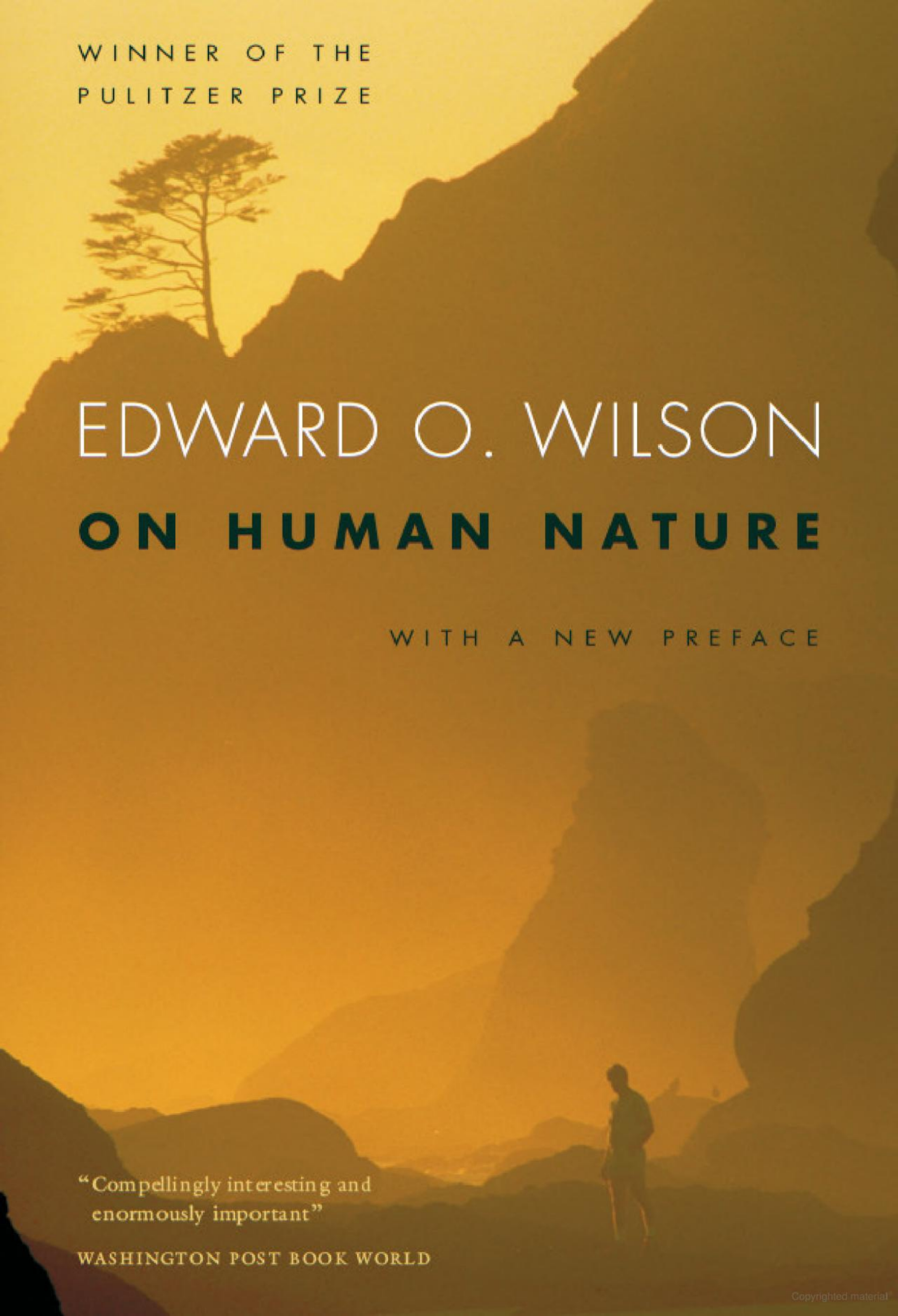

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EDWARD O. WILSON

ON HUMAN NATURE

WITH A NEW PREFACE

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On Human Nature

With a New Preface

EDWARD O. WILSON

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Contents

Can there be a more important subject than human nature? If the subject can be truly fathomed, then our species will be more precisely defined, and our actions perhaps more wisely guided. When *On Human Nature* was written, in the 1970s, two conceptions of the human condition dominated Western thought. Theologians, plus all but the most liberal followers of the Abrahamic religions, saw human beings as dark angels in animal bodies awaiting redemption and eternal life. Human nature, in their view, is a mix of good and evil propensities, which we must sort out with the aid of writings by ancient Middle Eastern prophets.

In contrast, most intellectuals, whether religiously inclined or not, doubted that a human nature exists at all. To them the brain is a blank slate, an engine driven by a few elementary passions but otherwise an all-purpose computer that creates the mind wholly from individual experience and learning. Culture, the intellectual majority in the 1970s believed, is the cumulative learned response to environment and historical contingency.

Meanwhile, an alternative, naturalistic view was gaining strength. Still embryonic in form, it held that the brain and mind are entirely biological in origin and have been highly structured through evolution by natural selection. Human nature exists, composed of the complex biases of passion and learning propensities often loosely referred to as instincts. The instincts were created over millions of years, when human beings were Paleolithic hunter-gatherers. As a consequence, they still bear the archaic imprint of our species' biological heritage. Human nature can thus be ultimately understood only with the aid of the scientific method. Culture evolves in response to environmental and historical contingencies, as common sense suggests, but its trajectories are powerfully guided by the inborn biases of human nature. This view was encapsulated in the new discipline of sociobiology, which in its human applications was later re-christened evolutionary psychology (but remains sociobiology nonetheless).

Human sociobiology asks: What might the human instincts be? How do they fit together to compose human nature? Until the 1970s these central and ancient questions had rarely been addressed as a problem in biology. In particular, they had never been treated in any effective way as the province of two radically different but crucial and potentially consilient disciplines within biology. The first of these disciplines is neuroscience, needed to explain what the mind is and how the brain creates it. The second is evolutionary biology, required to explain why the brain works in the odd way it does, and not in some other way out of the many conceivable. In a nutshell, the conundrum of human nature, as I and a few others saw it in this early period, can be solved only if scientific explanations embrace both the *how* (neurosciences) and *why* (evolutionary biology) of brain action, with the two axes of explanation fitted together.

There is still more to be asked of the naturalistic approach to human nature. People may be endowed with instincts, and these may come to be well understood, but in precisely what manner have these biases in mental development shaped culture? The problem is deeper than most thinkers have visualized. If culture has evolved for millennia under the influence of a biological human nature, it is equally true that human nature has evolved at least in part during the hundreds of millennia in which the modern human species and its immediate antecedents in the genus *Homo* lived in bands, captured fire, invented tools, perfected language, and as a result of this burst of genius spread over the farflung continents and archipelagoes of Earth. Gene–culture coevolution, the synergistic coupling of the two forms of evolution, was inevitable. Yet of the true workings of gene–culture coevolution we know extremely little to this day.

On Human Nature, which is kept here in its original form, touches on all these issues. To provide a fuller context, I think it useful to explain how I came to write the book in 1977–78. Throughout my scientific career to that time, covering three decades, I had focused on the biology of ants. I was of course impressed by the complexity and precision by which instincts guide the lives of these insects (some critics were to suggest *too* impressed). Having committed myself also to research on biodiversity, I was also attracted to the general study of evolution and its relevance to the biology of populations. In the late 1950s I was struck by a connection, which in retrospect seems obvious today, that societies are populations, and many of their properties are therefore open to the same kinds of analysis applied more generally to the genetics and ecology of populations. In *The Insect Societies* (1971), I proposed that a coherent branch of biology might be constructed from a synthesis of social behavior and population biology. The new discipline, for which I suggested the name sociobiology, would for the first time bind together knowledge of social insects and social vertebrate animals:

> The optimistic prospect for sociobiology can be summarized briefly as follows. In spite of the phylogenetic remoteness of vertebrates and insects and the basic distinction between their respective personal and impersonal systems of communication,

> these two groups of animals have evolved social behaviors that are similar in degree of complexity and convergent in many important details. This fact conveys a special promise that sociobiology can eventually be derived from the first principles of population and behavioral biology and developed into a single, mature science. The discipline can then be expected to increase our understanding of the unique qualities of social behavior in animals as opposed to those of man. (*The Insect Societies*, p. 460)

The schema for the consilience of the relevant disciplines suggested in 1971 is reproduced in the accompanying figure.

In 1975 I expanded the conception of the discipline outlined in *The Insect Societies* to include vertebrate animals. The result was *Sociobiology: The New Synthesis*, a double-column, 697-page account of theory based on an encyclopedic review of all known social organisms, from social bacteria and coelenterates through the insects and vertebrates and human beings. The non-human part was a success among biologists. In a 1989 poll the officers and fellows of the international Animal Behavior Society ranked *Sociobiology: The New Synthesis* the most important book on animal behavior of all time, edging out even Darwin's 1872 classic, *The Evolution of Emotions in Man and Animals.*

Many scientists and others believed it would have been better if I had stopped at chimpanzees, short of *Homo sapiens*, remaining chastely on the zoological side of the boundary between the natural sciences and humanities. But the challenge and the excitement I felt were too much to resist, and in the final chapter, "Man: From Sociobiology to Sociology," I crossed the well-guarded boundary:

> Let us now consider man in the free spirit of natural history, as though we were zoologists from another planet completing a catalog of social species on Earth. In this macroscopic view the humanities and social sciences shrink to specialized branches of

some and noisy fashion, was again proving its mettle. The negative side of this tumult, however, was the opportunity it offered extremism. The fashionable mood in academia was revolutionary left. Elite universities invented political correctness, enforced by peer pressures and the threat of student protest. Marxism and socialism in this ambience were all right. Communist revolutions were all right. The regimes of China and the Soviet Union were, at least in ideology, all right. Centrism was scorned outside the dean's office. Political conservatives, stewing inwardly, for the most part dared not speak up. Radical left professors and visiting activists, the heroes on campus, repeated this litany: The Establishment has failed us, the Establishment blocks progress, the Establishment is the enemy. Power to the people it was—but with an American twist. Because ordinary working people remained dismayingly conservative throughout this sandbox revolution, the new proletariat in the class struggle had to be the students. And, unable to picture their futures as stockbrokers, bureaucrats, and college administrators, many of the students complied.

In academia's now necktie-free zone, race was a radioactive issue, deadly to any who touched it without extreme caution. Talk of the inheritance of IQ and human behavior were punishable offenses. Anyone who dared mention these subjects in any manner other than formulaic condemnation was at risk of being called a racist. Indictment as a racist in the eyes of the community, even if wholly false, would have been cause for banishment from academe. But that almost never occurred because the faculty were smart and timorous enough to stay entirely away from the subjects, at least in public. Even private conversations were cautious and muted.

The roots of the antipathy ran deep, and, the hysteria of the 1970s aside, had a core of validity. Social Darwinism and eugenics, arisen from the marriage of inadequate biology and right-wing nativist ideology, had been a blight on the natural sciences in the early decades of the twentieth century. They were favored by the Soviet Union in the 1930s, during its pre-Lamarckian period, and contributed fundamentally to the Nazi atrocities of the 1930s and 1940s. Partly as a reaction to this misuse of biology, and partly due to the laboratory successes of behaviorism as the dominant movement within psychology, social scientists steered away from the concept of instinct and the uses of genetics and evolutionary theory to explain human behavior. As late as the 1970s, the blank-slate interpretation of the brain sheltered the social sciences and humanities from the storms of biology and vouchsafed their independence as two of the three great branches of learning.

Sociobiology, therefore, was widely seen not as an intellectual resource, as I had hoped, but as a threat to the blank-slate worldview. Worse, within a small but outspoken segment of the intellectual elite, it was considered a threat to Marxist ideology. In rejecting sociobiology, these critics managed to redefine the word in a wholly new and misleading way. In the popular media, it came to mean the theory that human behavior is determined by genes, or at least strongly influenced by them, as opposed to learning. Of course, that proposition is nowadays seen to be correct, and there was already plenty of evidence to support it in the 1970s. But regardless of the evidence, that is not what sociobiology meant originally or is understood to mean by scientists today. Sociobiology is a scientific discipline, the systematic study of the biological basis of all forms of social behavior in organisms, including humans. As an ensemble of working theories, it even encompasses the possibility of a blank-slate brain, recognizing that in order to flatten out innate predispositions to achieve such a brain would require a great deal of evolution involving a large number of genes. In other words, the theory of a blank slate is at base an intensely sociobiological idea, albeit wrong.

The sociobiology controversy stemming from this mix of misunderstanding, suspicion, and resentment persuaded me early on that I had not adequately explained the relevance of the discipline to the understanding of human behavior. The final chapter of *Sociobiology: The New Synthesis* should have been a book-length exposition. It needed to go deeper into behavioral genetics, to address more persuasively the issue of culture, and more generally to address some of the philosophical and social issues that sociobiology had raised. It needed to address in a focused manner the main objections that had arisen and yet might arise from political ideology and religious belief. Consequently, in 1977 I sat down to write the book before you, *On Human Nature*, in an attempt to achieve these various ends. I was considerably relieved to have it generally well received, and to see it remain in wide circulation to the present time.

Edward O. Wilson
Lexington, Massachusetts
June 2004

Suggestions for Further Reading

The following books, written for broad audiences, are among those that track the developments in human sociobiology (most often called evolutionary psychology) in the twenty-five years following the publication of *On Human Nature*.

Alcock, John. *The Triumph of Sociobiology* (New York: Oxford University Press, 2001).

Barkow, Jerome H., Leda Cosmides, and John Tooby, eds. *The Adapted Mind* (New York: Oxford University Press, 1992).

Degler, Carl N. *In Search of Human Nature: The Decline & Revival of Darwinism in American Social Thought* (New York: Oxford University Press, 1991).

Segerstråle, Ullica. *Defenders of the Truth* (New York: Oxford University Press, 2000).

On Human Nature is the third book in a trilogy that unfolded without my being consciously aware of any logical sequence until it was nearly finished. The final chapter of *The Insect Societies* (1971) was entitled "The Prospect for a Unified Sociobiology." In it I suggested that the same principles of population biology and comparative zoology that have worked so well in explaining the rigid systems of the social insects could be applied point by point to vertebrate animals. In time, I said, we will account for both termite colonies and troops of rhesus monkeys by a single set of parameters and one quantitative theory. Unable to resist the rhetoric of my own challenge, I set out to learn the large and excellent literature on vertebrate social behavior and wrote *Sociobiology: The New Synthesis* (1975). In its final chapter "Man: From Sociobiology to Sociology," I argued that the biological principles which now appear to be working reasonably well for animals in general can be extended profitably to the social sciences. This suggestion created an unusual amount of interest and controversy.

The aftermath of the publication of *Sociobiology* led me to read more widely on human behavior and drew me to many seminars and written exchanges with social scientists. I became more persuaded

8 contain a few sections from Chapter 27 of *Sociobiology*. The permission of the publishers to reproduce this material is appreciated. Permission for the quotation of work by other authors has been obtained variously from the University of California Press, the University of Chicago Press, and Macmillan Company; the specific citations are given in the bibliographic notes.

ON HUMAN NATURE

These are the central questions that the great philosopher David Hume said are of unspeakable importance: How does the mind work, and beyond that why does it work in such a way and not another, and from these two considerations together, what is man's ultimate nature?

We keep returning to the subject with a sense of hesitancy and even dread. For if the brain is a machine of ten billion nerve cells and the mind can somehow be explained as the summed activity of a finite number of chemical and electrical reactions, boundaries limit the human prospect—we are biological and our souls cannot fly free. If humankind evolved by Darwinian natural selection, genetic chance and environmental necessity, not God, made the species. Deity can still be sought in the origin of the ultimate units of matter, in quarks and electron shells (Hans Küng was right to ask atheists why there is something instead of nothing) but not in the origin of species. However much we embellish that stark conclusion with metaphor and imagery, it remains the philosophical legacy of the last century of scientific research.

No way appears around this admittedly unappealing proposition. It is the essential first hypothesis for any serious consideration of the human condition. Without it the humanities and social sciences are the limited descriptors of surface phenomena, like astronomy without physics, biology without chemistry, and mathematics without algebra. With it, human nature can be laid open as an object of fully empirical research, biology can be put to the service of liberal education, and our self-conception can be enormously and truthfully enriched.

But to the extent that the new naturalism is true, its pursuit seems certain to generate two great spiritual dilemmas. The first is that no species, ours included, possesses a purpose beyond the imperatives created by its genetic history. Species may have vast potential for material and mental progress but they lack any immanent purpose or guidance from agents beyond their immediate environment or even an evolutionary goal toward which their molecular architecture automatically steers them. I believe that the human mind is constructed in a way that locks it inside this fundamental constraint and forces it to make choices with a purely biological instrument. If the brain evolved by natural selection, even the capacities to select particular esthetic judgments and religious beliefs must have arisen by the same mechanistic process. They are either direct adaptations to past environments in which the ancestral human populations evolved or at most constructions thrown up secondarily by deeper, less visible activities that were once adaptive in this stricter, biological sense.

The essence of the argument, then, is that the brain exists because it promotes the survival and multiplication of the genes that direct its assembly. The human mind is a device for survival and reproduction, and reason is just one of its various techniques. Steven Weinberg has pointed out that physical reality remains so mysterious even to physicists because of the extreme improbability that it was constructed to be understood by the human mind. We can reverse that insight to note with still greater force that the intellect was not constructed to understand atoms or even to understand itself but to promote the must be made among the ethical premises inherent in man's biological nature.

At this point let me state in briefest terms the basis of the second dilemma, while I defer its supporting argument to the next chapter: innate censors and motivators exist in the brain that deeply and unconsciously affect our ethical premises; from these roots, morality evolved as instinct. If that perception is correct, science may soon be in a position to investigate the very origin and meaning of human values, from which all ethical pronouncements and much of political practice flow.

Philosophers themselves, most of whom lack an evolutionary perspective, have not devoted much time to the problem. They examine the precepts of ethical systems with reference to their consequences and not their origins. Thus John Rawls opens his influential *A Theory of Justice* (1971) with a proposition he regards as beyond dispute: "In a just society the liberties of equal citizenship are taken as settled; the rights secured by justice are not subject to political bargaining or to the calculus of social interests." Robert Nozick begins *Anarchy, State, and Utopia* (1974) with an equally firm proposition: "Individuals have rights, and there are things no person or group may do to them (without violating their rights). So strong and far-reaching are these rights they raise the question of what, if anything, the state and its officials may do." These two premises are somewhat different in content, and they lead to radically different prescriptions. Rawls would allow rigid social control to secure as close an approach as possible to the equal distribution of society's rewards. Nozick sees the ideal society as one governed by a minimal state, empowered only to protect its citizens from force and fraud, and with unequal distribution of rewards wholly permissible. Rawls rejects the meritocracy; Nozick accepts it as desirable except in those cases where local communities voluntarily decide to experiment with egalitarianism. Like everyone else, philosophers measure their personal emotional responses to various alternatives as though consulting a hidden oracle.

That oracle resides in the deep emotional centers of the brain, most probably within the limbic system, a complex array of neurons and hormone-secreting cells located just beneath the "thinking" portion of the cerebral cortex. Human emotional responses and the more general ethical practices based on them have been programmed to a substantial degree by natural selection over thousands of generations. The challenge to science is to measure the tightness of the constraints caused by the programming, to find their source in the brain, and to decode their significance through the reconstruction of the evolutionary history of the mind. This enterprise will be the logical complement of the continued study of cultural evolution.

Success will generate the second dilemma, which can be stated as follows: Which of the censors and motivators should be obeyed and which ones might better be curtailed or sublimated? These guides are the very core of our humanity. They and not the belief in spiritual apartness distinguish us from electronic computers. At some time in the future we will have to decide how human we wish to remain—in this ultimate, biological sense—because we must consciously choose among the alternative emotional guides we have inherited. To chart our destiny means that we must shift from automatic control based on our biological properties to precise steering based on biological knowledge.

Because the guides of human nature must be examined with a complicated arrangement of mirrors, they are a deceptive subject, always the philosopher's deadfall. The only way forward is to study human nature as part of the natural sciences, in an attempt to integrate the natural sciences with the social sciences and humanities. I can conceive of no ideological or formalistic shortcut. Neurobiology cannot be learned at the feet of a guru. The consequences of genetic history cannot be chosen by legislatures. Above all, for our own physical well-being if nothing else, ethical philosophy must not be left in the hands of the merely wise. Although human progress can be achieved by intuition and force of will, only hard-won empirical knowledge of our biological nature will allow us to make optimum choices among the competing criteria of progress.

The important initial development in this analysis will be the conjunction of biology and the various social sciences—psychology, anthropology, sociology, and economics. The two cultures have only recently come into full sight of one another. The result has been a predictable mixture of aversions, misunderstandings, overenthusiasm, local conflicts, and treaties. The situation can be summarized by saying that biology stands today as the antidiscipline of the social sciences. By the word "antidiscipline" I wish to emphasize the special adversary relation that often exists when fields of study at adjacent levels of organization first begin to interact. For chemistry there is the antidiscipline of many-body physics; for molecular biology, chemistry; for physiology, molecular biology; and so on upward through the paired levels of increasing specification and complexity.

In the typical early history of a discipline, its practitioners believe in the novelty and uniqueness of their subject. They devote lifetimes to special entities and patterns and during the early period of exploration they doubt that these phenomena can be reduced to simple laws. Members of the antidiscipline have a different attitude. Having chosen as their primary subject the units of the lower level of organization, say atoms as opposed to molecules, they believe that the next discipline above can and must be reformulated by their own laws: chemistry by the laws of physics, biology by the laws of chemistry, and so on downward. Their interest is relatively narrow, abstract, and exploitative. P.A.M. Dirac, speaking of the theory of the hydrogen atom, could say that its consequences would unfold as mere chemistry. A few biochemists are still content in the belief that life is "no more" than the actions of atoms and molecules.

It is easy to see why each scientific discipline is also an antidiscipline. An adversary relationship is probable because the devotees of the two adjacent organizational levels—such as atoms versus molecules—are initially committed to their own methods and ideas when they focus on the upper level (in this case, molecules). By today's standards a broad scientist can be defined as one who is a student of three subjects: his discipline (chemistry in the example cited), the lower antidiscipline (physics), and the subject to which his specialty stands as antidiscipline (the chemical aspects of biology). A well-rounded expert on the nervous system, to take a second, more finely graded example, is deeply versed in the structure of single nerve cells, but he also understands the chemical basis of the impulses that pass through and between these cells, and he hopes to explain how nerve cells work together to produce elementary patterns of behavior. Every successful scientist treats differently each of the three levels of phenomena surrounding his specialty.

The interplay between adjacent fields is tense and creative at the beginning, but with the passage of time it becomes fully complementary. Consider the origins of molecular biology. In the late 1800s the microscopic study of cells (cytology) and the study of chemical processes within and around the cells (biochemistry) grew at an accelerating pace. Their relationship during this period was complicated, but it broadly fits the historical schema I have described. The cytologists were excited by the mounting evidence of an intricate cell architecture. They had interpreted the mysterious choreography of the chromosomes during cell division and thus set the stage for the emergence of modern genetics and experimental developmental biology. Many biochemists, on the other hand, remained skeptical of the idea that so much structure exists at the microscopic level. They thought that the cytologists were describing artifacts created by laboratory methods of fixing and staining cells for microscopic examination. Their interest lay in the more "fundamental" issues of the chemical nature of protoplasm, especially the newly formulated theory that life is based on enzymes. The cytologists responded with scorn to any notion that the cell is a "bag of enzymes."

In general, biochemists judged the cytologists to be too ignorant of chemistry to grasp the fundamental processes, while the cytologists considered the methods of the chemists inappropriate for the idiosyncratic structures of the living cell. The revival of Mendelian genetics in 1900 and the subsequent illumination of the roles of the chromosomes and genes did little at first to force a synthesis. Biochemists, seeing no immediate way to explain classical genetics, by and large ignored it.

Both sides were essentially correct. Biochemistry has now explained so much of the cellular machinery on its own terms as to justify its most extravagant early claims. But in achieving this feat, mostly since 1950, it was partially transformed into the new discipline of molecular biology, which can be defined as biochemistry that also accounts for the particular spatial arrangements of such molecules as the DNA helix and enzyme proteins. Cytology forced the development of a special kind of chemistry and the use of a battery of powerful new techniques, including electrophoresis, chromatography, density-gradient centrifugation, and x-ray crystallography. At the same time cytology metamorphosed into modern cell biology. Aided by the electron microscope, which magnifies objects by hundreds of thousands of times, it has converged in perspective and language toward molecular biology. Finally, classical genetics, by switching from fruit flies and mice to bacteria and viruses, has incorporated biochemistry to become molecular genetics.

Progress over a large part of biology has been fueled by competition among the various perspectives and techniques derived from its dipole moment by passing the nitrogen atom back and forth through the triangle of hydrogen atoms at a frequency of thirty billion times per second. However, such symmetry is absent in the case of sugar and other large organic molecules, which are too large and complex in structure to invert themselves. They break but do not repeal the laws of physics. This specification may not be greatly interesting to nuclear physicists, but its consequences redound throughout organic chemistry and biology.

Consider a second example, closer to our subject, from the evolution of social life in the insects. In the Mesozoic Era, about 150 million years ago, primitive wasps evolved the sex-determining trait of haplodiploidy, in which fertilized eggs produced females and those left unfertilized produced males. This simple method of control may have been a specific adaptation that permitted females to choose the sex of their offspring according to the nature of the prey insects they were able to subdue. In particular, smaller prey might have been assigned to the male offspring, which require less protein in their development. But whatever its initial cause, haplodiploidy represented an evolutionary event that quite accidentally predisposed these insects to develop advanced forms of social life. The reason is that haplodiploidy causes sisters to be more closely related to each other than mothers are to daughters, and so females may derive genetic profit from becoming a sterile caste specialized for the rearing of sisters. Sterile castes engaged in rearing siblings are the essential feature of social organization in the insects. Because of its link to haplodiploidy, insect social life is almost limited to the wasps and their close relatives among the bees and ants. Furthermore, most cases can be classified either as matriarchies, in which queens control colonies of daughters, or as sisterhoods, in which sterile daughters control the egg-laying mothers. The societies of wasps, bees, and ants have proved so successful that they dominate and alter most of the land habitats of the Earth. In the forests of Brazil, their assembled forces constitute more than 20 percent of the weight of all land animals, including nematode worms, toucans, and jaguars. Who could have guessed all this from a knowledge of haplodiploidy?

Reduction is the traditional instrument of scientific analysis, but it is feared and resented. If human behavior can be reduced and determined to any considerable degree by the laws of biology, then mankind might appear to be less than unique and to that extent dehumanized. Few social scientists and scholars in the humanities are prepared to enter such a conspiracy, let alone surrender any of their territory. But this perception, which equates the method of reduction with the philosophy of diminution, is entirely in error. The laws of a subject are necessary to the discipline above it, they challenge and force a mentally more efficient restructuring, but they are not sufficient for the purposes of the discipline. Biology is the key to human nature, and social scientists cannot afford to ignore its rapidly tightening principles. But the social sciences are potentially far richer in content. Eventually they will absorb the relevant ideas of biology and go on to beggar them. The proper study of man is, for reasons that now transcend anthropocentrism, man.

Ch ity

We live on a planet of staggering organic diversity. Since Carolus Linnaeus began the process of formal classification in 1758, zoologists have catalogued about one million species of animals and given each a scientific name, a few paragraphs in a technical journal, and a small space on the shelves of one museum or another around the world. Yet despite this prodigious effort, the process of discovery has hardly begun. In 1976 a specimen of an unknown form of giant shark, fourteen feet long and weighing sixteen hundred pounds, was captured when it tried to swallow the stabilizing anchor of a United States Naval vessel near Hawaii. About the same time entomologists found an entirely new category of parasitic flies that resemble large reddish spiders and live exclusively in the nests of the native bats of New Zealand. Each year museum curators sort out thousands of new kinds of insects, copepods, wireworms, echinoderms, priapulids, pauropods, hypermastigotes, and other creatures collected on expeditions around the world. Projections based on intensive surveys of selected habitats indicate that the total number of animal species is between three and ten million. Biology, as the naturalist Howard Evans expressed it in the title of a recent book, is the study of life "on a little known planet."

Thousands of these species are highly social. The most advanced among them constitute what I have called the three pinnacles of social evolution in animals: the corals, bryozoans, and other colony-forming invertebrates; the social insects, including ants, wasps, bees, and termites; and the social fish, birds, and mammals. The communal beings of the three pinnacles are among the principal objects of the new discipline of sociobiology, defined as the systematic study of the biological basis of all forms of social behavior, in all kinds of organisms, including man. The enterprise has old roots. Much of its basic information and some of its most vital ideas have come from ethology, the study of whole patterns of behavior of organisms under natural conditions. Ethology was pioneered by Julian Huxley, Karl von Frisch, Konrad Lorenz, Nikolaas Tinbergen, and a few others and is now being pursued by a large new generation of innovative and productive investigators. It has remained most concerned with the particularity of the behavior patterns shown by each species, the ways these patterns adapt animals to the special challenges of their environments, and the steps by which one pattern gives rise to another as the species themselves undergo genetic evolution. Increasingly, modern ethology is being linked to studies of the nervous system and the effects of hormones on behavior. Its investigators have become deeply involved with developmental processes and even learning, formerly the nearly exclusive domain of psychology, and they have begun to include man among the species most closely scrutinized. The emphasis of ethology remains on the individual organism and the physiology of organisms.

Sociobiology, in contrast, is a more explicitly hybrid discipline that incorporates knowledge from ethology (the naturalistic study of whole patterns of behavior), ecology (the study of the relationships of organisms to their environment), and genetics in order to derive general principles concerning the biological properties of entire societies. What is truly new about sociobiology is the way it has exorganizations of social species on this planet and a still smaller fraction of those that can be readily imagined with the aid of sociobiological theory.

The question of interest is no longer whether human social behavior is genetically determined; it is to what extent. The accumulated evidence for a large hereditary component is more detailed and compelling than most persons, including even geneticists, realize. I will go further: it already is decisive.

That being said, let me provide an exact definition of a genetically determined trait. It is a trait that differs from other traits at least in part as a result of the presence of one or more distinctive genes. The important point is that the objective estimate of genetic influence requires comparison of two or more states of the same feature. To say that blue eyes are inherited is not meaningful without further qualification, because blue eyes are the product of an interaction between genes and the largely physiological environment that brought final coloration to the irises. But to say that the *difference* between blue and brown eyes is based wholly or partly on differences in genes is a meaningful statement because it can be tested and translated into the laws of genetics. Additional information is then sought: What are the eye colors of the parents, siblings, children, and more distant relatives? These data are compared to the very simplest model of Mendelian heredity, which, based on our understanding of cell multiplication and sexual reproduction, entails the action of only two genes. If the data fit, the differences are interpreted as being based on two genes. If not, increasingly complicated schemes are applied. Progressively larger numbers of genes and more complicated modes of interaction are assumed until a reasonably close fit can be made. In the example just cited, the main differences between blue and brown eyes are in fact based on two genes, although complicated modifications exist that make them less than an ideal textbook example. In the case of the most complex traits, hundreds of genes are sometimes involved, and their degree of influence can ordinarily be measured only crudely and with the aid of sophisticated mathematical techniques. Nevertheless, when the analysis is properly performed it leaves little doubt as to the presence and approximate magnitude of the genetic influence.

Human social behavior can be evaluated in essentially the same way, first by comparison with the behavior of other species and then, with far greater difficulty and ambiguity, by studies of variation among and within human populations. The picture of genetic determinism emerges most sharply when we compare selected major categories of animals with the human species. Certain general human traits are shared with a majority of the great apes and monkeys of Africa and Asia, which on grounds of anatomy and biochemistry are our closest living evolutionary relatives:

- Our intimate social groupings contain on the order of ten to one hundred adults, never just two, as in most birds and marmosets, or up to thousands, as in many kinds of fishes and insects.
- Males are larger than females. This is a characteristic of considerable significance within the Old World monkeys and apes and many other kinds of mammals. The average number of females consorting with successful males closely corresponds to the size gap between males and females when many species are considered together. The rule makes sense: the greater the competition among males for females, the greater the advantage of large size and the less influential are any disadvantages accruing to bigness. Men are not very much larger than women; we are similar to chimpanzees in this regard. When the sexual size difference in human beings is plotted on the curve based on other kinds of mammals, the predicted average number of females per successful male turns out to be greater than one but less than three. The prediction is close to reality; we know we are a mildly polygynous species.
- The young are molded by a long period of social training, first

by closest associations with the mother, then to an increasing degree with other children of the same age and sex.

- Social play is a strongly developed activity featuring role practice, mock aggression, sex practice, and exploration.

These and other properties together identify the taxonomic group consisting of Old World monkeys, the great apes, and human beings. It is inconceivable that human beings could be socialized into the radically different repertories of other groups such as fishes, birds, antelopes, or rodents. Human beings might self-consciously *imitate* such arrangements, but it would be a fiction played out on a stage, would run counter to deep emotional responses and have no chance of persisting through as much as a single generation. To adopt with serious intent, even in broad outline, the social system of a nonprimate species would be insanity in the literal sense. Personalities would quickly dissolve, relationships disintegrate, and reproduction cease.

At the next, finer level of classification, our species is distinct from the Old World monkeys and apes in ways that can be explained only as a result of a unique set of human genes. Of course, that is a point quickly conceded by even the most ardent environmentalists. They are willing to agree with the great geneticist Theodosius Dobzhansky that "in a sense, human genes have surrendered their primacy in human evolution to an entirely new, nonbiological or superorganic agent, culture. However, it should not be forgotten that this agent is entirely dependent on the human genotype." But the matter is much deeper and more interesting than that. There are social traits occurring through all cultures which upon close examination are as diagnostic of mankind as are distinguishing characteristics of other animal species—as true to the human type, say, as wing tessellation is to a fritillary butterfly or a complicated spring melody to a wood thrush. In 1945 the American anthropologist George P. Murdock listed the following characteristics that have been recorded in every culture known to history and ethnography:

> Age-grading, athletic sports, bodily adornment, calendar, cleanliness training, community organization, cooking, cooperative labor, cosmology, courtship, dancing, decorative art, divination, division of labor, dream interpretation, education, eschatology, ethics, ethnobotany, etiquette, faith healing, family feasting, fire making, folklore, food taboos, funeral rites, games, gestures, gift giving, government, greetings, hair styles, hospitality, housing, hygiene, incest taboos, inheritance rules, joking, kin groups, kinship nomenclature, language, law, luck superstitions, magic, marriage, mealtimes, medicine, obstetrics, penal sanctions, personal names, population policy, postnatal care, pregnancy usages, property rights, propitiation of supernatural beings, puberty customs, religious ritual, residence rules, sexual restrictions, soul concepts, status differentiation, surgery, tool making, trade, visiting, weaving, and weather control.

Few of these unifying properties can be interpreted as the inevitable outcome of either advanced social life or high intelligence. It is easy to imagine nonhuman societies whose members are even more intelligent and complexly organized than ourselves, yet lack a majority of the qualities just listed. Consider the possibilities inherent in the insect societies. The sterile workers are already more cooperative and altruistic than people and they have a more pronounced tendency toward caste systems and division of labor. If ants were to be endowed in addition with rationalizing brains equal to our own, they could be our peers. Their societies would display the following peculiarities:

> Age-grading, antennal rites, body licking, calendar, cannibalism, caste determination, caste laws, colony-foundation rules, colony organization, cleanliness training, communal nurseries, cooperative labor, cosmology, courtship, division of labor, drone control, education, eschatology, ethics, etiquette, euthanasia,