FIFTH EDITION

Clifford J. Jolly • Randall White

# Physical Anthropology and Archaeology

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# PHYSICAL ANTHROPOLOGY AND ARCHAEOLOGY



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# ABOUT THE AUTHORS

**CLIFFORD J. JOLLY** was born in 1939 and raised in Lehigh-on-Sea in Essex, England. He received both his B.A. (1960) and his Ph.D. (1964) from University College, London. He began teaching at University College in 1963 and came to the United States in 1967 to teach at New York University, where he is now Professor of Anthropology.

His research interests in primate and human evolution, population structure, and genetics and behavior have taken him to field sites from Peru to Pakistan. His current research focuses on the genetics of speciation and hybridization in primates, and is conducted in the field in Ethiopia and in the laboratory in New York.

Dr. Jolly has published with Michael R. Chance a book entitled *Social Groups of Monkeys, Apes, and Man*. He also edited *Early African Hominids*. His articles have been published in edited collections and in journals such as *Nature, Man, Proceedings of the Royal Society, Folia Primatologica, American Journal of Primatology*, and *American Journal of Physical Anthropology*.

**RANDALL WHITE** (born 1952) is Professor of Anthropology at New York University, and is also Director of the New York based *Institute for Ice Age Studies*. He has worked on the Upper Paleolithic cultures of France since 1974. His Doctoral thesis (University of Toronto, Canada) was entitled *Upper Paleolithic Land Use in the Périgord: A Topographic Approach to Subsistence and Settlement.*

In 1986, he was the curator of a remarkable exhibition in New York, at the *American Museum of Natural History*. This three-month exhibition, entitled *Dark Caves, Bright Visions: Life in Ice Age Europe* was mounted in collaboration with several European museums. It brought to New York many of the great treasures of Paleolithic art and was visited by 400,000 people.

White has been instrumental in bringing to light, and publishing in a scientific manner, important European Upper Paleolithic collections that were acquired early in this century by North American museums.

His attention has now turned to the origins of art and personal adornment in Europe, a project that has taken him to various museums from France to Russia. He is currently the co-director of excavations at the 35,000 year old site of Abri Castanet in SW France.

# PREFACE

This book is intended to introduce human biological and cultural evolution to students with little or no previous experience of these two related fields of evolutionary anthropology. Instructors who have used previous editions will find much that is familiar. In no small measure, this is thanks to the coauthor of editions one through four, our late colleague, Professor Fred Plog, to whom we owe the organization of much of the text. On the whole, our interpretations seem to have held up under the test of time and discovery; indeed, it is satisfying to find that some are more widely accepted now than when first enunciated! But the field has progressed and, after eighteen years and a change of publisher and authorship, a major revision was imperative. The whole text has been rewritten; these are some of the changes:

- Though still intended primarily for a single semester course that combines archaeology and physical anthropology, the text now falls more naturally into halves, each of which can stand alone as an introduction to its field.
- New evidence and theoretical advances are incorporated. Fresh examples illustrate the principles.
- Boxes on three themes—*New Frontiers, Viewpoints, Analyzing the Evidence*—go into greater depth on specific topics of interest in the text.
- A special feature called *Poster Pages* uses a combination of illustrations to highlight certain concepts.
- The illustration program has been improved with more art and photos to clarify and expand on facts and concepts. A new level of detail and beauty is derived from the four-color format.
- The level of documentation is enhanced.
- The glossary and references have been expanded.

After an Introduction that sets biological and archaeological anthropology in their common historical context, the first half of the book is devoted to human evolution, broadly defined. It opens with a consideration of evolutionary theory, and its logical derivation from the elements of genetics. The present state of human biological diversity is considered in the context of population genetic theory. In the next section, which includes a new chapter devoted to primate society, we consider the human species in the evolutionary context of living species. Here we introduce the methods and vocabulary of cladistics, which provides a much sounder framework than the all-too-familiar, and anthropocentric, concept of "grades." A new chapter on the nature of paleontological evidence sets the stage for a fossil-based evolutionary narrative that carries the reader up to the evolutionary origin of modern human beings.

The second half of the book begins with an account of some methods and theory that are specific to the interpretation of archaeological evidence. The sharp-eyed reader will note the second "a" in "archaeology," absent in earlier editions. The change symbolizes a slight theoretical reorientation, in favor of a more humanistic approach to archaeological science, one that acknowledges its intellectual ties to cultural anthropology, and to the humanities, as well as to biological and earth sciences. Within this theoretical framework, we then present a narrative of human cultural evolution in its ecological context. This begins with the earliest evidence of toolmaking, and continues with the appearance of landmarks of human innovation that apparently signal the evolution of "true" culture. The narrative ends with the invention, in a few societies, of written records, and thus, by definition, the "end of prehistory." A brief Epilogue emphasizes the artificiality of this traditional breakpoint, and the relevance of an evolutionary perspective to life in today's world.

Students will, we hope, find the text demanding, but not frustrating. Each chapter is designed to build upon the previous one, and assumes little prior anthropological or biological knowledge. We do not gloss over complex arguments or avoid necessary technical terms, but we have tried to minimize jargon, obscurity, and internal inconsistency. To this end, when covering contentious topics, we do not conceal our own preference for the interpretations and theoretical approaches we consider the strongest, though we do try to give a fair account of all reasonable alternatives. Our primary intent is not simply to tell a story, since any we could concoct would undoubtedly become obsolete with new discoveries and analyses. Rather, by emphasizing method and theory we aim to provide the student with the tools to evaluate discoveries and interpretations—including our own narrative.

Since both authors are active in anthropological research, we naturally tend to draw illustrative examples of general phenomena from our own experience. We trust that this has produced a work that is recognizably ours, without being overly idiosyncratic.

Producing a text such as this requires a complex interaction among authors, editors, and reviewers. Clifford J. Jolly wrote Chapters 1 through 10; Randall White, Chapters 11 through 16; both contributed to the Introduction and the Epilogue. Editor Jill Gordon guided this revision, while Ira Roberts ably coordinated its completion; the complex process of redesigning to a full color format was overseen by Joan Greenfield and photo researchers Mira Schachne, Elyse Rieder, and Kathy Bendo provided the illustrative materials. Special thanks, for all her patience and hard work, is due to Valerie Raymond. Thanks, too, to Sylvia Shepard and the many hands at Knopf who helped produce previous editions.

We are grateful to the many colleagues who read and commented on various parts of the manuscript: Robin Burgess, University of Illinois; Michael Deal, Memorial University of Newfoundland; Eric Delson, Herbert H. Lehman College of the City University of New York; Frank W. Eddy, University of Colorado at Boulder; Bill Engelbrencht, Buffalo State College; Michael Gibbons, University of Massachusetts at Boston; Jeffrey L. Hantman, University of Virginia; Terry Harrison, New York University; Gregory A. Johnson, Hunter College of the City University of New York; G. E. Kennedy, University of California, Los Angeles; Lynnette E. Leidy, State University of New York at Buffalo; Jeffrey C. Long, University of New Mexico; Anthony J. Mendonca, Community College of Allegheny County; Thomas R. Rocek, University of Delaware; Vincent Sarich, University of California, Berkeley; Brian Shea, Northwestern University Medical School; Tal Simmons, Western Michigan University; Fred H. Smith, Northern Illinois University; Maria O. Smith, Northern Illinois University; Janet D. Spector, University of Minnesota; Katherine Spielmann, Arizona State University; Gil J. Stein, Northwestern University; Forrest D. Tierson, University of Colorado at Colorado Springs; Wenda R. Trevathan, New Mexico State University; Erik Trinkaus, University of New Mexico; Charles Watrall, University of Regina; Norman Yoffee, University of Arizona; and Steve Zegura, University of Arizona.

Our colleague at New York University, Terry Harrison, contributed substantially to bringing Chapter 9 up to date, and both he and Eric Delson, of the City University of New York, deserve special thanks for the many occasions they endured "trial runs" of ideas. Of course, neither they nor our other colleagues are to be held responsible for those errors from which they failed to dissuade us!

Special thanks are due to Larry Mai at Temple University who prepared a spectacular Instructor's Manual that includes chapter summary material as well as additional information and teaching guides. Dr. Mai also prepared an extensive Test Bank. His efforts are greatly appreciated.

Finally, we should like to dedicate this edition to the memory of our friend and colleague, Fred Plog, who did so much for archaeology in general, and for this book in particular.

Clifford J. Jolly
Randall White

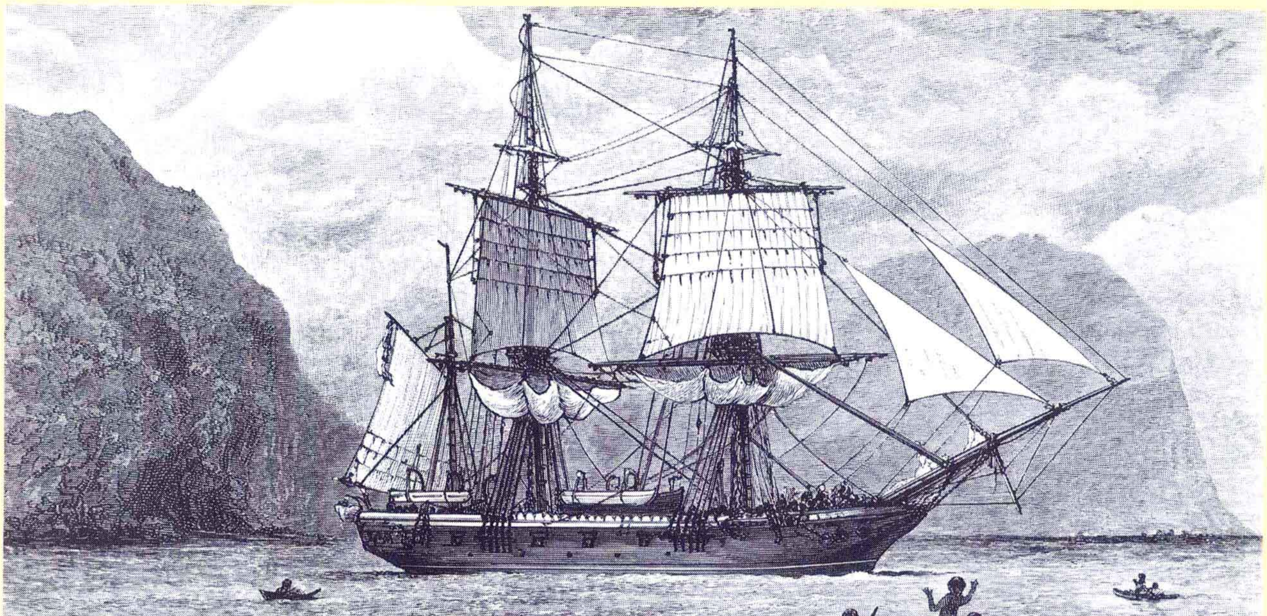
*This book is intended to introduce the field of* ***evolutionary anthropology****, which examines the way that human physical structure and behavior have changed, or* ***evolved****, over time, from prehuman roots. As a scientific discipline, evolutionary anthropology starts from the assumption that human beings and their behavior have natural—rather than "divine" or "supernatural"—origins, and thus can best be understood by using the logic and methods of scientific enquiry. The subject matter and methods of evolutionary anthropology are introduced in the first half of this introduction.*

*Historically, accepting that human beings and their behavior were part of nature was an important first step in the development of evolutionary anthropology. But the evolutionary framework for understanding humanity did not develop overnight. It grew, step by step, along with the theory of evolution itself, in the context of social and economic change. Indeed, although the fact of human evolution is now part of mainstream science, its development is by no means complete. Scientifically based ideas about how evolution works, and the course that human evolution has taken, have changed, and are still evolving, as new discoveries are made, and new insights are developed. The history of evolutionary theory, as applied to human biology and culture, is the topic of the second half of the introduction.*

# CONTENTS

# *Evolutionary Anthropology and Its Historical Development*

▼ *Charles Darwin's travels exposed him to some of the simplest surviving human cultures, including that of the natives of Tierra del Fuego, seen here approaching the* Beagle *by canoe. These contacts, along with experience of the earth's geological and biological diversity, helped plant the notion of human evolution in Darwin's thinking.*



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## THE HUMAN SPECIES IN NATURE

Traditionally, most people have regarded themselves as apart and distinct from nature, and human origins have been explained by myths, rather than scientific theory. In the Judaeo-Christian tradition, for example, the human species was seen as a divinely appointed exploiter or custodian of other species, a link between nature and God. By contrast, a naturalistic point of view emphasizes that human beings are "special" only in the same sense that all species are, in their own way, unique. We are one animal species among many, linked to the rest of nature by networks of evolution and ecology.

Once we overcome our "us versus the rest" prejudice, our relatedness to all other living organisms becomes obvious; the cells of our bodies function in basically similar ways, and the similarity extends to the minutest details of molecular structure. The most reasonable scientific explanation for these resemblances is that we are quite literally "kin" to these other organisms, in exactly the same sense as two cousins are related by having the same grandparents. Moreover, we clearly have a place in nature that is defined by our resemblances; in behavior, anatomy, and molecular structure, we are closer to a chimpanzee than a dog, a dog than a frog, a frog than a bacterium. The theory of evolution explains this orderly pattern of resemblance by suggesting that we are related to all these organisms in different degrees. We believe, in fact, that the common ancestor of chimpanzees and humans lived about half a million generations ago, while we would have to draw a family tree of several million generations to include the family dog, let alone the goldfish, or the bacteria living on our skin. But in theory it could be done; ultimately, all living things, you, we, the dog, and the bacteria, are descended from the same forebears—minute organisms that lived billions of years ago on an earth quite unlike today's.

Although bearing many signs of its relationship to the rest of the living world, the human species, like any other, shows a distinctive combination of physical and behavioral characteristics. We walk upright on two feet, use our hands extensively for grasping and manipulating objects, live in complex social groupings, and fashion and use many kinds of tools. Most distinctive of all, we are capable of learning abstract theories and complex ideas and have developed a complex form of symbolic communication called language.

Most of these characteristics, considered individually, can be matched in one nonhuman animal species or another. Other animals walk upright at times. Chimpanzees, sea otters, and some birds use simple tools. Other species have evolved complex forms of social organization—consider the bees and the ants. And even the simplest organisms are capable of some learning and some communication with other members of their species. But no other species has elaborated these abilities as we have, building them into an interactive complex that is the essence of the human way of life.

In particular, our distinctive mental qualities—our behavioral flexibility and our capacity for learning, abstraction, and the use of symbols in thought and communication—enable us to devise, to communicate and share, and to transmit this wealth of information down through the generations. This is **culture** in the broadest sense; the system of shared meanings that people learn from their society and use to cope with their surroundings, communicate with others, and make sense of the terrors and mysteries of life and death. This definition includes an enormous range of practices, customs, beliefs, and values. It also includes the rules of technique and style that guide the production of human artifacts—tools, pottery, houses, machines, works of art, and so on. Since they are the products of culturally transmitted skills, techniques, and traditions, such artifacts are often called **material culture**.

It is important to realize, however, that culture is neither uniform nor static. From the first toolmakers on the African savanna, to the residents of a modern urban metropolis, each human society has developed its own distinct culture in response to its own particular circumstances. What distinguishes our species, then, is not the possession of *a* culture but the capacity to evolve a great many *different* cultures.

Although the human capacity for culture has modified our relationship with the rest of nature, it has not abolished it. We, along with every other form of life, are part of a single **ecosystem**—a cycle of matter and energy that includes all living things and links them to the nonliving. All organisms depend on energy, derived ultimately from the huge nuclear furnace that we call the sun, and matter, derived ultimately from the earth. Each species survives by finding, and holding onto, a place in the system—its **econiche**—a way of procuring the matter and energy it needs in the face of competition from other species. A species' econiche is defined by its relationships with its environment and with other species—what it eats, what eats it, and so on.

Our capacity for culture has put us in an unusual ecological position. Compared to most species, we humans occupy an exceptionally broad econiche (think of the great variety of foods eaten by human beings, and the many ways they are procured). This, in turn, allows us to live and flourish in a wide range of environments, from deserts to arctic ice sheets to tropical rain forests.

The process by which a species responds and adjusts to changes in its environment is called **adaptation**. Adaptation may be physiological, behavioral, genetic, or cultural. On a day-to-day basis, individuals make physiological and behavioral adjustments; as the sun goes down on a chilly day, for instance, you respond by shivering (physiological) or putting on a sweater (behavioral). However, when an environmental change is prolonged, it can produce genetic or cultural adaptations of the population as a whole. For example, the onset of the next ice age (due within the next 2 thousand years or so) will presumably stimulate the invention of more effective heating and insulation (cultural response) in the temperate zone and, perhaps, the spread of inborn resistance to the diseases caused by cold and overcrowding (genetic response). All these can be regarded as adaptations of different kinds. Since human societies have been able to survive in very different habitats and ecosystems, we can say that *Homo sapiens* is a highly adaptable species.

**▼ TABLE I-1** *The Four Major Subfields of Anthropology*

**Physical** (or **biological**) **anthropology** is the study of human beings as members of an animal species. Some physical anthropologists specialize in the fossil evidence for human evolution, others in the study of nonhuman primates, the interpretation of prehistoric human bones, or the genetics, physiology, and physical adaptations of modern peoples. The research methods of physical anthropology are shared with the other biological sciences, such as zoology and genetics.

**Archaeological anthropology** (or **anthropological archaeology**) studies culture and processes of cultural evolution, using the material remains of societies. Most, but by no means all, archaeological anthropology is also **prehistoric archaeology**—the study of the material remains of societies that have left no written records.

**Cultural anthropology** (often called **sociocultural**, or simply **social anthropology**) is the study of the human societies and cultures of the present and the recent past, using direct observation of people's behavior, or historical records of such observations made in the past.

**Linguistic anthropology** (or **anthropological linguistics**) is the study of a particular aspect of human culture: language. It examines the ways human languages are structured and used, and how they develop and change over time.

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## EVOLUTIONARY ANTHROPOLOGY

Literally, anthropology (from the Greek, *anthropos*, "a human being") is the study of the human species. But modern anthropology is both less and more than this definition suggests. It is less, because there are many aspects of humanity and its works that are not part of anthropology—though anthropologists may find a knowledge of them essential. These are investigated by related fields such as medicine, physiology, anatomy, psychology, history, literature, economics, philosophy, geography, sociology, and art history. And it is more, because the anthropological study of human evolution inevitably extends beyond the human species—notably to our close, nonhuman relatives, the other primates. Most distinctively, anthropology integrates the study of what people are, as members of an animal species, with what people do, as human beings. That is, it combines the study of human biology—including human evolution—and human culture into a single discipline.

Inevitably, given its huge subject matter, anthropology has split into a number of *subdisciplines*, each with its own particular emphasis and methods (Table I-1). We shall concentrate on physical anthropology and archaeology, the two subdisciplines that combine to tell the story of human evolution. Physical anthropology deals with the physical evolution of the human species; its anatomy, physiology, and genetics. As well as studying these aspects of living peoples, physical anthropologists draw upon information preserved in the remains of the dead—both the skeletons of prehistoric and historic human populations, and the fossil remains of prehuman and nonhuman animals. Important insights are to be gained from the social behavior, ecology, and anatomy of living species related to human beings in an evolutionary sense. Many physical anthropologists therefore specialize in the study of living apes, monkeys, and other primates, both in the laboratory and in the field. The physical anthropologist interprets this body of evidence—drawing upon the theoretical insights shared with the other biological sciences. The aim is a picture of the how, why, when, and where of the events of human evolution—from our origin among the mammals to the present state of the species.

The archaeologist's raw material is not the physical remains of human and prehuman species, but rather the material remains of ancient peoples' institutions, customs, and behavior. These include anything made by early humans: clay pots, fish hooks, hearths, beads, burial urns, tools, and our ancestors' garbage—the stone flakes left behind by their toolmakers, the piles of animal bones left over after their meals. Finally, the archaeologist also collects environmental evidence—clues as to climate, plants, animals, and other resources. By studying the cultural remains, and piecing them together with the environmental evidence and the anatomical evidence provided by physical anthropology, archaeologists try to understand the lives that people led in ancient societies—how large their populations were, how they procured their food, how they dealt with one another and with neighboring groups, whether they had class distinctions, how they buried their dead, what they thought about the world they lived in. By gaining insights into individual groups, archaeologists gradually reconstruct prehistory—the major events of the many thousands of years during which people had no form of writing with which to record the concerns and events of their lives. Furthermore, they try to describe general processes of cultural evolution—how, for example, agriculture transforms human societies or why cities and states arise.

While their subject matter is different, both subdisciplines have an evolutionary orientation, and, most important, both approach the study of human evolution from a scientific point of view.

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## THE SCIENTIFIC APPROACH TO HUMAN EVOLUTION

Evolutionary anthropology is a scientific pursuit. What makes it one is not the fact that we often work in the laboratory, or that we use techniques of chemical and physical analysis, complex and expensive instrumentation, or fancy computation. It is scientific because it uses a particular logic, shared with other sciences, to advance its understanding of a body of subject matter. Science in general has the aim of discovering how the natural world works. There are two main aspects to this process. The first is the collection of **data**[1]—observations about the world, made by human beings. Data may be gathered by using the unaided human senses, or by means of instruments that extend and supplement these senses—microscopes, radio receivers, and so on. The essential quality of scientific observations is not so much that they should be perfectly objective and accurate (the human senses are notorious for perceiving what they think should be there), but that they should be *repeatable*. That is, any trained observer with the right skills and equipment could make the same observation. For example, any observer with an accurate clock can time the appearance of the sun above the horizon at dawn, and arrive at the same piece of data. The second major activity of science is the organization of observations into generalizations. These are statements that enable us to predict what should happen under particular conditions, and why. Thus, it is a scientific prediction that the sun will rise tomorrow in the east, not because (as far as we know) it always has, but because the earth is spinning from west to east at the rate of one revolution per day, and according to the laws of physics, such a spinning body will (unless there is a totally unpredictable catastrophe) maintain that motion by momentum until (at least) tomorrow morning.

The relationship between particular observations and general laws is a complicated one, and one that scientists debate continually. However, it is clear this is a two-way street. Our forecast that the sun will rise was based upon a theoretical law—the conservation of motion by massive, moving bodies. But that law itself comes from observation of the behavior of particular massive, moving objects, including the earth. Scientists today mostly favor a **deductive system of reasoning**, in which a **hypothesis**, which is a prediction based upon existing knowledge, general laws, and intuition, is tested **empirically**; that is to say, it is measured against new observations and experiment. If the prediction turns out to be false, then its theoretical foundations must be reexamined and modified if necessary. Like astronomy (but unlike chemistry, for example) evolutionary anthropology is an *observational* rather than an *experimental* science. Our data come largely from observation of the "experiments" that nature sets up for us.

Often, we shall find conclusions about a particular set of events summarized in the form of a **scenario**. This is not a generalization or law, and is not predictive. It is the combination of particular observations and general laws into a logically coherent explanation. For example, astronomers have constructed a scenario for the evolution of our solar system from its origin as a whirling cloud of dust, through its present state, to its explosive end. Obviously, no one has observed this story unfolding; it has been pieced together from observations of other, older and younger stars, from

[1]This word is plural; the singular (meaning "a piece of information") is **datum**.

bits of ancient solar-system debris like comets and meteorites, and from general laws that apply to the behavior of all matter in the observable universe. This book includes many scenarios—indeed, Chapters 8 through 10, and 12 through 16 are mostly made up of one long scenario—our best story, as of now, describing "what happened" in human evolutionary history, and why. On the other hand, Chapters 1 through 4, 7, and 11 present the body of theory—the laws, generalizations, and methods that evolutionary anthropologists use when they construct their scenarios.

Thus, testing ideas against experience—whether observational or experimental—is the central business of science. But in science not all "experience" is equally valid. Science is concerned *only* with ideas that can be tested against data that can be repeatably collected by human senses and instrumentation. Ideas that cannot be tested in this way include ethical and aesthetic judgments and human values (truth, morality, justice, and beauty). These are the province of ethics and religion. Science is about what is, or might be; not what ought to be, and it is logically weak to claim that one can deduce the latter from the former. This does not mean (we hope) that scientists are, as people, less truthful, moral, just, or appreciative of beauty than anyone else. It just means that their science has nothing to do with their judgment in these fields.

Another aspect of this separation between science and ethics is that scientific judgment should ideally be unaffected by the scientist's personal, cultural, or religious values and prejudices. It is not legitimate to say, "I have the right to prefer hypothesis A to hypothesis B because I am a Christian (Jew, feminist, male, Fascist, Marxist, Democrat)." Of course, few scientists would be unprofessional enough to make a statement of that kind, but unconscious bias may creep in, and become obvious only when the same subject matter is studied by a variety of investigators. For example, in the 1960s, monkey societies studied by American male primatologists were described as being regulated by hierarchies of competitive, achievement-oriented, young adult males. Those studied by Japanese workers, on the other hand, tended to be much more orderly, with respect paid to elder males of the group. By the late 1970s, women primatologists were discovering that the same societies were in fact run by wise, senior female monkeys! Similarly, in archaeology; the enigmatic megalithic monuments of Western Europe (such as Stonehenge) have been interpreted as temples of a pre-Christian monotheistic religion (by Stukeley, an Anglican clergyman); examples of precision engineering (by a civil engineer, Thom); and a celestial observatory and computer (by two astronomers, Hawkins and Hoyle, respectively). To an archaeologist (Burle):

> . . . some of the motives and beliefs of . . . prehistoric people can be perceived plainly, depositing into the earth the "ghosts" of the things they most desired, good flint and stone, broken axes . . . fruit, meat-bones, [broken pottery] vessels for food and grain, fertile soil. (Burle, 1979, p. 190)

In other words, this was a place where prehistoric people revered the raw materials of archaeology! None of these interpretations is necessarily incorrect, but each is strikingly close to the heart of its author.

The detachment of scientists from their subject matter, then, is often less than perfect. It is especially hard to be objective when we are examining the behavior, biology, and close relatives of the human species—the subject matter of anthropology. In some ways, this works to the advantage of scientific understanding; to generate imaginative hypotheses for scientific testing, we need all the sources of inspiration we can get. As we shall see, the scientific theory of evolution would never have been produced had not Lamarck, Darwin, and others been influenced by the ethical and political ideals of their time. In our example from primatology, *all* the different interpretations seem to reflect real aspects of monkey society, a fact that most primatologists would now accept. This illustrates the value of different viewpoints in producing hypotheses. However, good science cannot tolerate personal bias or motives—no matter how lofty—affecting the process of hypothesis *testing*, and choosing between alternative, competing scenarios.

Evolutionary anthropology, to its credit, has been grappling with this problem, especially over the past 20 years. In our view, recognizing the potential for bias is in itself a major advance. One safeguard against it is to ensure that anthropological science is practiced by trained people of both sexes, and of varied cultural and religious backgrounds. Another is to monitor ourselves, to watch for extraneous factors affecting our judgment. We must constantly ask ourselves questions like: "Do I prefer that hypothesis because it fits my personal (national, cultural, religious, gender) self-image? Or reinforces my ideals about the way society should be? Is my judgment clouded (for or against) because its author was my graduate instructor?" The more we can truthfully answer "no" to such questions, the more successfully we are avoiding the pitfall of treating a scientific hypothesis or scenario as though it were a myth of validation, or a sacred pronouncement of the ancestors.

Though we must constantly guard against human error in observation and bias in interpretation, by and large the scientific method works well. It has provided us with an accumulated body of established theory—generalizations that are firm enough to act as a foundation for further rounds of experiment and testing. No good scientist would claim that these "laws" of science represent absolute truth. Unlike the laws of society, those of science are meant to be broken, or at least tested to see how far they can be bent. No scientific statement ever represents "certainty," let alone "absolute truth." However, it is important to realize that "scientific uncertainty" does *not* imply an anarchic chaos in which every statement is equally untrustworthy, and every theory, no matter how harebrained, is entitled to "equal time." Many hypotheses need no longer be considered, because they had no merit to begin with, or have been decisively refuted, or are incompatible with a competing hypothesis that is more strongly supported. Similarly, there are many hypotheses and laws of nature that have been tested so often, by scientific experiment and everyday experience, that they are most unlikely to be disproved in the future. They may not be absolute truth, but for all practical purposes we can treat them as though they were. At the other extreme, on the live, growing edge of scientific knowledge, there are well-founded speculations—"good ideas"—that still need to be critically tested. In between are hypotheses that fit quite well with today's knowledge, but might yet give way in favor of others that are stronger and more inclusive. As we move through our account of the science of evolutionary anthropology, we shall see many cases where neither one of a pair of competing hypotheses or scenarios can yet be abandoned in favor of the other, because the crucial data are not yet in.

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## THE DEVELOPMENT OF EVOLUTIONARY ANTHROPOLOGY

Evolutionary anthropology has itself evolved. From the time that scientists first began to consider our species as part of nature, subject to nature's laws, human origins and history have been the object of scientific enquiry. Evolutionary anthropology has developed out of and alongside the other biological and social sciences, incorporating their insights and advances, and contributing some of its own. There are four major, intertwined strands in this historical process:

- The development of general evolutionary theory in biology and geology
- The development of *cultural evolutionary theory* in archaeology and sociology
- The application of *biological evolutionary theory* to the study of human origins and diversity, leading to the development of physical anthropology
- The application of evolutionary theory to the study of human society and culture, leading to the development of anthropological archaeology

### The Development of Biological Evolutionary Theory

We late twentieth-century Westerners are so familiar with the idea that the world and its living species have changed beyond all recognition, over billions of years of existence, that it is sometimes hard to believe that these concepts are a comparatively new development in our thinking. Yet such is the case. Our ancestors of only 250 years ago—the contemporaries of George Washington—would have scoffed at the notion that the plants and animals in their fields and barns were any different from those divinely created, in 6 days, in exactly 4004 B.C. After all, this date had the authority of scripture. It was calculated, by a literal interpretation of the mythic chronology of the Bible, by James Ussher, Episcopalian bishop of Armagh, Ireland, and was widely accepted from the mid-seventeenth century onward. But already the seeds of a new, grander scheme had been sown. Naturalists and philosophers were beginning to develop a scientifically based vision of life's history on earth that was independent of the Bible's origin myths.

#### Linnaeus and the Fixity of Species

The philosophers of classical and medieval times proposed a variety of theories about the origins of life on earth. By the middle of the eighteenth century, however, nearly all scientists and philosophers were agreed that, apart from some minor variation owing to environmental influence, living things were created in their present form. Species were unchanging and quite distinct from one another.

This doctrine, known as **fixity of species**, is expressed in the work of the Swedish naturalist Carolus Linnaeus (Karl von Linné, 1707–1778) (see Figure I-1). Linnaeus developed the first comprehensive classification system for living things. In this system, each clearly recognizable type of plant and animal was named as a separate **species**. Then, on the basis of their resemblances, species were grouped into broader categories, called **genera** (singular, **genus**), the genera into orders, and so on. The result was a hierarchy express-

▲ FIGURE I-1 *Carolus Linnaeus (Karl von Linné, 1707–1778) not only invented the first consistent, practical system of natural classification, he also turned natural history into a fashionable pastime among his wealthy patrons.*

ing the variety of nature in an orderly and static arrangement. Linnaeus expressed the special relationship of the human species to the monkeys, apes, and lemurs by including all of them in his order **Primates** (capital "p," pronounced pry-MAY-tees). (The members of the order are commonly called **primates**, with a small "p," pronounced PRY-mates). For Linnaeus, the characteristics that united species in larger categories were shared because the divine Creator had followed a plan in his creation. The genera, and higher categories, represented the themes of creation, while species were the variations. At the same time, however, Linnaeus inadvertently planted the seeds of evolutionary thought by using terms like "family" and "genus" (Latin for a group of kin, like a clan) for his groupings, thereby hinting that species could be related by descent.

Linnaeus' hierarchical organization of the diversity of nature laid a solid foundation for the idea of different degrees of relationship among living things. Translated into evolutionary terms, this is still the key to our understanding of diversity in the living world. But another, far less positive, part of Linnaeus' legacy is also still with us. This is the idea that species can be *ranked*, along a single scale, from lowest to highest. Among animals, for instance, "worms" are on the bottom rung of this imaginary ladder, and we human beings, naturally, are at the top. This concept—known as the *Scala Naturae*, literally, "Nature's ladder"—has caused enormous misunderstanding about the way the world works, and, as we shall see, still continues to do so. In Linnaeus' time, however, the *Scala Naturae* was an obvious concept.

### de Buffon, Lamarck, and the Drive toward Perfection

One of the first to see nature as changing rather than fixed was Georges-Louis Leclerc, compte de Buffon (1707–1788). Rather than seeing each species as the product of a separate act of divine creation, de Buffon suggested that clusters of similar species—all monkeys, for example—were descendants of a common ancestor. Under the influence of different environments, these descendants had come to differ from the ancestral species (and from each other), but they still retained the ancestor's essential characteristics. Thus, though the themes might reflect divine creation, the variations were the result of natural change. These evolutionary ideas were developed by Buffon's student, Jean Baptiste de Lamarck (1744–1829).

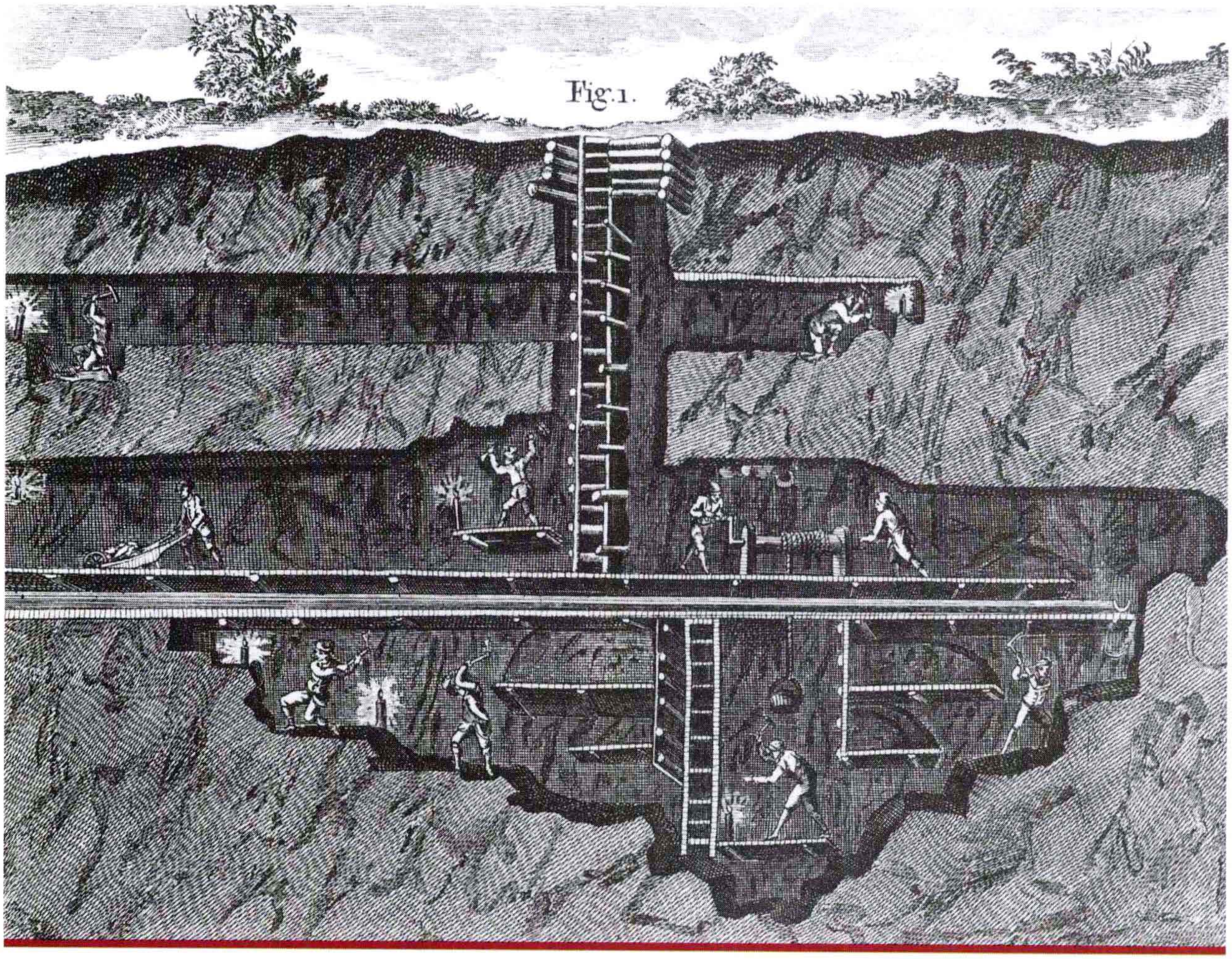
Lamarck argued that natural processes still active in the world were capable of producing, not merely modification, but radical change and *improvement* in living organisms. Powered by an inward drive toward perfection, organisms were constantly changing physiologically during their lifetimes in order to cope better with their environment. These acquired changes were then passed on to their young, so that in time the species as a whole changed. The giraffe's long neck, for example, could be explained as the result of many generations of ancestral giraffes stretching their necks to reach the leaves of tall trees and transmitting this acquired trait to their offspring. In this way, Lamarck argued, living organisms could make unlimited progress, not only adapting to local conditions, but actually climbing up the evolutionary scale. The *Scala Naturae* had become a moving staircase. This idea, that each living thing is driven toward perfection by an internal force, is called *vitalism*.

Unfortunately for Lamarck's theory, the idealism of the revolutionary period gave way, after the fall of Napoleon, to a much more conservative social and political climate. In a Europe sickened by bloody revolution, ideas of inevitable, progressive change were regarded as dangerously radical. To avoid this taint, scientists had to change their tack and explain the observable facts of nature in a theoretical framework that appeared less threatening to social stability. And those "facts" were accumulating fast.

### Ideas from Geology: Catastrophism and Uniformitarianism

Even though evolutionary ideas were out of fashion, there was no going back to the old notions of a single, once-and-for-all creation and a short earth history. Thanks to the Industrial Revolution, the evidence of geology no longer allowed it. Year by year, work crews building canals or digging quarries had uncovered the remains of unfamiliar animals, often arranged in rock layers, lying one above the other in orderly succession (see Figure I-2). As early as 1773, de Buffon had suggested that the earth's history was much longer than the biblical 6 Kyr, and was divided into a series of different epochs, which could be recognized in these rock layers—the geological record. He further suggested that many of the remains in the lower, earlier layers were of animals that had become extinct. Obviously, the idea of one, finite, and perfect creation was no longer adequate.

However, in the reactionary years following the Napoleonic Wars, the leading student of fossils, the Baron Georges Cuvier (1769–1832), proposed a theory that could account both for the geological evidence, and the extinction, without threatening religious doctrine (see Figure I-3). According to Cuvier's theory, called **catastrophism**, the planet had been shaken by sudden and violent upheavals, of which the Great Flood described in Genesis was only the latest. Each catastrophe left its geological mark, and also destroyed almost all living things. Then the planet was




▼ **FIGURE I-2** *When the Industrial Revolution began to sweep Europe in the eighteenth century, workers digging canals, mines, and quarries unearthed the bones of unfamiliar, primitive-looking animals that were clearly extinct. These finds helped lay to rest the longstanding belief in a single and perfect creation.*

▲ FIGURE I-3 *Georges Cuvier (1769–1832) was a highly influential paleontologist who proposed the theory of catastrophism. According to this hypothesis, the earth was shaken periodically by sudden and violent catastrophes in which almost all living things were destroyed.*

repopulated by the few survivors, perhaps with the help of some newly created species. Thus, the theory accounted for both the successive geological layers and their fossil contents. So great was Cuvier's influence and so plausible was his theory—consistent both with a literal interpretation of the Bible, and, apparently, with the empirical evidence of the rocks—that it stifled evolutionary ideas among biologists of the day.

But eventually a concept from geology was to provide a major stimulus for the revival of evolutionary ideas. This concept, called **uniformitarianism**, had first been clearly expressed in the work of Buffon's contemporary, the English geologist James Hutton (1726–1797). Hutton proposed that the earth, far from being only a few thousand years old, is inconceivably ancient, and that its rocks are continually laid down, uplifted, eroded, and laid down again, in an eternal cycle that does not call for divine intervention or any process beyond those that are currently observable. This concept, that the evidence of the past can be interpreted in terms of natural processes still visible in today's world, was, of course, directly opposed to the catastrophist model. In the 1830s, the **uniformitarian** model was revived by the geologist Charles Lyell (1797–1875), who used it to reinterpret the growing body of geological evidence. The earth, Lyell argued in his *Principles of Geology* (published 1830–1833), had an immensely long history. During this time, imperceptibly slow geological processes such as erosion and earth movements had produced continuous change in the earth's surface. Where there was now a plain, mountains had once stood. Where there was dry valley, a river had once flowed. Century by century, slow changes had cut and molded the plain's crust into its present form. No supernatural catastrophes were needed to explain the facts of geology—just enough time, and the patient forces of nature. As it happened, in 1831 the first volume of Lyell's work, hot off the press, found its way into the traveling bag of a young naturalist—and ex-student of divinity—about to embark for the South Seas. His name was Charles Darwin (see Poster Page I-1).

### Darwin's Insights

Perhaps it seems odd that Charles Darwin (1809–1882), the man who showed how new species appear without divine intervention, was trained for a career in the Anglican church. But there is a connection. When young Darwin was cramming at Cambridge, a basic text was *Natural Theology*, by William Paley (1743–1805), an Anglican clergyman. For Paley, the fact that each species was adapted to its own way of life proved both the existence of God, and God's concern for each of his creatures. It focused the attention of naturalists upon the study of adaptations; explaining the fit between the characteristics of a species and its way of life.

Paley's work may have been comforting as theology, but as science it was fast becoming something of an embarrassment. In the early nineteenth century, rigorous application of scientific methods was leading to rapid progress, and the discovery of natural laws, in many branches of science. The idea of thousands of species, each supernaturally handcrafted, was beginning to seem quaint. The hunt was on for a solution to the "species question"—a more scientific, nonsupernatural explanation for the diversity and adaptations of species—and preferably one that did not rely upon Lamarck's unfashionable vitalism. Darwin himself joined the hunt when, as he recorded in his journal