use of Malthus' essay on population, Hughlings-Jackson's reliance of Spencer's views on differentiation and hierarchy, and, more recently, Maynard Smith's adaptation of game theory to evolutionary equilibria. A final reason to pay attention to history is to learn that the social science disciplines were not always so well insulated from each other, and that if biology and the social sciences are to once again influence each other, the boundaries among the social sciences disciplines need to be reexamined to see what they once had in common.

We need not adopt E.O. Wilson's somewhat arrogant belief that sociobiology would be the basis for the "new synthesis" to recognize that the use of biological ideas within the social sciences may represent an important way to bridge disciplinary boundaries. Hence, there are good reasons to look back at the history of the social sciences and their involvement with biology before we look forward to the creative use of biological concepts and models in the social sciences today.

The purpose of this chapter is not to present a comprehensive history of these disciplines. Rather, it offers reflections by contemporary theorists on the past and current impact of biology in each of their disciplines. The situating of contemporary attempts to bridge disciplinary gulfs between social sciences and biology within their respective contexts is necessary both for understanding the significance of the current foray into what have been embattled territories and for eluding the traps of potential confusion and misunderstanding.

BIOLOGY AND SOCIOLOGY

Jonathan H. Turner, Alexandra M. Maryanski, and Bernhard Giesen

Sociology and economics share common roots in the work of Adam Smith (1776 [1937]), who posed the central problem that was to guide the use of biological metaphors in sociology as they were blended with Newtonian physics and Enlightenment philosophy. For Smith, the key dilemma of modern society was the division of labor: If societies were to reveal ever more specialization of activities, what force was to hold this
diversity together? A similar question consumed the French Philosophers. In the first decades of the 19th century, Auguste Comte (1830–1842) merged the British and French wings of the Enlightenment into a discipline that, in deference to Newtonian mechanics, he initially termed social physics and later sociology. In seeking to forge sociology as a "positivistic" social science, Comte turned to biology. Sociology was to arise out of biology in the hierarchy of the sciences, and, once developed, was to inform biology. But aside from superficial analogies between society and organisms, Comte's linking of sociology with biology seems to have been primarily a legitimating ploy to make sociology respectable by associating it with what was fast becoming the most respected of all the sciences.

It was Herbert Spencer (1874–1896 [1898]) who systematically incorporated biological concepts into sociology and, in so doing, articulated three lines of biosocial thinking. One was a sophisticated developmentalism, or stage model of human history ranging from simple to complex societal forms. Another was a revived organicism, or the drawing of analogies between organic and superorganic (societal) bodies. A third was selectionism, or the view that a driving force behind the evolution of superorganic bodies was conflict and selection of the fittest. Each of these modes of thinking about society was to be developed more fully in the post-Darwinian era, but the seeds for all three were clearly evident in Spencer's synthetic philosophy. Spencer is a key figure in establishing the basic way sociologists and other social scientists still use biological and evolutionary thinking.

Spencer's initial borrowing from biology involved an analogy between the growth of an organism and the development of a society. Before Darwin, evolutionary thinking often focused on how a single cell becomes a multicellular organism, and hence developmental and evolutionary ideas were often fused. In particular, the embryology of von Haller, Bonnet, Wolf, and, most important, Karl Ernst von Baer was critical of Spencer's analogy to organismic development. Spencer's view that societal evolution involves a movement from "homogeneity" to "heterogeneity" was taken from von Baer's work on embryology and cell theory. It was then blended with notions from physics about "matter," "motion," and "force" to form a general "law of evolution" for all domains of the universe—organic, superorganic, psychological, inorganic, and ethical. Thus, by employing an embryological, rather than Darwinian, analogy, Spencer saw, as a process of growth and differentiation, a conceptual emphasis followed by virtually every sociologist since Spencer.

Only well after Darwin did evolutionism become associated with the notion of "descent with modification" through selection processes as these affect heritable variation. With Darwinian theory, the emphasis was on speciation through competition and selection, whereas with pre-Darwinian thinking, the concern was about growth and development. Ironically, the most Darwinian sounding ideas in Spencer's philosophy (i.e., competition and the "survival of the fittest") predate his major scientific treatises on biology (H. Spencer, 1864–1867 [1887]), psychology (H. Spencer, 1854–1855), and sociology (H. Spencer, 1873, 1874–1896 [1898]). As Spencer moved into sociology in the 1870s, he was more apt to emphasize organicism and developmentalism. Yet curiously, it is H. Spencer's (1852 [1888]) early, more philosophical tracts on "survival of the fittest" that are most remembered. Even when H. Spencer (1874–1896 [1898]) employed selectionist arguments in his sociology, these are group-selectionist in tone: Better organized societies are more "fit" and can conquer, annex, and assimilate less organized societies, and thus over the long course of human history, war has been a force in increasing the scale and complexity of societies. In these arguments, societies are the units of competition, selection, and adaptation. This position is still dominant in modern theorizing in sociology that employs selectionist models.

Spencer's other modes of thinking are also still prominent. His analogies between organisms and society ultimately represent the logic of modern functionalism (J. H. Turner & Maryanski, 1979), where a sociocultural part is analyzed with respect to its functions for the operation, maintenance, and adaptation of the larger social whole. In his more functional analyses, which are explored in more detail in chapter 6, he implicitly introduced another kind of selectionist argument: The potential for disintegration or "dissolution" of a population creates selection pressures for new kinds of social structures in the absence of density and competition among structures (i.e., selection often works without an existing range of variation on which competition and selection can operate).

Spencer's construction of an evolutionary stage model, where basic types of historical societies are arrayed along an assumed evolutionary continuum from simple to complex, is still the dominant way sociologists think about evolution (e.g., G. Lenski, 1966; G. Lenski, J. Lenski, & Nolan, 1991; Maryanski & J. H. Turner, 1992; Parsons, 1966, 1971; Sanderson, 1990; J. H. Turner, 1972, 1984). Indeed, Spencer's model is by
far the best of all the 19th-century models constructed by sociologists and anthropologists.

In the late decades of the 19th century, and well into the first two decades of the 20th-century, some sociological theorizing became intertwined with Darwinian metaphors, although it should be emphasized, once again, that the most prevalent mode of evolutionary thinking in sociology was, and still is, the non-Darwinian stage model, which, it can be argued (e.g., Nisbett, 1969), represents the continued influence of Enlightenment thinking about human "progress" (especially the French who provided the vision of progress for Saint-Simon, Comte, de Tocqueville, and Durkheim, but also the lineage of German idealism from Hegel through Marx and on to Habermas and his disciples in contemporary social theory). Notions of competition and selection were often blended with organicism in Europe, particularly after the widespread translation of Darwin's *The Descent of Man*, published in 1880 (cited in Barnes, 1925). Beginning in the 1870s, Lilienfeld (1873–1881; 1898), Schäffle (1875–1878), and Worms (1896) all sought to extend Spencerian organismic analogies to social systems. Although Lilienfeld went so far as to argue that society is an organism, most of these thinkers simply repeated Spencer's views that societies and organisms reveal some common processes (e.g., growth and development, size and differentiation, structural and functional interdependence). These analogies were undergirded by a view of societal development (i.e., growth, differentiation, interdependence, decline, and death) as being driven by competition and selection. True to Enlightenment thinking, scholars like Schäffle could conclude that "the progressing formation of society (civilization) is the highest result of perfecting selection of human struggles for life." (p. 3)

Other Europeans, such as Gumplovicz (1875), pursued a more explicitly Spencerian, geopolitical argument: As humans evolved, they formed heterogeneous groupings, which, inevitably, came into conflict over resources; the conquered were often exterminated, but eventually the state was created for political subjugation; once the state existed, internal conflicts increased, leading to assimilation of diverse groups to mitigate such conflicts. Thus, in Gumplovicz's view, societal evolution had revolved around war, internal conflicts, state formation, amalgamation, and assimilation. Others (e.g., Ratzenhofer, 1881) pursued these ideas, although they saw selection for the political state primarily as a response to internal conflicts.

1. HISTORICAL CONTEXT OF PRESENT PRACTICE

These approaches all appeared in early 20th-century texts of the first generation of American sociologists (e.g., Ward, 1903; Small, 1905). It was William Graham Sumner's student and colleague, Albert Galloway Keller (1915), who, in his *Societal Evolution*, sought to use Darwinian concepts as replacements for Spencer's ideas about evolution as movement from incoherent homogeneous to coherent heterogeneous. Instead, Keller proposed that notions of variation, selection, transmission, and adaptation should be used in the analysis of societal evolution. Drawing on Sumner's (1906) conception of "mores," as well as his ongoing collaborative work with Sumner (Sumner & Keller, 1927), Keller anticipated modern coevolutionary theory's emphasis on cultural symbols and memes, arguing that certain variations in mores are selected and then transmitted (through imitation and education) when they increase the adaptation of groups (rather than individuals) to an environment.

Accompanying this kind of sophisticated analysis in both Europe and the United States was, unfortunately, a more sinister ideological argument: Social Darwinism (Hofstadter, 1945). Keller's mentor, Sumner (1914), was the most vociferous advocate of the view, initially articulated by H. Spencer ([1852]1888) in *Social Statics* and picked up by Gumplovicz and others in this German–Austrian lineage, that unregulated competition among individuals should be allowed to proceed, sorting out the fittest from the least fit, with inequalities being the natural outcome of this competition and selection. Moreover, to maximize societal fitness, this basic law of nature should not be subverted by uncalled-for social intervention and amelioration. The advocates of eugenics emerged from this ideological movement, and even important figures in genetics such as R. A. Fisher (1930) incorrectly used Spencer's words to propose arguments in favor of "unnatural selection" (or selective breeding of the fit; see chap. 2).

All of these models fell into intellectual oblivion, except for the persistence of the organismic analogy in modern functionalism. Drawing heavily on Spencer's views about size and differentiation, Durkheim ([1893]1933) added an explicitly Darwinian dynamic: Differentiation is the result of competition and selection, which, in turn, are generated by increased moral (rates of interaction) and material (population size, ecological concentration) density. But in human populations, such selection does not lead to the "death" of the less fit, but rather to their differentiation into specialties more suited to their talents. Thus, the driving mechanisms behind evolution from simple to complex structures are niche den-
sity, competition, and selection. It is from these Durkheimian metaphors that human ecology as a theoretical perspective emerged in post-World War I American sociology, and it is in this theoretical school that Durkheimian thinking exerts the most influence in sociology today.

In essence, there are two levels of ecological work within sociology: At the mesolevel, there is organizational ecology and urban ecology; at the macrolevel, there are societal analyses from an ecological perspective. At the mesolevel, all these models proceed from the assumption that the aggregation of a population generates competition for resources, especially land and space, under conditions of high density or concentration (Burgess, 1925; C. Harris & Ullman, 1945; Hoyt, 1939; McKenzie, 1953; Park, 1916, 1936; Park & Burgess, 1925; Wirth, 1928; Zorbaugh, 1926). Such competition was seen to create a high-velocity real estate market that, reciprocally, fuels competition over land use (McKenzie, 1933), leading to spatial differentiation. Differentiation and competition eventually push the boundaries of the urban region outward (suburbanization) as "less fit" users of space seek less costly land resources.

Later extensions and adaptations of this basic ecological model add some useful refinements (see, e.g., Berry & Kasarda, 1977; Frisbie & Kasarda, 1988), and in many ways, these extensions have obscured the underlying Darwinian dynamic. By contrast, although urban ecology has increasingly obscured its Darwinian-inspired origins, where emphasis is on density, competition, and selection, the other mesolevel approach—organizational ecology—has given special emphasis to these processes and, in fact, has sought to supplement Durkheim's metaphorical use of Darwinian ideas, with the explicit adoption of concepts from bioecology (Hannan & Freeman, 1989).

The units of analysis in Hannan and Freeman's approach are populations of organizations revealing similar forms in terms of their structure of positions, patterns of activity, products and services, norms, and reliance on external resources. A population or subpopulation of organizations in a larger and more inclusive social system is the analogue of a "species" in bioecology because its member organizations evidence similar characteristics and dependence on particular kinds of environmental resources. Following earlier ecological work in sociology (e.g., Hawley, 1950), a basic assumption in their approach is that there is an "isomorphism" between the diversity of subpopulations of organizations, on the one hand, and the variability of resource environments, on the other. This isomorphism between types of organizational structure and configur-
Carroll, 1984) employed this logic to predict the pattern of foundings and failures of organizational types. Foundings increase rapidly at an accelerating rate (as a consequence of underutilization of resources in a niche and increasing legitimation) up to the point of high density, when the number of organizations of this type should begin to decline (as a result of increased competition for resources and selection).

This line of ecological work has stimulated many variants (e.g., McPherson, 1981, 1983, 1990), but the essential argument remains the same: Types of organizations are the equivalent of a species in the biotic world. The prevalence or decline of a given type of organization is related to the level of resources in its niche, the density of organizations in this niche, and the resulting competition and selection among organizations in a niche.

Along with the proliferation of urban and especially organizational ecological approaches, there have been efforts to "upsise" ecological theory back to the macrolevel originally pursued by Spencer and Durkheim (Hawley, 1986; J. H. Turner, 1994a, 1994b, 1995). The key figure here has been Amos Hawley (1944, 1950, 1971, 1973, 1978, 1981, 1986) whose early work continued the urban ecological tradition of his mentor, McKenzie (1933). From the beginning, Hawley sought to move beyond the Durkheimian metaphor and, thereby, to incorporate ideas from biocology into the analysis of the dynamics organizing human populations. For Hawley, the basic units of human organization are "corporate" units (goal-oriented structures organizing and coordinating individuals' activities) and "categoric" units (classifications of individuals in terms of distinguishable characteristics). Therefore, ecological analysis must explain the dynamics of corporate and categoric units that enable a population to become organized for survival in an environment. In pursuing this explanatory goal, Hawley introduced the notion of "mobility costs" for moving people, material, and information about a population. Such costs are an inverse function of communication and transportation technologies, and they ultimately determine how many corporate units can organize a population. If mobility costs are high, relatively few corporate units revealing little differentiation or spatial dispersion can survive. Because of this, few categoric units can be created or sustained. If a societal system is exposed to information from other populations, it is likely that new technologies will be adopted, thereby lowering mobility costs and increasing the number and differentiation of corporate and categoric units, up to the limits of complexity allowed by a particular type and level of technology.

To the extent that Darwinian ideas are still employed by Hawley, the focus is on how competition for resources affects patterns of growth and differentiation in a population. Population size, density of settlement, and extensiveness of markets all escalate competition for resources, which then increase the number of corporate units seeking resource niches and the number and size of categoric units. Corporate units generate categories (e.g., job classifications, education levels), but more important is the effect of threat arising from competition on the formation of large categoric units (e.g., by ethnicity, region, social class) which can disrupt balances of power. Such potential leads to a complex set of dynamics revolving around co-optation of categoric units into existing networks of power, which, in turn, have effects on the overall level of political regulation among members of a population. The details of this analysis are beyond this brief overview, but to the degree that ecological analysis can be used at a macrolevel of analysis, the focus is on how competition for resources affects balances of power. If competition and selection generate threats to significant numbers of individuals, these threats create large categoric units that can potentially become mobilized as a corporate unit to challenge centers of power.

As the vagueness of Hawley's macrolevel ecological approach testifies, the adoption and adaptation of Darwinian ideas to sociological analysis works best at the mesolevel, particularly for the analysis of competition and selection among types of organizations. Urban ecology is also amenable to this kind of analysis. However, once one moves beyond the narrow forces of the competition for land and space, it becomes more difficult to delineate resource niches, units and populations, and densities, which, in the end, are the key forces behind competition and selection.

Recently, Darwinian-inspired ecological arguments have been extended to new topics. For example, in a vein reminiscent of Keller in the United States, Wuthnow (1987) has sought to analyze the rise and fall of religious movements in terms of variation, competition, and selection among ideologies. In England, Runciman (1989) attempted to reconnect a stage view of societal evolution to a model of competition and selection among the "practices" within units he termed syntacts. Syntacts are "carriers of mutant or recombinant practices" that compete for ideological, economic, and coercive advantage, and, in so doing, transform societies.
Both of these approaches are highly metaphorical, borrowing images of Darwinian selection with little precision.

A more detailed (although still analogous) use of Darwinian concepts can be found in several European attempts to reconstruct key problems of social theory in a selectionist way (Giesen, 1980, 1991; Schmid, 1982; Schmid & Wuketits, 1987). Attacking the general evolutionism of the Hegelian tradition, but also the straightforward reductionism of radical sociobiology, these reconstructions treat the Darwinian paradigm as an analytic model that can be separated from its material-biological interpretation and transferred to the domain of sociology. For example, social rules are considered to be the analogues of biological genes; they are recombined in processes of social interaction, and are selected by the particular social situation to which they apply. In contrast to rational choice models of social evolution (e.g., Axelrod, 1984; Boulding, 1978), however, the individual actor and his or her preferences are no longer the reference for processes of selection. The single actor perspective is replaced by a Durkheimian or Hobbesian orientation: A social rule is selected because of its superior ability to cope with the complexity of a given situation. These selectionist reconstructions of classical social theory claim to account for the differences between the material domains of sociobiology and biology—thus leaving the core assumptions of sociological ontology untouched—but also to bridge the gap between the disciplines by an interdisciplinary theoretical heuristic.

In summary, the post-Darwinian period produced a variety of models that were seriously flawed. Because of this, selection arguments receded in sociology. The only persistent Darwinian model has been human ecology, which emerged with Durkheim's adoption and adaptation of Spencer. There has been a recent effort to extend this kind of ecological analysis to ideological competition and societal evolution. The latter effort is reminiscent of models in the late 19th and early 20th centuries, which also sought to connect Darwinian notions of selection to an analysis of the stages of societal development. Yet today the dominant evolutionary model in sociology is primarily a non-Darwinian analysis of societal types in terms of such macrolevel forces as technology, production, power, and inequality, although a recent theory by J. H. Turner (1995) sought to synthesize selectionist and non-Darwinian analyses.

It is in this context that the failure of sociobiology to take hold in sociology must be viewed. Drawing from Fisher, who invoked Spencer, but owing the most basic argument to G. Williams (1966) and others, sociologists typically see sociobiology as ignoring those "emergent" sociocultural phenomena that reveal their own dynamics and that require their own modes of explanation. Second, sociobiology is viewed as simplistic, trying to explain complex, emergent phenomena in terms of ideas about genic fitness. Even those who argue that sociological explanations should be simple and parsimonious recoil at the thought of explanations revolving around a couple of extensions of fitness assertions (e.g., inclusive fitness and reciprocal altruism). Third, sociobiology is viewed as producing glib, ad hoc, and easily constructed stories about how a phenomenon promoted genic fitness in the evolutionary past (Maryanski & J. H. Turner, 1991).

For at least these reasons, then, sociobiology has made few inroads into sociology. Although there now appears to be some interest in introducing biological models back into sociology, above and beyond the models of human ecology, it is unlikely that even a more muted form of sociobiology will enjoy much success.

A more recent alternative to sociobiology is a set of approaches emphasizing that cultural phenomena operate in terms of Darwinian principles. Early versions of this argument (e.g., R. D. Alexander, 1977; Dawkins, 1976; Lumsden & E. O. Wilson, 1981) still insist that cultural evolution is highly circumscribed by considerations of genic fitness, and so they are not likely to have much influence on sociology for the reasons noted earlier. Coevolutionary approaches from anthropology, however, have more potential because they only assert that isomorphisms between
the processes of biological and cultural transmission can be the basis for constructing theoretical models. Such an approach does not aver that cultural transmission is reducible to genic processes, although a number of coevolutionary approaches propose interactions between genetic and cultural transmission (e.g., Cavalli-Sforza & Feldman, 1981; Durham, 1991). Other approaches, such as the dual inheritance models of Boyd and Richerson (1985), only emphasize that because culture is transmitted, it can be studied employing the same Darwinian methods used to study genetic evolution (Richerson & Boyd, 1992).

This emphasis on Darwinian ideas (i.e., variation, competition, selection, and transmission of traits) is as old as Keller's (1915) effort to examine the evolution of mores in Darwinian terms, or as recent as Wuthnow's (1987) analysis of the competition among religious ideologies. (The more general argument that Darwinian dynamics also operate on sociocultural processes echoes the conceptual thrust of the long-running cybernetics school.) With the exception of a few scholars (e.g., Hanan & Freeman, 1977; Hawley, 1950), the use of Darwinian ideas has not been very precise; instead, only metaphorical analogies to Darwinian ideas are generally made. In contrast, as is examined shortly in the review of anthropology, coevolutionary and dual inheritance models are more precise, using Darwinian ideas to build elegant models, rather than imprecise metaphors.

In summary, sociology was born as a self-conscious discipline by drawing parallels to biological processes—at first analogies to organisms and later to Darwinian selection processes. Yet despite this early connection, biology has not served as a great source of theoretical inspiration for the discipline, save for human ecology and modern-day functionalism (which has long repressed its roots in the organismic analogy). With a few exceptions, evolutionary models are clearly non-Darwinian, and owe more to Enlightenment thinking about stages of human progress than to Darwinian selection. Part of the reason for this lack of real influence of Darwinian concepts has much to do with the extremes of Social Darwinism and the eugenics movement in the early decades of this century, which caused subsequent generations of sociologists to stay away from concepts and models with such unsavory connotations (see chap. 2). The emergence of sociobiology did not help this situation because of its extreme reductionism (at least in the eyes of most sociologists, see Freese, 1994). Hence, biology has not made significant inroads into sociology in recent decades. Coevolution and dual inheritance models offer some hope for a rapprochement of Darwinian and sociological models beyond the narrow confines of the human ecology school.

BIOLOGY AND ANTHROPOLOGY

Monique Borgerhoff Mulder, Alexandra M. Maryanski, and Jonathan H. Turner

Sociology and anthropology share common origins, although the concern of anthropology with preliterate cultures increasingly led to the separation of the disciplines, despite the fact that early pioneers such as Radcliffe-Brown and Malinowski saw their work as sociology. Anthropology, at least in the United States, differs from sociology in that biological and archaeological components were kept organizationally attached to the social or cultural wing of the discipline.

This connection of the "physical" side of anthropology to the "social" or "cultural" side created problems during the formative beginnings of the discipline. Before Darwin, the physical side focused on the question of "race" and especially on documenting the biological superiority of white Europeans. Much of the effort to "scientifically" establish the superiority of Europeans focused on the measurement of skulls, postulating that absolute cranial size, narrow or wide skulls, size of frontal lobe, and other features distinguished the races. The leader of this movement, Paul Broca, established the Anthropological Society in Paris during the same year that Darwin's (1859) On the Origin of Species was published. After Darwin, and along with the growing acceptance of an evolutionary view, a new justification for such racist thinking emerged: Whites were the most evolved humans, and hence most distinct from apes (with Africans being viewed as the closest). These kinds of arguments were to prove compatible with Social Darwinism, as well as the eugenics movement. As a result, when the racism and ethnocentrism contained in these ways of thinking were destroyed by Boas (1911) and Klineberg (1935), the use of biological theory to interpret sociocultural processes remained under a cloud of suspicion in anthropology and sociology for several decades.

Parallel to the use of biological theory to buttress the ethnocentrism of white Europeans came the development of stage-model evolutionism in the cultural wing of the discipline. For example, in England Tylor (1871) saw societies as evolving from "the simple savage" to the "com-
plex Englishman." Tylor (1888) also saw a "psychic unity of mankind," in which institutions "succeed each other in a series substantially uniform over the globe, independent of what seemed the comparatively superficial differences of race and language, but shaped by a similar human nature acting through successively changing stages in savage, barbaric and civilized life" (p. 54). In America, L. H. Morgan (1877) echoed these sentiments when he argued that, "since mankind were one in origin, their career has been essentially one, running in different but uniform channels upon all continents, and very similarly in all tribes and nations of mankind down to the same status of advancement" (p. 7). Although these developmental approaches were not blatantly racist, the portrayal of stages in these models suffered from heavily evaluative terms like primitive, savages, barbarism, and civilization. No one questioned the assumption that European society was the most advanced stage of human evolution.

The mechanisms driving movement from one stage to another were not systematically theorized. Independent invention and diffusion were the favorite explanations; for the most part, they did not invoke Darwinian ideas of selection, adaptation, and descent. Some evolutionists focused on particular institutions, like kinship (e.g., Bachofen, 1861) or law (Maine, 1861), as crucial evolutionary forces. Compared to Spencer's model, they seem conceptually and empirically inadequate.

Outside the Anglo-American line, the "culture history school" in Germany, including such scholars as Leo Frabenius, Robert Graebrer, Friedrich Ratzel, and Wilhelm Schmidt, all attacked simple models of unilinear evolution, arguing instead that complexes of culture develop and then diffuse. Instead of "armchair" speculations about straight-line stages of human progress, the contingent and unique history of a culture must be examined.

The ethnocentrism of stage models of evolution and the undocumented assumption that diffusion was a driving mechanism of evolution and cultural history both came under attack from Franz Boas (1911). For Boas, who came to Columbia University in 1896 and trained the first generations of American anthropologists, the goal of anthropology was to describe the characteristics of "each culture" and to reconstruct its history, although the latter proved rather difficult for populations without written records. As Boas pushed stage-model evolutionism and diffusionism to the margins of anthropology, he inadvertently fostered a number of alternatives. First, he helped keep physical and cultural anthropology together in America, ensuring that a nonracist approach to biology could be part of the anthropological approach. Second, his students' interest in the ethos, or Weltanschaung, of each culture initiated an interest not just in "culture and personality," but also in cultural transmission processes. The first efforts in analyzing culture and personality were Freudian, later ones less so. But when these died out, the issue of transmission of cultural patterns remained, and it was here that more systematic incorporation of biological models could occur. Third, by rejecting evolutionists' and diffusionists' claims, and by focusing attention on the history of a population as a means to explaining its culture, concerns with the effects of habitat, environment, and ecology began to increase, especially because history was impossible to reconstruct among preliterates, and this set the stage in later decades for cultural ecology and, eventually, more sociobiological approaches. Finally, without stages of evolution or diffusion as an explanatory tool, a door was opened for functionalism to be incorporated into anthropology.

The last development reinvigorated an approach that was dying in sociology by the turn of the century. In fact, had Radcliffe-Brown and Malinowski not turned to functional explanations, this approach would have died with Durkheim (J. H. Turner & Maryanski, 1979). In saving functionalism, the organismic analogy was kept alive. With Malinowski (1944), biological needs for survival, or what he termed vital sequences, were the "primary needs" on which social structure is first built, later to be supplemented by emergent, "derived needs" that came when structure and symbols are elaborated. But Malinowski and later Parsons (1951) made biological forces once again a parameter of sociocultural organization.

By the middle of the century, the biological models were more systematically incorporated into cultural anthropology, as the explanatory power of alternative approaches seemed limited. Leslie A. White (1959) sought a return to stage-model evolution in a much more sophisticated form, and suffered for his efforts by heated critiques from the Boasians. It was perhaps Julian Steward (1955) who made the connection between evolutionary biology and cultural anthropology. Influenced by his training in evolutionary biology, Steward proposed that the environment, together with the technological achievements of the social group in question, determine the payoffs to various patterns of human action. Hence, a modern, if somewhat loosely defined, notion of adaptation lay at the heart of Steward's account of cultural change. Like his intellectual forbears, however, Steward never came up with a clear explanation or pre-
aversion to evolutionary thinking, associated no doubt with the notorious excesses of Social Darwinism; (b) a poor specification of the causal roots whereby evolutionary processes might influence human behavior (Kit-cher, 1985); and (c) disagreement among sociobiologists as to the implications of cultural influences on behavior (e.g., Daly, 1982).

Yet sociobiology, and especially the closely related fields of human behavioral and evolutionary ecology, presently holds a legitimate position within anthropology (Cronk, 1991; L. Lieberman, 1989; E. A. Smith, 1992). This position can be attributed to four principal factors. The first is that anthropology as a discipline has long been concerned with cross-cultural variation as arising from adaptation to different environmental challenges. Although Steward had a somewhat loose definition of adaptation, at least compared with that of modern evolutionary biologists, he saw the adaptation of behavior to ecological contingencies as lying at the heart of sociocultural evolution. Therefore, one of the central tenets of evolutionary ecology was not entirely foreign to anthropologists. Furthermore, archaeologists, many of whom were committed to a comparative, materialist, evolutionary stance, were receptive to some of the branches of adaptationist reasoning, especially optimal foraging theory (e.g., Bet-tinger & Baumann, 1982).

The second reason that sociobiology, and in particular behavioral and evolutionary ecology, has met with some success within anthropology is its empiricism. Stimulated by early field and comparative studies (e.g., R. D. Alexander, 1979; Chagnon & Irons, 1979; Daly & M. Wilson, 1983; Symons, 1979; Winterhalder & E. A. Smith, 1981), a host of empirical work that tested sociobiological and evolutionary ecological hypotheses accumulated throughout the 1980s (Borgerhoff Mulder, 1988a). These focused on two areas: (a) mating and parental behavior, with detailed investigations of such old anthropological chestnuts as marriage, family, inheritance, mate choice and nepotism (e.g., Betzig, Borgerhoff Mulder, & Turke, 1988); and (b) resource acquisition, with studies on foraging, food sharing, and territoriality (e.g., E. A. Smith & Winterhalder, 1992a). This empirical work makes an increasingly significant contribution to contemporary anthropology. Inspired by a variety of theoretical frameworks, authors not only utilize the data and codes developed by sociobiologists (e.g., D. R. White, 1988), but test hypotheses derived from cultural ecology against those of sociobiology (e.g., E. A. Roth, 1993). Appreciation of the empirical contribution of sociobiology is fostered, in part, by the broader reaction against antiempiricism, so prominent within an-

cise mechanism for adaptive optimization that linked material conditions to cultural change. As noted by Bettinger (1991), this is reflected in his tendency to downplay materialist considerations as he became increasingly concerned with the study of cultural change.

The evolutionary core of cultural ecology was incorporated into two schools of American anthropology emerging in the 1960s: (a) the reincarnation of functionalism in a more ecological guise (e.g., Vayda & Rappaport, 1968), and (b) the rise of cultural materialism (e.g., M. Harris, 1979). Proponents of the former theoretical persuasion, in particular, borrowed models from biology (e.g., Wynne-Edwards, 1962) and ecology (e.g., Odum, 1959). However, the opportunity for a genuine transfer of Darwinian ideas between the biological and social sciences occurring at that time was again lost, primarily because of the excessive reliance of the functionalists on group selection and systems theory—concepts that were already losing credence within biology in the 1960s. As many have discussed in detail (e.g., Orlove, 1980; E. A. Smith; 1984), this newer functionalism was as riddled with tautology as were the older functionalism of Spencer and Durkheim and the mid-century functionalism of Malinowski and Radcliffe-Brown.

Hence, the rise of evolutionary ecology and sociobiology within anthropology in the late 1970s ironically owes much more to the insights of Steward than to the more recent, and more explicitly biological and ecological, schools of neofunctionalism and cultural materialism. Informed by a neo-Darwinism emphasizing individual-level selection, as well as a host of new theories developed for the study of foraging, nepotism, reciprocal altruism and parental care, several anthropologists began to pursue functionally inspired ecological work (e.g., R. D. Alexander, 1979; Chagnon & Hames, 1979; E. A. Smith, 1984).

The introduction of sociobiology into anthropology occasioned hostility for reasons now well rehearsed (e.g., Caplan, 1978; Sahlins, 1976). These revolved around two issues: the conflation of scientific matters with ideological ones, and the legitimacy of hypothetico-deductive and deterministic approaches within anthropology. Analysis of the disputa-tious exchanges within anthropology reveals that, in a very real sense, the implications of sociobiology for anthropology were misunderstood. There was widespread confusion (e.g., M. Harris, 1979; Sahlins, 1976) over whether conventional theories of economics, culture, consciousness, learning, and rationality generated alternative or compatible hypotheses with those of sociobiology. This arose, in part, because of (a) a general
thropology these days, and against the deconstructionist stance of critical theorists. Indeed, the situation in contemporary anthropology is reminiscent of C.P. Snow's *Two Cultures* (see Carrithers, 1990; Lee, 1992). In the current, somewhat hostile antiscience climate, then, empirically oriented anthropologists unite in getting down to the business of exploring diversity and testing hypotheses, as recent volumes of the journal *Current Anthropology* attest.

The third factor contributing to the gradual acceptance of Darwinian thinking was that the early sociobiological position papers emphasizing neo-Darwinian individual-level selection dovetailed quite nicely with the pioneering work of Barth (1967) and Britain's Manchester School. Barth and his followers explicitly focused on how political organization emerges from the decisions made by individual actors operating under different constraints. This methodological individualism developed into rational choice theory (Elster, 1986). Like evolutionary ecologists, rational choice theorists draw their models from neoclassical economics; they also generally assume that actors are both selfish and rational. Evolutionary ecologists rely heavily on rational choice theory as providing a mechanism for adaptive optimization (E. A. Smith & Winterhalder, 1992b), because it is through such individual choices that predictable behavioral outcomes occur in different social and ecological contexts. Finally, and undoubtedly more contentiously, evolutionary ecologists suspect that the preferences that individuals express for options with high payoffs ultimately depend on a history of natural selection.

The fourth factor that has already contributed somewhat to the success of sociobiology within anthropology is the challenge raised by evolutionary psychologists. As discussed in chapter 7, the causal factors whereby evolutionary processes might influence human behavior have been rather poorly specified by sociobiologists, generating considerable misunderstanding among critics over how sociobiological theories articulate with those of ecological anthropology, cultural ecology, and psychological anthropology. Humans were predicted to behave "as if" they were maximizing their fitness, with little or no consideration of how they reached the optimal decision. Hence, with the amendment of evolutionary psychology (see chap. 6), sociobiological analyses may extend their analytical objective from that of the actor's acts to that of his or her goals, beliefs, and motives. In addition, early studies paid little attention to the constraints on optimality, either phylogenetic, psychological, or environmental. As an understanding of such constraints develops, sociobiologi-cal theory should become more acceptable to anthropologists (see also Harpending, Rogers, & Draper, 1987).

In summary, sociobiology and the related fields of evolutionary and behavioral ecology have done much better in anthropology than in sociology. The reasons for this success include: (a) their power in exploring what is, in effect, the *raison d'etre* of sociocultural anthropology—diversity—through their reliance on concepts that were not entirely foreign to anthropologists—adaptation and strategic behavior; (b) their strong empirical bent, attractive at least to the "antiscience" anthropological coterie in these times of heady postmodernism; (c) their close links with methodological individualism and rational choice theory; and (d) their increasingly sophisticated treatment of mechanism, causality, and constraint.

Early sociobiologists recognized that genes may not be the only replications driving the evolution of smart animals. For example, Richard Dawkins (1976) hedged his bets in the last chapter of *The Selfish Gene*, as have many contemporary sociobiologists in recent years. Dawkins posited a "new replicator" that he termed *memes*. The basic tenets of sociobiology—genic selection, inclusive fitness, and reciprocal altruism as these produce strategies and "survival machines" for genes—can explain how humans came to exist, but culture begins to supplement and supplant biology as the major replicating mechanism. Memes are those new cultural units that exist inside brains and that, via socialization, are passed on and preserved in a "meme pool." Dawkins recognized that meme evolution will now begin to accelerate, because, "once genes have provided their survival machines with brains which are capable of rapid imitation, the memes will automatically take over" (p. 21). It might even be possible for memes to rebel against their creators—the selfish genes. Similarly, other biologically oriented social scientists have begun to talk in terms of "coevolution," operating at both the genetic and cultural levels.

As noted in the discussion of sociology, coevolutionary approaches all emphasize that evolution involves Darwin's emphasis on descent with modification, in which a set of elements is related by inheritance. In coevolutionary approaches, this process of inheritance operates at both the biological and sociocultural levels, and thus biological and sociocultural evolution are guided by similar evolutionary processes. Yet the isomorphism with biological forces varies in different coevolutionary approaches. For some (e.g., Durham, 1991), biological evolution is but one type of a more general evolutionary process that also includes cultural evolution. For others (e.g., Boyd & Richerson, 1985, 1990), biological
processes can provide the conceptual leads to develop distinctive models for understanding the evolution of traits in sociocultural systems. There are also differences in how much the biological and cultural inheritance systems influence each other. For some who remain sympathetic with sociobiology (e.g., R. D. Alexander, 1979; Lumsden & E. O. Wilson, 1981, 1983), much sociocultural inheritance is circumscribed by biology. For others much less committed to sociobiology (e.g., Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981), the two systems of inheritance—the genetic systems of biology and the traits of sociocultural systems—are distinctive, although understandable with similar models emphasizing variation and selection processes. Boyd and Richerson were the first to use the term dual inheritance, in connection with the development of a more detailed set of models to explain cultural transmissions (see chap. 10). Because culture is transmitted, it can be studied using the same Darwinian methods employed to study genetic evolution (Boyd & Richerson, 1992; Durham, 1991, 1992).

Perhaps because of the maintenance of the biological component in anthropology, along with the long flirtation with functionalism, the recent application of biological ideas has proceeded furthest in cultural anthropology. Although sociologists have rejected the extremes of sociobiology and have remained largely indifferent to coevolutionary models, these approaches have provided a new theoretical spark to anthropology, which, as a whole, has become atheoretical and antiscience. Into this vacuum has swept biology, whereas in the other social sciences, the existence and acceptance of non-biological theories have kept biological ideas at the margins.

BIOLOGY AND ARCHAEOLOGY

Stephen J. Shennan

Like many other subjects, archaeology began to emerge as an academic discipline in the 19th century, in an intellectual environment heavily influenced by the evolutionist ideas of such authors as Spencer, Darwin, and L. H. Morgan. One of its most important roles was to document the history of progressive civilization—visible, for example, in the technological succession from Stone through Bronze to Iron Age. However, these evolutionary concerns did not last, or, rather, they became transmuted. As knowledge of archaeological material increased, it came to be seen that enormous geographic variation existed, and a concern with documenting the stages of human progress gave way to an interest in the explanation of this variation. The result was an "ethnic" model of the prehistoric past in which regional differences were seen as relating to different peoples, and changes were largely explained in terms of their migration. Those peoples seen as expanding over the widest area were held to be representatives of "races" which were successful in the process of evolutionary competition. Many of those involved in archaeology, however, simply jettisoned virtually all theoretical baggage and studied the material for its own sake, but with an emphasis on defining culture areas and tracing cultural traditions.

Outside the Soviet Union, it was only in the 1960s and 1970s that evolutionary ideas returned explicitly to archaeology. This was the result of North American neo-evolutionary anthropology, and especially the work of L. A. White (1959) and Steward (1955). White's legacy, via the enormous influence of his student, Elman Service, was an archaeological emphasis on progressive social evolution, and especially the rise of the state. Steward's ecological anthropology viewed this process as arising from the overcoming of adaptive challenges, especially those posed by an increasing population size. These concerns, although still current in some archaeological research, have been widely rejected since the beginning of the 1980s. The first published sign of dissatisfaction from a Darwinian point of view was Dunnell's (1980) paper, which suggested that a selectionist perspective provided a more appropriate theoretical framework for archaeology than the progressive models derived from L. A. White (1959) and Service (1962). The latter lacked convincing explanatory mechanisms. Since then, there has been a steadily growing interest in such selectionist models, closely connected to their development in anthropology more generally.

In fact, one can review the whole history of archaeology from a Darwinian perspective, although it is not usually done. The late 19th and early 20th centuries interest in describing and explaining regional cultural history and its variations can be seen as a concern with tracing the history of descent with modification. However, the approach paid no attention to adaptive processes. The neo-evolutionary archaeology of the 1960s and 1970s discarded the study of descent with modification in favor of a concern with adaptation, based on an implicit notion of group selection within a functionalist framework. This position was subsequently criticized by Gould and Lewontin (1979) and Elster (1983) among others. In neo-
evolutionary models, the motor for change or the reasons for stability came from the "environment," broadly construed, to which past populations responded.

The 1980s saw attempts to reunite the two strands of descent with modification and adaptation from a more rigorously selectionist perspective. This meant a new concern with cultural transmission, on the one hand, and with the specification of costs and benefits in social interactions, on the other, especially in the context of conflicting interests.

An example of such a cost–benefit model is Kohler and van West's (1992) study of the emergence and disappearance of food-pooling cooperation in the North American southwest A.D. 900–1300. Given a situation in which agricultural production is variable, both spatially and temporally, they showed by an analysis of harvest size in relation to the marginal utility of the product to consumers that it would be in the interest of individual households to share food when average production was high, not when it was low. They then used detailed climatic records as a proxy measure for variation in agricultural production, and showed that evidence for sharing, in the form of aggregations of population with storage facilities, was largely restricted to periods favorable to agriculture, suggesting that, when conditions deteriorated, households defected from the arrangements and the pooling system collapsed. However, a model based entirely on the self-interest of the participants generates patterns in the settlement of the region, in terms of aggregation and dispersal, which correspond closely to those actually found. The success of such a self-interest model is, at first sight, surprising in the light of the ethnographically known patterns of social organization in the southwest, which are strongly group-oriented. However, there is also a contrast in settlement processes. Although the period from A.D. 900–1300 was characterized by cyclical patterns of aggregation and dispersion, since that time, aggregated village settlement has been uninterrupted in the areas actually occupied. The reason for this, Kohler and van West suggested, was the emergence of new sharing rules emphasizing village-level activities, combined with new sanctions against defection.

Studies like Kohler and van West's are in many ways an obvious step from the previous functionalist adaptive concerns. But since the discrediting of culture history in the 1960s left cultural transmission without a viable theoretical framework, it had not been on the archaeological agenda. In this respect, the key development of the 1980s has been the emergence of "dual inheritance" theory (especially Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981), with its account of the mechanisms of cultural transmission and the factors affecting these mechanisms. This approach has a considerable number of implications for archaeology, both in its study of the history of changing material culture and more generally.

In the first place, it is clear that archaeologists will have to change their whole approach to the study of their material. In the past, archaeology has been based on the construction of "types,"—archetypal forms or essences seen as existing in the minds of the makers, reproduced in the real world, and therefore subject to its contingencies. Thus, the reality is the "mental template" and the variation is so much noise, which may be ignored in the type definition. In the light of transmission theory, the concern with essences now has to be replaced by a conceptualization in terms of populations of traits affected by selection and by nonselective processes such as drift and linkage.

An example of a study based on such an approach is that by O'Brien and Holland (1992), who examined the changing frequencies of grit, shell, and limestone tempered vessels from the North American midwest during the later Woodland period. Initially, grit was the most common type of temper, although other materials were occasionally used as well, including limestone and shell. For about 300 years after its first appearance, shell remained a minor component of the temper before suddenly increasing A.D. 900–1000 and taking over as the predominant temper type. It appears that shell enhances the workability of the flood plain clays of the region, which were the raw material for pottery throughout the period, but until A.D. 900 were largely tempered with grit. Shell also increases the strength of the pot, as well as being a better preventer of cracks during firing. However, use of shell temper requires the control of firing temperatures below 700°C. Once the ability to control firing temperature was achieved, shell tempering spread rapidly. In this case, we see a process of descent with modification operating on pottery tempering, leading via a selective process to changes in the frequencies of the different temper types in the population as a whole. In effect, once firing temperatures could be controlled, a process of directly biased transmission led to a rapid increase in the use of shell tempering, as potters perceived the successful consequences of the use of this material by others and therefore adopted it themselves. Thus, shell tempering is an adaptation for strength, stability, and facility in handling pottery. That is, selection occurred for these functional consequences of shell tempering, and it
was adopted preferentially as a direct result of the selection process. Therefore, we have a postulated "causal history" (S. D. Mitchell, 1989), in which the mechanisms are derived from the experimental technological study of pottery, and the phenomenon is identified by the observation of differential patterning in frequency changes in temper use through time.

Other recent studies have used dual inheritance theory in a much more generalized manner. In a recent article on the role of ritual in foraging societies, Aldenderfer (1993) has suggested that ritual appears to have an analogous role to reciprocal altruism and kin-based reciprocity, in that it produces group functional behavior that may be advantageous in competition between rival groups by virtue of creating and maintaining a conformist tradition. However, there are pressures in the opposite direction because all societies contain inequalities and individuals will compete for prestige and status. This is satisfactory if there is a means to escape the stresses that may arise, but under conditions of circumscription, stresses may be created that threaten both individual and group benefits. Ritual may be called into question if existing practices cannot cope with new conditions. If individuals find that their expected benefits from participation in ritual do not appear, or the costs begin to exceed the benefits, this may lead to the emergence of cultural variants modifying existing ritual practice, and to a situation where group-level selection is no longer protected from the effects of individual selection. In these circumstances, those who hold ritual power may lose it, and the prestige that goes with it, and those who have been cooperating face the loss of group-level benefits. Aldenderfer went on to explore the possible implications of such a situation, particularly as they concern the ability of holders of ritual power to extend it in other directions. On this basis, he proposed a model of social change that has ritual as its core.

Aldenderfer's (1993) study dealt with a broader subject of greater general archaeological and anthropological interest than that of O'Brien and Holland (1992), but did so at the expense of specificity, at least as far as the evolutionary models are concerned. Dual inheritance theory provides little more than a general theoretical framework that offers an interesting slant on the topics being examined (see C. S. Spencer, 1993, for a study that is rather similar in this respect). Additionally, there is always a danger, that Aldenderfer avoided, of slipping back into the sloppy adaptive functionalism of the 1960s and 1970s. Moreover, although he dealt with a topic of archaeological importance, he did not actually use archaeological data.

Archaeological data by their very nature provide little information about the mechanisms of transmission processes. This must come from experimental and ethnographic studies in the present. Nevertheless, as O'Brien and Holland's (1992) study shows, patterns can be distinguished in the archaeological record that can convincingly be argued to arise from some specific processes rather than others. Such studies can be made more rigorous by the application of mathematical/computer-based modeling techniques, rather than informal comparisons.

Furthermore, the archaeological record provides the only long-term record of the histories of cultural descent with modification and the factors that may have influenced it. The question is, how much interest do these histories have if they remain exclusively at the level of documenting changing temper use in prehistoric pottery? In recent years, archaeology's claim to be a subject of general interest has lain in its efforts to produce a history of society. But what is largely missing from recent evolutionary models is the social, which has been squeezed out between the cultural and the genetic.

What follows is a sketch of some links between social and cultural processes, and an indication of some ways in which they might be investigated archaeologically. Any model of such processes has to take into account the fact that people's interests and the "interests" of their cultural attributes do not necessarily coincide. Cultural traits are not just aspects of people's phenotypes as interactors, but have their own "life" as replicators (see S. D. Mitchell, 1987). As is seen here, archaeology can provide information about both the replicators and the interactors, although some of the discipline's unsuccessful research programs in the past arose from a failure to distinguish the two. The starting point of this sketch is some recent work in anthropology and in the analysis of cooperation processes.

Brunton (1989) developed an argument for the cultural instability of egalitarian societies based on Woodburn's distinction between "immediate-return" and "delayed-return" foragers. Recent ethnographically known hunter-gatherer groups who operate immediate-return foraging systems tend to be strictly egalitarian, in that there is an automatic entitlement to equality of social outcomes. This is in contrast to "other acephalous societies, such as those in Melanesia, where equality has to be earned through fierce competition, which inevitably results in a substantial de-
gree of de facto inequality" (Brunton, 1989, p. 673). Egalitarian societies, which are very unstable in their group membership, also tend to be culturally fluid, Brunton argued—susceptible to acculturation, and relatively limited in their collective representations. This arises because of the structural nature of genuine egalitarianism because it can never provide a basis for ensuring a correct version or interpretation of that which is communicated. Any attempt to distinguish what is valuable and what is not requires an act of evaluation, which implies inequality. To the extent that evaluation, and exclusion on the basis of evaluation, takes place, egalitarianism is compromised. To the extent that egalitarianism is thoroughly going, such cultures can be little more than heaps of randomly associated elements, whose persistence is always fortuitous (Brunton, 1989).

On this view, authority relations are necessary for the transmission of culture, and egalitarianism can only be maintained by according little value to cultural products, which indeed accounts for the general indifference to such products in the egalitarian societies discussed by Brunton. In fact, the rarity of such societies is not surprising because they are weak in political terms, and they have no basis to defend their values against the cultural subversion of egalitarianism. This may or may not matter to the human groups concerned, although if such egalitarian arrangements do persist, it raises interesting questions about the factors that make this possible. It may be that group fluidity is more important than continuity.

Delayed-return economies, whether agricultural or based on foraging, involve returns on labor that take place over a considerable period of time and require long-term claims on resources and relationships, including systems of rights and obligations. Furthermore, "inter-generational inequality, as well as inequality between household heads in terms of power, wealth and status are commonly present" (Brunton, 1989, p. 674). In these circumstances, group continuity is important. Such circumstances are also ideal for some degree of coherent cultural continuity, in that the inequalities present provide a basis for necessary cultural evaluation processes. Moreover, group membership is longer lasting, and thus provides a better basis for the consistent transmission of particular sets of cultural practices (Braun, 1991).

Nevertheless, even allowing for the greater tendency toward group continuity implicit in delayed-return systems, the possibility of group fission in the face of cooperation problems is always present, with potentially undesirable consequences. Simulation studies of the maintenance of cooperation in the face of social dilemmas have shown that it will be pro-

moted in situations where individuals have a long future expectation of cooperation, and where groups have structures that are fluid but hierarchical, not necessarily in the manner of a conventional social hierarchy, but in the sense that members of a large group do not interact equally with one another. They interact closely with members of a small group, and small groups interact with one another via representative individuals and organizations (Glance & Huberman, 1993). This corresponds closely to the notion of "sequential hierarchy," coined by G. A. Johnson (1982).

Groups based on such forms of organization tend to be perpetuated through time more successfully than those that are not. At the same time, their particular sets of cultural practices are also successfully perpetuated. Furthermore, those practices that are conducive to group continuity are more successful, creating a positive feedback loop in favor of group continuity and social practices that encourage it. But group continuity is not the only relevant factor. There is also the question of the positive and negative social evaluation of particular practices as discussed by Brunton. Even if group continuity is an important aspect of this, it requires some notion of inequality among group members as to who are the arbiters of these standards—often older males. Here again, positive feedback loops can develop. For example, existing inequalities connected, with the operation of delayed-return foraging systems could be associated with cultural evaluation, and the prestige and status of these arbiters could increase as a result of their role as guardians of cultural tradition. At the same time, those practices are likely to be more successful, and thus more conducive to increasing the arbiters' prestige.

The group continuity loop and the prestige/status loop are potentially incompatible with one another. The unbridled expansion of prestige and associated inequality may be detrimental to some group members' interests, and thus can lead to group fission (see Aldenderfer, 1993). Furthermore, although both group continuity and the growth of prestige are positively associated with the propagation of cultural practices through time, the factors involved may be different. The kinds of attributes successfully replicated by virtue of their prestige may not particularly require group continuity for their replication, nor will they necessarily be restricted by group boundaries; speed of spread may be an alternative to group longevity. How the implications of such incompatibilities play themselves out over time is a contingent process: The extent to which regularities are present at a larger scale than microlevel transmission and interaction processes remains an open question.
Archaeology as it is currently practiced could potentially throw a great deal of light on the history of such processes, but has not yet been used for this purpose. In the first place, it provides an extensive record of the spatial and temporal distributions of a great range of material cultural attributes. These were the raw material of the cultural history discussed earlier, but from the current point of view they provide information on the transmission/replication history of the material attributes concerned. However, to make use of this information to investigate the social interaction—cultural transmission mutual causal processes discussed earlier, one must also have information about the social life of the interactors, as well as the history of the replicators. In the last 30 years, the kind of archaeology concerned with documenting the history of social evolution—in the sense of the emergence of different types of society—has made a great deal of progress in the reconstruction of prehistoric social and economic organization. Its methods and results can be used in the kinds of investigations that a Darwinian approach to cultural transmission and the factors affecting it require; important aspects of the lives of social interactors can be reconstructed.

One example is the study of prestige and social inequality. In certain regions at certain times, the presence of individual inhumation burials with varying quantities and qualities of grave goods makes it possible to infer patterns of social differentiation and link certain items with people of higher status. The higher status individuals may also have had different living conditions, as evident from the results of various kinds of scientific analysis of their bones. Once one has inferred that certain items are associated with prestige or higher status and others are not, one can examine their spatial distributions and see how these vary. It is clear that types associated with prestige in general have far wider distributions than those that are not. However, they also tend to have shorter life spans, in the sense of the length of time they are in circulation before they fall out of use. In the specific case of later prehistoric Europe, it is clear that some of these differences are associated with gender. The majority of prestige items with wide distributions are linked to males rather than females—a situation that raises interesting questions concerning different “strategies” for replicative success in male and female cultural attributes; female attributes may be favored by group continuity and male ones by the growth of prestige. It is of some interest in this connection that the Neolithic and Bronze Age prehistory of Europe shows broad patterns of periods when localized patterns of cultural variation seem to be domi-

1. HISTORICAL CONTEXT OF PRESENT PRACTICE

BIOLOGY AND ECONOMICS

Geoffrey Hodgson

Adam Smith, the founder of modern economics, was more influenced by Newtonian physics and astronomy than by biology. Nevertheless, there are traces of the biological metaphor in his works (A. Smith, [1759] 1976a, [1776b]). The most important example is his central use of the concept of the “division of labor,” which was coined by Mandeville (1709) in his *Fable of the Bees* to represent the division of types and tasks in the hive. The idea is passed on directly to Smith and the classical economists, and from there to sociology, where it became the central metaphor for the organismic analogy and for the emphasis in functional sociology on growth and differentiation.

In addition, Thomas Robert Malthus was affected by visions of the natural world. On the first page of his *Essay on Population* (1798), Malthus observed the “crowding and interfering with each other’s means of subsistence” among plants and animals. Such considerations about nature influenced his thinking about political economy. Given the Malthusian influence on Charles Darwin, it is appropriate to suggest that some proto-
evolutionary ideas traveled from biology to Malthus and the social sciences, only to return later and influence Darwin and biology in a refined form. Moreover, there is no doubt that Malthus' essay influenced Herbert Spencer’s ([1852]1888) political essays and his first book, Social Statics, where the phrase "survival of the fittest" was used. Indeed, in the preface to On the Origin of Species, Darwin ([1859]1964) cited and credited Spencer's work. Thereby, the early development of the natural sciences and economics involved substantial interdisciplinary dialogue.

Overall, however, the influence of pre-Darwinian biology on economics is not that pronounced. The single major exception is Alfred Marshall, who was profoundly influenced by the biology of Herbert Spencer (Hodgson, 1993a, 1993b; Thomas, 1991). This influence is evident in his direct adoption of the Spencerian law of evolution as involving increasing heterogeneity, which Spencer took from von Baer, and in his widespread adoption of the idea of "use and disuse," which Spencer took from Lamarck.

Marshall made a distinction between "economic statics" and "economic dynamics," indicating that, like Comte before him, the metaphors of classical physics were appropriate for the former and biology for the latter. His Principles of Economics (1890) concentrated largely on statics, and he planned a second volume to explore the dynamic aspects. Unfortunately, this was never written.

The example of Marshall's appeal to biology is thus an ironic one. Much more than his contemporaries, he saw the limitations of the mechanistic metaphor, and perceptively saw biology as providing a more appropriate alternative. Yet his work remained almost entirely in a static and mechanistic mode, even when he found inspiration in biology, it was in the rather mechanistic and pre-Darwinian ideas of Spencer, whose law of evolution blended simplistic views of Newtonian mechanics with organismic growth and development.

The most important influence of Darwinian evolutionary theory in economics was on Thorstein Veblen (1899, 1919). Just before the end of the 19th century, Veblen (1898) asked in a famous article: "Why is economics not an evolutionary science?" In asking this question, Veblen made a direct appeal to biological science for inspiration, but subsequently, and until very recently, his example has rarely been replicated.

Veblen saw the evolutionary metaphor as crucial to the understanding of the processes of technological development in a capitalist economy. He explicitly characterized his own economics as post-Darwinian, and argued that economics should embrace the metaphor of evolution and change, rather than the static ideas of equilibrium, which had been borrowed by the neoclassical economists from physics. Veblen had two primary reasons for the adoption of a Darwinian and evolutionary metaphor. One relates to the idea of cumulative causation and an opposition to depictions of the economic process that are consummated in equilibrium. The other is based on the formation of analogies to both the gene and the processes of natural selection in the social world. He stated, "The evolution of social structure has been a process of natural selection of institutions" (Veblen, 1899, p. 188).

However, Veblen was faced with a biology at a stage of development at which the mechanisms of evolution were only partly understood. Consequently, and given his own personal aversion to intellectual "symmetry and system-making" (Veblen, 1919, p. 68), there was little chance that Veblen would be able to build an economic theory on the Marshallian scale. Yet Veblen was relatively successful in establishing the basis of Darwinian economics. First, his principle of "idle curiosity" became the ongoing source of variety or mutation in the evolutionary process. Second, the institution became the unit of relative stability and continuity through time, ensuring that much of the pattern and variety is passed on from one period to the next, so that selection has relatively stable units on which to operate. Third, mechanisms are identified through which well-adapted institutions are imitated and replicated, and the less adapted become extinct, analogous to the "struggle for existence."

Hence, a principal component of this achievement is its embodiment of the idea of the cumulatively self-reinforcing institution as a unit of evolutionary selection, subject to the procedures of mutation and selection. The nature of the evolutionary process governing these elements is selective rather than purely developmental, and phylogenetic rather than ontogenetic. Veblen's writings stand out as the most successful attempts, at least until the 1970s, to incorporate post-Darwinian biological thinking into economics and social science.

For a long period after the deaths of both Marshall and Veblen in the 1920s, biological and evolutionary ideas made limited impact on economics. Arthur Pigou and other inheritors of the Marshallian tradition regarded the use of biology as an idiosyncratic diversion. Institutionalis such as John Commons echoed Veblen, but little attempt was made by subsequent institutionalists to develop the links between economics and biology. Strikingly, this is true for Joseph Schumpeter as well, although
Schumpeter is celebrated today as a mentor of evolutionary economics, and his name is explicitly connected with its modern developments. However, Schumpeter's own notion of economic evolution is distanced explicitly from evolution of a biological kind, and excludes any suggestion of a Darwinian process of selection (Schumpeter, 1939, 1954).

The most important subsequent use of Darwinian ideas in economics was by Alchian (1950), with his adoption of the idea of "natural selection" in theory of the behavior of firms. This was subsequently developed by Friedman (1953) in an effort to support the neoclassical hypothesis of profit maximization. Later, other economists (e.g., Williamson, 1975) appealed to the idea of competitive "natural selection" in an attempt to support the notion that survival means efficiency. No doubt, these modes of analysis influenced, and were influenced by, the emergence of organizational ecology in sociology, where the unit of analysis became populations of organizations in a resource niche (Hannan & Freeman, 1977).

The most important recent work on the application of ideas of evolutionary selection to economics is the pioneering volume by Nelson and Winter (1982). Although the authors described this work as "Schumpeterian," its explicit use of biological analogies puts it closer to Veblen, and perhaps Hayek, than Schumpeter. This volume is mainly responsible for a revival of evolutionary economics in the 1980s and 1990s.

Another recent influence of biology is found in the work of Friedrich Hayek. Although traces of Hayek's evolutionism can be found as early as the 1930s, it did not appear in a fully developed form until the 1970s (Hayek, 1982, 1988). Hayek's employment of evolutionary thinking is largely used in support of a pro-market and noninterventionist policy stance.

Despite these incursions from biology, the influence of biology on economics remains on the fringes. This conclusion is particularly apt for sociobiology which has had little impact on economics, although there are a few exceptions. The first is the work by contemporary economists Becker (1976), Hirshleifer (1987) and Tullock (1979). They proclaimed themselves "economic imperialists," and declared that common "economic" principles bind biology to economics. These principles include scarcity, self-interest, and competition. The Becker–Hirshleifer–Tullock school saw these ideas as universal and applicable to both the economic and biological spheres. The inspiration drawn from sociobiology is that the process of natural selection should result in the emergence of something like "rational economic man," providing the bridgehead for the maximizing postulates of economics across to biology and other social sciences.

There is a second instance where sociobiology has interchanged ideas with economics. Evolutionary biologists such as John Maynard Smith and others have made use of game theory, which was originally developed in economics by von Neumann and Morgenstern (1944). Notably, after developing the concept of an evolutionary stable strategy within game theory, this concept was then transferred back to economics in the work of Sugden (1986).

In many ways, the Becker–Hirshleifer–Tullock arguments are redolent of the Social Darwinists, and many of the earlier criticisms of this current are still relevant in regard to this contemporary work. However, such criticisms are rarely made. Furthermore, the postulated link between economics and sociobiology is ignored by most economists because they simply assume the existence of individual preference functions, without trying to found them on any theory, including that provided by sociobiology, as well as those found in psychology, sociology, and anthropology.

An important exception, however, is the work of Hayek (1982, 1988). His work is more interdisciplinary, and he is a strong advocate of the preeminence of cultural, rather than genetic, evolution. His criticism is essentially that cultural evolution works much more rapidly than genetic evolution and swamps its effects. Other rare criticisms are found in the work of Witt (1991). Still, given that most economists take individual preferences as given, and explicitly reject any inquiry into the processes governing their formation, it is a matter of little importance to them as to how they are determined, whether by genes or by culture. Accordingly, thus far dual inheritance or coevolutionary approaches have had little impact on economics (see Boyd & Richerson, 1985). Although biology offers no ready-made solutions, it provides a metaphor that has to be employed with discrimination and care. In particular, the idea of a hierarchy of levels and units of selection seems to be eminently transferable to economics and the social sciences in general through the incorporation of hierarchies of habits, routines, and institutions. Although economic analogies to units mechanisms and processes of evolution are limited, they can be applied to socioeconomic evolution in a nonreductionist way.
The founders of scientific psychology, Wilhelm Wundt and William James, saw it as "the science of the mind," although today one would have difficulty reconciling this early vision with what has become a large and highly diverse discipline. Decades before Wundt and James, Herbert Spencer wrote the first of his scientific treatises, *Principles of Psychology* (1854–1855), where he first utilized a non-Darwinian, progressive principle of evolution that was to be more fully developed later in *First Principles* ([1862]1898). Here, too, emphasis was on the mind, or the "mental faculties," of organisms as they became more complex in the course of progressive development. Although this work was indifferently received and soon passed into obscurity, such universities as Cambridge and Harvard used *Principles of Psychology* as a text in the 1870s and 1880s. Yet, unlike economics and sociology, psychology developed as a discipline primarily after Darwin, and indeed, unlike other social sciences, Darwin himself ventured into the field. Thus, the history of Darwinism in psychology began with Darwin, as did the controversy about whether the theory of evolution by natural selection and other biological conceptions could be applied to psychology.

One of the most productive fields of interaction of these two disciplines has become neuropsychology, which investigates the brain's mechanisms for psychological processes. Although the term neuropsychology was introduced into scientific discourse as late as 1949 (Hebb, 1949), the majority of important discoveries, theoretical insights, and actual controversies in the field goes back to the second half of the 19th century. Under the direct influence of Spencer's ideas on the evolution of the brain in a series of steps, each of which brought about the capacities for new forms of behavior, the English neurologist John Hughlings-Jackson (cited in Taylor, 1959) worked out (in hundreds of case studies dispersed across medical journals of that time) a theory of the functional hierarchy of the brain's functions. He differentiated three such phylogenetic levels, from the spinal cord to the frontal cortex. The latter level of this hierarchy was described as responsible for the highest psychological functions, such as conscious monitoring of activity, thinking, and personality. This was a modern conception both from the point of view of contemporary scientific psychology as well as biology. It proposed that the entire period of human evolutionary existence could be considered as the "age of the frontal lobe" (Deacon, 1992; Tilney, 1928). Another aspect of his theory, which makes it very modern, was Jackson's insistence that every major part of the brain is involved in a specific activity (e.g., language), with each part making some unique contribution to such distributed across the whole of brain processing (see Kolb & Whishaw, 1990).

Yet, more mechanistic views dominated the scene. By the beginning of the 20th century, psychological textbooks were filled with almost unrestricted speculations about dozens of specialized "centers" within the brain and interconnections among them. These views were especially supported by Broca's and Wernicke's discovery of a relatively narrow "language core area" around planum temporale of the left cerebral hemisphere (see e.g., Kolb & Whishaw, 1990; Luria, 1980, for further discussion). A more or less deliberate splitting of neuropsychological mechanisms into "centers" (or "modules," as they might be called today) was a reproduction of ideas from phrenology, leading to a direct classification of human abilities and personality traits in the topography of the brain.

Since Descartes, educated opinion was quite willing to hold that the physical body was a machine, subject to physical law, and that animals were automatons. It was mental phenomena, such as reason, emotions, goal-seeking, language, and culture, that were believed to exist only in humans, and hence were separated off by religious belief and Cartesian dualism into the extranatural domain of the soul, the mental, and the physical (Descartes, 1977). In contrast, like Spencer before him, Darwin believed that mental faculties were explicable in the same evolutionary terms that accounted for the origin of species and the acquisition of their physiological characteristics—a position that even Alfred Russell Wallace, co-originator of the theory of natural selection, was not willing to endorse. In fact, by 1904, Wallace had become convinced that human mental faculties required supernatural explanation (Wallace, 1904). If human mental processes represent an essence or spiritual agency that makes them qualitatively different from physical processes, then there would be an abyss between the mental and the physical that evolutionary explanations could not bridge (Darwin, 1873). To convince a disbelieving world, Darwin had to refute this dualistic claim.

The form that Darwin's argument took had a large impact on the history of evolutionary thought within psychology. There are two interwoven threads of explanation in Darwinism: (a) phylogenetic explanations emphasizing descent, and (b) adaptationist explanations stressing
selection. That is, some take an "evolutionary perspective" to mean a phylogenetic perspective, or the search for phylogenetic continuities implied by the inheritance of homologous features from common ancestors. Others take an "evolutionary perspective" to mean an adaptationist perspective, or the search for niche-differentiated adaptive design created by natural selection. Phylogenetic and adaptationist analyses are both components of an evolutionary approach, and both have value, but their relative validity may depend on which psychological mechanism is being investigated and at what level. Adaptationist approaches are often more appropriate for investigations at the cognitive level, whereas phylogenetic approaches are often appropriate for investigations at the neuroscience level (Tooby & Cosmides, 1989c).

One would expect both strands of Darwin's thought to be represented in theories of psychology. Instead, insofar as psychology has been Darwinian at all, the adaptationist thread has been largely ignored. Only phylogeny has been given an important explanatory role. This is a legacy from Darwin himself; he was trying to combat the dualist idea that the human mind was composed of different "stuff" than the physical body, rendering it exempt from evolutionary explanations (see Fridlund, 1992, for discussion). For example, in The Expression of the Emotions in Man and Animals (Darwin, 1873), Darwin showed how expressions of anger in humans were similar to those in other primates—mere tweaks on a basic design. He argued that these similarities only made sense if they were forged by a common descent—by a close evolutionary ancestry. Obviously, a phylogenetic approach was necessary to convince skeptics that minds were part of the natural world, and therefore subject to natural selection. Adaptationist analyses could not help him make this point because they tend to emphasize qualitative differences between the minds of different species. The dualists were already convinced that human minds were qualitatively different from those of other animals; an adaptationist approach would only have added fuel to the dualist fire (Degler, 1991).

This emphasis on phylogenetic analyses of the human mind gave rise to what became known as the "doctrine of mental continuity." Drawing inspiration from Darwin, animals were anthropomorphized while humans were "zoomorphized" (Krementsov & Todes, 1991). Little difference was seen between animals and humans, with human behaviors being observed in animals and vice versa. Thus, toward the latter third of the 19th century, such scholars as Romanes, Lubbock, Brehm, Lewes, Fodor, and others drew analogues and asserted homologies. For example, Romanes (1898) posited a long list of emotional states common to humans and animals. These sentiments were echoed in others such as Sutherland (1898), who postulated even longer lists of homologies between animals and humans. By the turn of the century, one could find a plethora of popular publications that posited such things as judicial and educational systems, states, factories, arts and crafts, families, and war among nonhuman animals (Krementsov & Todes, 1991). Although popular for a time, such analogizing soon fell into disrepute as the study of behavior in both animals and humans became more precise and specialized.

At the birth of experimental psychology in the 1880s, there were a few adaptationists. The most famous were William James and William McDougall. In their view, the human mind is a collection of "faculties" or "instincts": complex, functionally specialized mechanisms, each of which evolved to solve a different adaptive problem, some of which are qualitatively different from the faculties of other animals. Nevertheless, most experimental psychologists of the time were phylogeneticists. In fact, by the 1920s, Darwin's doctrine of mental continuity had been over-literalized by most experimental psychologists into the idea that the minds of humans and other animals exist on a linear continuum, with only quantitative differences in their capacities—different sized memory stores, different proficiencies in forming associative links between stimuli, and so on (see Hodos & C. B. G. Campbell, 1969; Lockard, 1971, for a critical discussion of this issue; see Macphail, 1987, for a postbehaviorist defense of the doctrine of mental continuity).

The adaptationist faculty psychology of James and McDougall did not catch on. James admired the German experimental psychology of his day, but had no taste for it himself, so he did not leave a legacy of empirical research implementing his program (or students trained in such). McDougall's views were dismissed for reasons that appear largely political (Cosmides, 1979). W. James' (1890) Principles of Psychology and McDougall's (1908) Introduction to Social Psychology seem modern today because they advocate what cognitive scientists such as Chomsky (1980) and Fodor (1983) call a "modular view of mind." James and McDougall both thought that: (a) one can precisely characterize the mind, and not just behavior; (b) the mind is a collection of complex, functionally specialized mechanisms, or what Chomsky calls mental organs and Fodor calls modules; (c) these specialized mechanisms—these
"instincts"—make learning possible; and (d) human thought and action are so flexible because these instincts are sophisticated and large in number. Yet James and McDougall lacked a good language for describing the mind. Hence, it was easy for critics to argue that "mind" was a woolly concept that had no place in a science of behavior, which should restrict itself to analyzing the relationship of publicly observable stimuli and responses (a view lent philosophical support from the logical positivists). Critics also argued that too many instincts were being posited, violating the principle of parsimony (a version of parsimony that was derived from physics, not biology). In addition, they argued that there was no sound basis for positing one instinct rather than another, and that every time a new behavior was observed, a new instinct was posited to explain it (Dunlap, 1919, 1922; G. C. Field, 1921; Kuo, 1921).

There was certainly something to this last criticism. First, faculty psychology was developed before the "modern synthesis" of the 1930s (the melding of Mendelian genetics with natural selection theory). The modern synthesis gave birth to more precise techniques for identifying and analyzing adaptive problems, which were not available to James and McDougall. So, when they were writing, the implications of Darwin's theory and genetics were not as clear as they are now. Second, some of McDougall's followers did seem to abuse his approach by making up instincts willy-nilly. This was perhaps an unfair criticism to raise against McDougall, who tried to define empirical criteria for positing an instinct, which included converging lines of evidence from physiology, comparative psychology, and psychopathology.

McDougall's dialectical opponent became John B. Watson, the founder of the behaviorist school of psychology. Watson scoffed at the mentalism of introspectionists and viewed their methods as unscientific. In essence, Watson was arguing that the mind has neither inherent content nor functionally specialized faculties or instincts. All mental content derives from the external world, via an associationistic process of learning that functions, memory images, or emotional processes. All that was needed for a science of behavior was the reinforcement history of an organism and the phylogenetic history of a species, which provided it with its "genetic endowment"—most notably, the ability to be classically and operantly conditioned.

Several schools of thought (all European in origin) challenged American behaviorism, and all of these schools have links to evolutionary and biological thought. These schools were (a) the Berlin branch of Gestalt psychology, (b) the cultural-historical school of Russian psychology, (c) the genetic epistemology of Jean Piaget, and (d) the ethological school developed by Niko Tinbergen and Konrad Lorenz.

Gestalt psychology may have been the most important school of psychological science in the first half of the 20th century. Its leading figures (e.g., Wertheimer, 1925; Köhler, 1947; Kohler, 1935) were physicists. They attempted to use concepts and methods of contemporary physics for the analysis of psychological problems. Basically, they operated with the notion of fields of forces, applying methods of subdisciplines of physics
such as crystallography and thermodynamics. This was an overtly antilocutionist approach: "The whole is more than the sum of its parts." At about the same time, Lashley (1963), a neurologist deeply influenced by Gestalt psychology, performed a series of neurological experiments on animals that persuaded him that there is a lack of any narrow localization of psychological functions within the neocortex. He introduced the term *equipotentiality* into psychological literature.

Another American student, influenced by this European school, was Gibson (1979). After many ingenious studies demonstrating context dependency of our perception of the world, Gibson concluded that the organization of environmental context (not any type of learning, as in behaviorism) is the main determinant of our subjective perception of objects within the environment. Gibson founded a school called *ecological psychology*. One of its methodological postulates is: "Do not ask what is inside of your head, but ask what is your head inside of" (Mace & J. James, 1977).

Vygotsky (1985) and Luria (1932) in the Soviet Union discovered another grave limitation of behaviorist analysis. Devoted followers of an evolutionary approach (broadly construed), they stressed the importance of cultural, not just physical or biological, environment for all so-called "higher psychological functions." Compared with natural (i.e., genetically determined or acquired in the course of conditioning) functions, the higher psychological functions, such as deliberate recollection or purposeful problem solving, are under conscious control and include historical "tools" as mediated components. They argued that the sociocultural environment supports human behavior and cognition. All these higher, culturally mediated psychological functions are specific only to human beings, and hence it is at this point where continuity ceases to exist.

In his neuropsychological work, Luria (1980) showed that these higher psychological functions rely heavily on the mechanisms of phylogenetically new, prefrontal parts of the brain. Luria (1970) and Bernstein (1947) proposed modern versions of levels classifications, more detailed than in the case of Hughlings-Jackson, but following the same evolutionary design. Recently, similar approaches have also been proposed within experimental psychology and cognitive science (see Lockhart & Craik, 1991; Velichkovsky, 1994, for an application of the levels approach to the problems of cognitive psychology).

Piaget considered himself a biologist, studying the ways in which organisms adapt to their environment (Boden, 1980). Seeking a middle ground between Lamarck and Darwin, between empiricism and rationalism, between behaviorism and Gestaltism (Boden, 1979; Piaget, [1940]1967), Piaget proposed that organisms can adapt to their environment because they possess two very general processes: assimilation and accommodation. According to Piaget, these innate processes are evolved adaptations that guide learning (among other things), and all animals have them in one form or another (phylogenetic continuity), operating uniformly across a wide variety of domains and causing cognitive development to proceed in discrete stages. Piaget thought the resulting mental structures and the processes that govern their transformation could be characterized precisely. But Piaget, like James and McDougall, lacked a convenient language for doing so. When the cognitive revolution provided a convenient language for talking about the mind, Piaget's views gained influence. But before that time, Piaget was relatively ignored by the American behaviorists, who dismissed him as a mentalist.

The ethologists, by contrast, played a major role in the demise of American behaviorism. Tinbergen (1951) and Lorenz (1965), who eventually won the Nobel prize for their work, argued that an animal's behavior should be studied in its natural habitat. Natural selection theory says that form follows function, and therefore the only way one can understand the form a behavior takes is to see what adaptive function it fulfills in that animal's niche. Different animal species have different niches; consequently, different species can be expected to have evolved different functionally specialized, psychological mechanisms (e.g., different instincts, reflexes, fixed action patterns, imprinting processes, etc.). Ethological demonstrations that animals possess functionally specialized mechanisms challenged the behaviorist assumption that learning mechanisms are equipotential (e.g., Lorenz, 1965; Tinbergen, 1951). In an article entitled "The Misbehavior of Organisms," which was a play on the title of Skinner's book, *The Behavior of Organisms*, K. Breland and S. Breland (1961) declared the ethologists were right. The Brelands' attempts to train animals using classical and operant conditioning were constantly foiled by the animal's "instincts"—its functionally specialized adaptations.

This latter finding sent shock waves through the behaviorist community, but experimental psychologists did not seriously question the equipotentiality assumption until it was decisively shaken by Garcia and Koelling in 1966. Using classical conditioning, they showed that it is difficult—perhaps impossible—for a rat to learn to avoid flavored water,
even when it receives an electric shock immediately after tasting it. Yet in just one trial, the rat can learn to avoid the flavored water when tasting is followed by (experimentally induced) nausea, even when the nausea occurs 2 hours after the flavored water was tasted. During the 1970s, evidence against the equipotentiality assumption kept accumulating. By the end of the decade, the equipotentiality assumption was virtually dead in the field of animal behavior (Herrenstein, 1977).

Thus, the first pillar of behaviorism was seriously damaged. The second pillar—antimentalism—was destroyed by the advent of the computer. Computers are physical systems that process information, but they can parallel (although usually in a very modest way) human cognitive processes that cause reasoning, memory, knowledge, skill, judgment, choice, purpose, problem solving, foresight, and language. The computer is an existence proof: "Mental" activities can occur in a physical device, with no need to posit spirits, souls, or ghosts in the machine. One can characterize its data structures and the internal processes that transform them with precision. As computers became more common—and psychologists began to understand what these tools in their laboratories were capable of doing—behaviorist arguments against mentalism began to ring hollow. Finally there was a convenient and precise language for describing mental phenomena: the language of information processing, which is used to describe what a computer does. One has described the "mind" when one has described what the brain does in information-processing language. Cognitive psychology was born. Several of its paradigmatic texts, such as *Cognitive Psychology* by Neisser (1967), were published in the 1960s.

The equipotentiality assumption became increasingly questioned after the cognitive revolution was well under way. The new cognitive psychologists were primarily interested in "higher" mental processes, which were presumed absent from other animals. Moreover, they associated studies of animal learning with the dreaded behaviorism. As a result, they paid little attention to the animal behavior literature, which was exploding with ethiological and evolutionary critiques of the equipotentiality assumption. They also ignored the game theoretic analyses of the evolution of social behavior, which began pouring out of biology departments in the 1970s, traveling under names such as *sociobiology* and *behavioral ecology* (Hamilton, 1964; Krebs & N. B. Davies, 1984; Maynard Smith, 1982; Trivers, 1971, 1972, 1974; G. Williams, 1966). While the cognitive psychologists were not looking, the study of animal behavior became an adaptationist discipline.

The recent adaptationist approach involves a return to concern with the organization of "mental faculties" evident in James' and McDougall's approach. But this time around, efforts are informed by the modern synthetic theory of evolution and the implications of the information sciences spawned by the advance of computer technology. Thus, over the last two decades, a growing number of cognitive scientists have realized that general-purpose computational systems with no inherent content are weak problem solvers. Consequently, many are now arguing that the mind must contain a large number of complex, domain-specific, functionally specialized computational mechanisms: modules, mental organs, or instincts (for discussion, see Chomsky, 1980; Fodor, 1983; Marler, 1991; Pinker, 1984, 1994; Pylyshyn, 1987; Tooby & Cosmides, 1992). At the same time, animal behavior researchers have been trying to educate cognitive psychologists about the considerable body of research demonstrating that functionally specialized cognitive adaptations are ubiquitous in the animal world (e.g., Carey & R. Gelman, 1991; Gallistel, 1990; Rozin, 1976). This line of evolutionary psychology proposes that theoretical analyses drawn from evolutionary biology can guide the search for complex, functionally specialized cognitive adaptations in humans because they can provide a way of deciding what kind of modules, mental organs, or instincts are likely to have evolved (see, e.g., Barkow, Cosmides, & Tooby, 1992).

However, this search for functionally isolable (but not necessarily spatially located) units of processing in the mind and brain has not remained without criticism. An approach within artificial intelligence (i.e., "connectionism") has formed an important theoretical school of contemporary psychology and related fields. Connectionism is based on the theory of parallel computation and adaptation effects in large neural networks (McClelland, Rumelhart, & PDP Research Group, 1986). This is a different type of computation than is typical of a common computer. The latter, a serial processing model, brought about the paradigmatic metaphor of the symbol information-processing models of cognitive psychology.

Modules can, of course, operate in parallel, and there are some modular connectionists (e.g., Jacobs, Jordan, & Barto, 1990). But connectionism as a form of equipotential empiricism has run into the same problems as its behaviorist and associationist precursors (e.g., Pinker & Prince,
1. HISTORICAL CONTEXT OF PRESENT PRACTICE

Biological thinking was intimately intertwined with each of the social sciences at their respective inceptions. Much of this early influence involved borrowing images from physics and biology, and, in some cases, borrowing back ideas from social discourse that had been expropriated by the natural sciences. Yet after this promising connection among the "life sciences"—both biological and social—each discipline failed for a time to utilize evolutionary theory as it developed in the latter decades of the 19th century and the first decades of the 20th century. In sociology and anthropology, H. Spencer's ([1852]1888) metaphor about "the survival of the fittest" along with Darwin's ([1859]1964) emphasis on "natural selection," created widespread suspicion of biology when used to justify Social Darwinism and eugenics. (Interestingly, sociologists and anthropologists embraced radical equipotentiality—which promises that human wants and beliefs are arbitrary social constructions that can be easily molded by social engineers into any form determined by the rules of a society. Yet such theories were used to justify repression and genocide by Marxist regimes in (for example) Cambodia, China, and the USSR. Why these theories were not considered equally morally suspect for the genocides they "legitimated" remains a mystery, which will have to be addressed by future historians of science.) Biology kept a foothold in anthropology via the "physical" side of the discipline, whereas Darwinian metaphors in sociology were sustained via Durkheim's influence on urban ecology and later organizational ecology. In economics, Adam Smith's borrowing back from biology of the notion of division of labor and Veblen's advocacy of evolutionary economics were lost as the application of metaphors from physics and engineering—first articulated by Smith, but given substance by Pareto (who, ironically, later abandoned such mathematical formalisms for sociology)—came increasingly to push biological metaphors and then institutional considerations out of economics in favor of a narrow focus on market dynamics and equilibrium processes. In psychology, the early adaptationist implications of James' and McDougall's work were lost, somewhat because of Darwin's emphasis on continuity, but primarily because of the rise of behaviorism.

Each discipline has now begun to entertain biological ideas. Anthropology and, relatedly, archaeology have been the most influenced under the impact of sociobiological, dual inheritance, and coevolutionary approaches. Economists have started to incorporate ideas from evolutionary biology and evolutionary psychology into their theories and models (e.g., Cosmides & Tooby, 1994; Frank, 1988; Hirshleifer, 1987; Hoffman, K. McCabe, & V. Smith, 1995; Posner, 1992; Romer, 1993; Rothschild, 1992). Sociology has, by and large, rejected sociobiology, but has expanded on the ecological model first proposed by Durkheim's adoption of Darwin's idea of natural selection. Among psychologists, there is a growing interest in evolutionary psychology, and especially in basic questions about the universal architecture of the human mind.
It is unclear what the future holds. Within the natural sciences, physics, chemistry, biology, geology, astronomy, and other disciplines peacefully coexist, without fear that one discipline will "swallow" another. But for most of the 20th century, the social sciences have not shared a similar sense of equanimity. Aside from the movements discussed above, these disciplines have regarded biology (and one another) with a certain degree of paranoia. This trend may not continue, however. One possibility is that the various social sciences will adopt some biological ideas and reject others, in a piecemeal way, invoking evolution (and psychology) only when it is required to solve a specific problem within the discipline. Another possibility is that psychologists will fully incorporate evolutionary concepts into their work, recognize the relevance of research from the other social sciences and, as a result, develop an ever more detailed map of the evolved architecture of the mind. If so, then models of this evolved cognitive architecture may assume increasing importance in economics, sociology, and anthropology which, after all, make many assumptions about human nature and human decision-making. In this possible future, the various disciplines within the biological and behavioral sciences will work together, in a mutually reinforcing way. We cannot, however, rule out a very different scenario: one in which the traditional rejection of such a synthesis prevails in the social sciences, and biological ideas are either ignored, or applied in a purely metaphorical way.
# CONTENTS

Preface ................................................................. vii  
General Introduction ............................................. 1

## PART I: CONTEXTS

Introduction: Bridges Between Biology and the Social Sciences .... 15

1 Looking Back: Historical and Theoretical Context of Present Practice ........................................... 17  

2 Shifting Boundaries Between the Biological and the Social: The Social and Political Contexts ......................... 65  
   Peter Weingart, Sabine Maassen, Ullica Segerstråle

3 The Whys and Hows of Interdisciplinarity .............................. 103  
   Sandra D. Mitchell, Lorraine Daston, Gerd Gigerenzer, Neven Sesardic, and Peter B. Sloep

## PART II: HOMOLOGIES

Introduction: The Value and Limitations of Homologies from Biology in the Study of Culture ................................. 151

4 The Social Intelligence Hypothesis .................................. 157  
   Hans Kummer, Lorraine Daston, Gerd Gigerenzer, and Joan B. Silk

5 The Social and Biological Foundations of Human Communication ......................................................... 181  
   Alexandra M. Maryanski, Peter Molnár, Ullica Segerstråle, and Boris M. Velichkovsky

## PART III: ANALOGIES

Introduction: The Value and Limitations of Analogies from Biology in the Study of Culture ................................. 283

8 Units of Culture, Types of Transmission ................................ 299  
   Peter Weingart, Robert Boyd, William H. Durham, and Peter J. Richerson

9 Models and Forces of Cultural Evolution ............................. 327  
   William H. Durham, Robert Boyd, and Peter J. Richerson

10 Are Cultural Phylogenies Possible? .................................. 355  
   Robert Boyd, Monique Borgerhoff Mulder, William H. Durham, and Peter J. Richerson

11 Complex Systems: Multilevel and Multiprocess Approaches ................................................................. 387  
   Peter M. Hejl, Raphael Falk, Hubert Hendrichs, and Eva Jablonka

References ............................................................... 427

Author Index ........................................................... 469

Subject Index ........................................................... 481

List of Authors .......................................................... 493