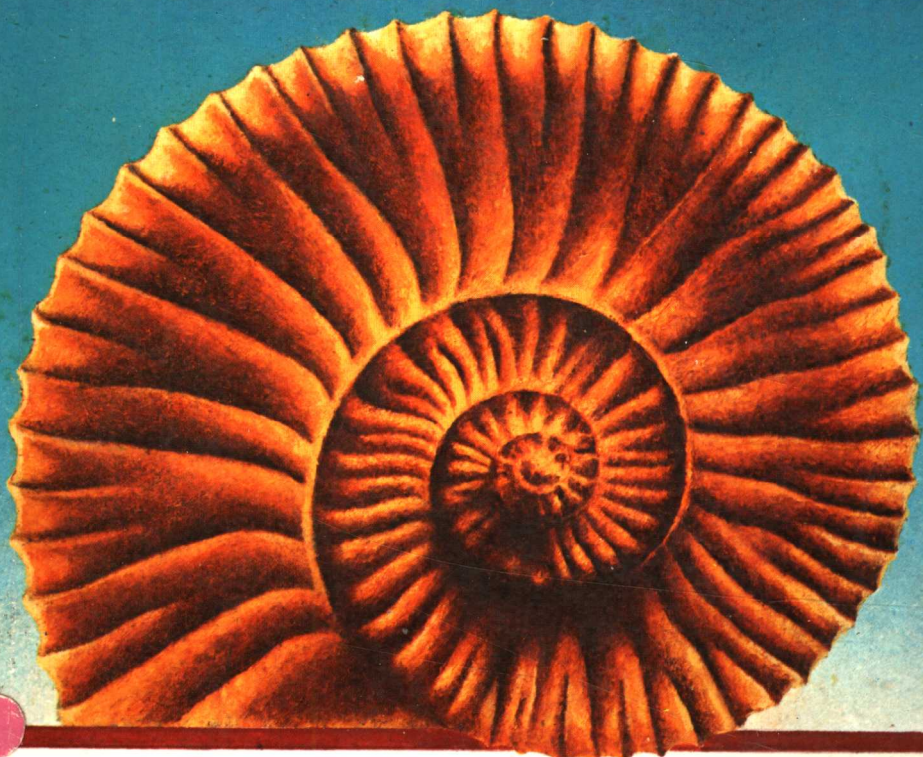


STEVEN M. STANLEY

THE NEW EVOLUTIONARY TIMETABLE

Fossils, Genes, and
the Origin of Species



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LIST OF ILLUSTRATIONS

- Figure 1.1 The Devonian trilobite *Phacops rana*, about 300 million years old, viewed from above. From Ricardo Levi-Setti, *Trilobites, A Photographic Atlas* (Chicago: University of Chicago Press, 1975)
- Figure 1.2 Algae that, more than 450 million years ago, floated in the ocean above what is now Oklahoma. *Baltisphaeridium parvigranosum* and *B. perclarum*, from Alfred R. Loeblich and Helen Tappan, *Journal of Paleontology* 52 (1970): 1233-1288
- Figure 1.3 Top view of a fossil sea urchin of late Jurassic Age (about 150 million years old) from Germany. (*Pseudocidaris comani*, courtesy of Porter M. Kier and the Smithsonian Institution)
- Figure 1.4 Side view of a fossil sea urchin of late Jurassic Age (about 150 million years old) from Saudi Arabia. (*Plegiocidaris coronata*, courtesy of Porter M. Kier and the Smithsonian Institution)
- Figure 1.5 Fossil fish preserved after overestimating its appetite and choking to death trying to swallow another fish. (*Mioplosus* swallowing *Knighitia*, Princeton University Museum of Natural History)
- Figure 1.6 Four-hundred-million-year-old snail from Czechoslovakia, displaying its original color pattern. From Jirí Kríz and Pavel Lukes, *Journal of Paleontology* 48 (1974): 41-48
- Figure 1.7 Fossil leaf of late Paleocene Age (almost sixty million years old). (Courtesy of Leo J. Hickey and the Smithsonian Institution)
- Figure 1.8 Top view of a fossil brachiopod shell from the Permian of Pakistan (about 250 million years old). (Courtesy of Richard E. Grant and the Smithsonian Institution)
- Figure 1.9 Lineage of European mammoths (genus *Mammuthus*) reconstructed from fossil data.
- Figure 2.1 Ripple marks in two-billion-year-old sandstone north of Lake Huron, Ontario, Canada. (Courtesy of D. M. Baird)
- Figure 2.2 Ichthyosaur with the outline of its skin preserved, from the Lower Jurassic of Germany (about 190 million years old). (Photograph

List of Illustrations

- by Division of Photography, Field Museum of Natural History, Chicago)
- Figure 2.3 Charles R. Knight's reconstruction of the woolly mammoth, which lived in Europe during the Ice Age, just a few thousand years ago. (Courtesy of The Field Museum of Natural History, Chicago)
- Figure 2.4 *Rhea darwinii*, a rare species that Darwin learned about from the gauchos in Patagonia. Painting by John Gould, in Charles Darwin, *Zoology of the Voyage of H.M.S. Beagle, Under the Command of Captain FitzRoy During the Years 1832 to 1836*, 3 vols. (London: Smith and Elder, 1838–1843)
- Figure 2.5 The extinct giant sloth, *Megatherium*, and the giant armadillo, *Glyptodon*, Ice Age mammals whose remains Darwin studied in South America. (Courtesy of The Field Museum of Natural History, Chicago. Drawing by Charles R. Knight)
- Figure 2.6 The giant tortoises that gave the Galápagos Islands their name. From A. F. Brehm, *Thierleben*, vol. 7 (Leipzig: Verlag des Bibliographischen Instituts, 1878)
- Figure 2.7 Galápagos finches with heavy bills, like those of grosbeaks. Painting by John Gould in Charles Darwin, *Zoology of the Voyage of H.M.S. Beagle, Under the Command of Captain FitzRoy, During the Years 1832 to 1836*, 3 vols. (London: Smith and Elder, 1838–1843)
- Figure 3.1 The tree of life published by Darwin in *On the Origin of Species* (London: John Murray, 1859), p. 117.
- Figure 3.2 A baleen whale skeleton, with an enlargement of the vestigial pelvic bones. (Drawn by Gregory S. Paul.)
- Figure 3.3 Ornamentation of the male hummingbird *Spathura underwoodi* (right), shown with the female. From Charles Darwin, *The Descent of Man and Selection in Relation to Sex* (London: John Murray, 1871, p. 388)
- Figure 3.4 Male argus pheasant, displaying its plumage during the breeding season. (From Charles Darwin, *Descent of Man*, 1871, p. 399)
- Figure 3.5 Face of the male mandrill, which bears bright red, white, and blue markings. (From Charles Darwin, *Descent of Man*, 1871, p. 538)
- Figure 4.1 Charles Darwin in 1854. (Photograph courtesy of the American Museum of Natural History)

List of Illustrations

- Figure 4.2 Mendel's results in the experimental breeding of peas. From George Gaylor Simpson and William S. Beck, *Life: An Introduction to Biology* (New York: Harcourt, Brace & World, 1965)
- Figure 4.3 *Drosophila melanogaster*, the famous fruit fly that geneticists have studied extensively in the laboratory. From Adrian M. Srb, Ray D. Owen, and Robert S. Edgar, *General Genetics* (San Francisco: W. H. Freeman, 1965); after Sturtevant and Beadle, *An Introduction to Genetics* (San Francisco: W. B. Saunders, 1940)
- Figure 5.1 General stages in the evolution of the modern horse, as recognized by O. C. Marsh in 1879. From O. C. Marsh, *American Journal of Science*, ser. 3, 7 (1879): 247–258
- Figure 5.2 *Archaeopteryx*, an extinct Jurassic animal intermediate in form between dinosaurs and birds. (Courtesy of the Smithsonian Institution)
- Figure 5.3 Well-preserved, long-snouted weevil from Alaskan Ice Age deposits older than 1.5 million years. From J. V. Matthews, *Geological Society of America Bulletin*, 85 (1974): 1353–1384
- Figure 5.4 Close resemblance among a sixty-five-million-year-old bowfin fish of the Early Cenozoic (below), a mid-Cenozoic bowfin (center), and a modern bowfin (above). From J. R. Boreske, *Museum of Comparative Zoology Bulletin*, 146 (1974): 1–87
- Figure 5.5 Fossils of the latest Precambrian (more than 600 million years old) representing very early multicellular life of the sea floor. Upper three photos from M. F. Glaessner; lower two photos from N. L. Banks, *Geological Journal*, Special Issue 3 (1970): 19–34
- Figure 5.6 Fossil leaves of some of the oldest known flowering plants, showing primitive, poorly organized vein patterns. From J. A. Doyle and L. J. Hickey, in C. G. Beck, ed., *Origin and Early Evolution of Angiosperms* (New York: Columbia University Press, 1976)
- Figure 5.7 Early Eocene deposits forming badlands in the Big Horn Basin of Wyoming. (Courtesy of the American Museum of Natural History)
- Figure 5.8 Skeleton of the "dawn horse," *Hyracotherium*. (Courtesy of the Field Museum of Natural History, Chicago)
- Figure 6.1 Two Hawaiian species of banana-feeding moths. Drawings by Gregory S. Paul, after Elwood C. Zimmerman, *Insects of Hawaii* (Honolulu: University of Hawaii Press, 1958)

List of Illustrations

- Figure 6.2 Variation of bill shape among Hawaiian honey creepers. Drawings by Charles Papp, in Verne Grant, ed. *Organismic Evolution* (San Francisco: W. H. Freeman, 1977); drawn from photographs in D. Amadon "The Hawaiian Honeycreepers," *Bulletin of American Museum of Natural History*, 1950
- Figure 6.3 Three types of cichlid fishes from Lake Victoria, Africa. From P. H. Greenwood, *British Museum Natural History Bulletin Supplement* 6 (1974)
- Figure 6.4 Hydrobioid snail species that have evolved as part of an enormous adaptive radiation in the recently formed Mekong River system of Southeast Asia. (From George M. Davis, *The Origin and Evolution of the Gastropod Family Pomatiopsidae with Emphasis on the Mekong River Triculenae*, *Academy of Natural Sciences of Philadelphia*, monograph 20, 1979, p. 59)
- Figure 6.5 Some of the animals produced by the South American adaptive radiation of marsupials that occurred when South America was an island continent. From B. Patterson and R. Pascual, *Quarterly Review of Biology*, 43 (1963): 409–451
- Figure 6.6 "Juvenilized" amphibians that, because of simple genetic changes, remain in the water throughout life instead of metamorphosing to become terrestrial salamanders. From J. Z. Young, *Life of Vertebrates* (Oxford University Press, 1962)
- Figure 7.1 Reconstruction of *Aegyptopithecus*, a thirty-million-year-old animal of the type that may have been ancestral to apes and humans. (Drawing for Steven F. Kimbrough for Richard F. Kay)
- Figure 7.2 Geological durations of recognized species of the human family.
- Figure 7.3 A reconstruction of *Homo erectus*, formerly known as *Pithecanthropus*. Painting by Zdeněk Burian in Joseph Augusta, *Prehistoric Man* (London: Paul Hamlyn, 1960)
- Figure 7.4 Tracks of *Australopithecus* at Laetolil, Tanzania, in hardened volcanic ash more than three million years old. (Courtesy of John Reader, © The National Geographic Society)
- Figure 7.5 Humanlike head of a fetal orangutan, figured by Darwin. (From Charles Darwin, *The Descent of Man*, 1871, p. 17)
- Figure 7.6 Acheulian hand axes produced by *Homo erectus*. From John E. Pfeiffer, *The Emergence of Man* (New York: Harper & Row, 1969, p. 119)
- Figure 7.7 A variety of stone implements fabricated by Neanderthal. From John E. Pfeiffer, *The Emergence of Man*, 1969, p. 167

List of Illustrations

- Figure 7.8 Art of early Cro-Magnon (early *Homo sapiens*). (Courtesy of The American Museum of Natural History)
- Figure 8.1 A reconstruction of the ritualistic burial of the young Neanderthal discovered at Le Moustier, France. Drawing by Zdeněk Burian, in Joseph Augusta, *Prehistoric Man* (London: Paul Hamlyn, 1960)
- Figure 8.2 Layers of glacial sediment laid down in quiet water about two billion years ago. (Plate 86B, in *Atlas and Glossary of Primary Sedimentary Structures*, by F. J. Pettijohn and P. E. Potter; Courtesy of Springer-Verlag)
- Figure 8.3 A series of shells from the Devonian Hunsrück Shale of Germany, representing the derivation of ammonoids from straight-shelled nautiloids. From David M. Raup and Steven M. Stanley, *Principles of Paleontology*, 2nd ed. (San Francisco: W. H. Freeman and Company, 1978, p. 307), after H. K. Erben.
- Figure 9.1 A hypothetical evolutionary trend (change in shape) produced by species selection within a branch of the tree of life. Heavy vertical lines in the "tree" represent species of varying longevity. Light horizontal lines represent the rapid origins of species.
- Figure 9.2 Reconstruction of *Indrichotherium*, perhaps the largest mammal of all time. (Courtesy of The American Museum of Natural History)
- Figure 9.3 Skeleton of *Mesembriornis*, one of the giant, flightless birds that once inhabited South America. (Courtesy of the Field Museum of Natural History)
- Figure 9.4 *Megaloceros*, the Irish "elk" of the Ice Age. (Courtesy of the Field Museum of Natural History. Drawing by Charles R. Knight)
- Figure 9.5 Mollusks that flourished in South Florida until the Ice Age. (From Axel A. Olsson and Anne Harbison, *Academy of Natural Sciences of Philadelphia*, monograph 8, 1953)
- Figure 9.6 A two-billion-year-old sea floor covered by stromatolites long before destructive animals had come into existence. (Courtesy of Paul Hoffman)
- Figure 9.7 Wolflike marsupial mammals. (Drawing by M. Hill Werner, courtesy of Larry G. Marshall, Field Museum of Natural History)

P R E F A C E

THE THEORY of evolution is not just getting older, it is getting better. Like any scientific concept that has long withstood the test of time, this one has suffered setbacks but, time and again, has rebounded to become richer and stronger. What I describe in this book is evidence that evolution is not quite what nearly all of us thought it to be a decade or two ago. This evidence comes largely from the record of fossils—a record that until recently was not well scaled against absolute time. The record now reveals that species typically survive for a hundred thousand generations, or even a million or more, without evolving very much. We seem forced to conclude that most evolution takes place rapidly, when species come into being by the evolutionary divergence of small populations from parent species. After their origins, most species undergo little evolution before becoming extinct.

It is only fair to report that, while this “punctuational” view has displaced the traditional “gradualistic” view in the minds of many evolutionists, there remain dissenters. Among these are some physical anthropologists, who continue to assert that modern humans have evolved by the gradual, persistent modernization of an apelike ancestor. In chapter 7 I offer opposition to this traditional portrayal of our ancestry.

This book is not designed to build a rigorous case for the punctuational model of evolution—the goal of my more technical volume, *Macroevolution: Pattern and Process*, published in 1979. Rather, in the present book I attempt to give the interested non-specialist access to the punctuational view and its implications—implications that are by no means trivial. I also explore the history of the traditional, gradualistic view. Among the most fundamental questions here is why Charles Darwin was a gradualist. I hope that my explanations for Darwin's position will be given due consideration by historians of science, and I do not mean to be critical of Darwin here. For many reasons, he could only have been a gradualist.

The emergence of the punctuational model of evolution during the past

Preface

decade has at times caused acrimonious debate. This is an exciting time in the history of evolutionary science, and those of us laboring in this complex discipline can only hope that, during the next few years, important truths will float to the top of our collective crucible without occasioning undue rancor. I do not violate this wish by attacking the biblical creationists in chapter 8 of this book. The fact is, the fundamentalist creationists are parading antiscientific views falsely under a counterfeit banner of science. The recent antievolutionary efforts of the creationists constitute a grievous insult to natural science—to astronomy, as well as to geology and biology, and even to physics and chemistry, on which the other three sciences are partly founded. It is, after all, the behavior of atoms that reveals the earth to be more than four billion years old.

I express heartfelt thanks to Léo Laporte, Ledyard Stebbins, and Jim Valentine for thoughtful and kind, but sometimes dissenting, opinions of early drafts of the first seven chapters, and to Alan Walker for the same treatment of the initial version of chapter 7. Finally, I thank Jane Isay of Basic Books for her support and encouragement.

C O N T E N T S

LIST OF ILLUSTRATIONS	<i>ix</i>
PREFACE	<i>xv</i>
1. Introduction	3
2. The Voyage Toward Evolution	17
3. The <i>Origin</i> and Its Very Slow Process	35
4. Darwinism Challenged, Darwinism Affirmed	54
5. The Fossil Record: Our Window on the Past	72
6. On the Rapid Origin of Species	110
7. Human Origins	138
8. Continuity or Creation?	165
9. Macroevolution and the Direction of Change	180
10. Punctationalism and Society	203
NOTES	209
INDEX	213
	<i>vii</i>

*The New Evolutionary
Timetable*



CHAPTER

1

Introduction

THE WORD "evolution" means unfolding, and for more than a century biologists have portrayed the evolution of life as a gradual unfolding of new living things from old, the slow molding of animals and plants into entirely different forms. It was this persistent style of change that Darwin described as "The Origin of Species."

Today the fossil record—a rich store of information that was long untapped—is forcing us to revise this conventional view of evolution. As it turns out, myriads of species have inhabited the Earth for millions of years without evolving noticeably. On the other hand, major evolutionary transitions have been wrought during episodes of rapid change, when new species have quickly budded off from old ones. In short, evolution has moved by fits and starts.

I have composed the following description in order to express the traditional view of large-scale evolution:

All around us in nature, life is ceaselessly changing. Species are modified gradually, almost imperceptibly when scaled against human history, yet in the course of millions of years the accumulation of infinitesimal steps amounts to total restructuring. Thus, during some fifty million years, what early in the Eocene Epoch had been the four-toed, fox-terrier-sized "dawn horse" was molded into the large, hoofed animal that today strains in the harness of a two-legged creature of enormous intellect. The master creature descended gradually from apelike animals, in part because changed surroundings forced these simian forebears down from the trees to a life on the savannah.

THE NEW EVOLUTIONARY TIMETABLE

This passage would fit comfortably into many accounts of evolution published in recent decades, but its credibility fades rapidly in the light of recently recognized facts. Some of these facts pertain to the ancestry of the two-legged creature who harnessed the horse, and others relate to the ancestry of the horse itself.

Let us first look briefly at the pattern of human evolution. According to the traditional view, modern humans arose by the gradual modification of an ape-like animal during an interval of several million years. Fossil evidence now challenges this simple scenario. We now know that the human family tree has included several discrete branches, and that, at certain times, two or more humanoid species have walked the earth side by side. Even more important is the fact that species of the human family have existed almost unchanged for long stretches of geological time. *Homo erectus*, our evolutionary parent or grandparent, endured for at least a million years, and our own species, *Homo sapiens*, has undergone almost no bodily change in Europe since appearing there suddenly some forty thousand years ago. I will evaluate these aspects of human evolution and others in chapter 7 of this book, but the fundamental point is easily grasped: human evolution has apparently followed a stepwise course, with important biological change occurring as one species has branched rapidly from another.

The fossil record of horses also testifies to an episodic tempo for evolution, and this is particularly notable because for decades the record of ancient horses was heralded as the classic illustration of gradual transformation. Although this fossil record, like all others, is incomplete, so that it fails to document the full history of the horse family, one of its striking revelations is great evolutionary stability for tiny dawn horses, which, as the earliest representatives of the horse family, browsed on leaves about forty million years ago. For at least three or four million years, two species of these dawn horses roamed through woodlands of western North America. In other words, populations of these small animals replicated themselves through a million generations or so without undergoing appreciable change in form. Looking to the upper end of the horse family tree, we find the same kind of evidence. In North America, at least four species of horses survived virtually unchanged for the better part of two million years, through almost the entire recent Ice Age. In Africa during the same interval of time, four or more species of the zebra variety persisted almost without modification. All of these Ice Age species belong to the *Equus* group, which includes all living horses and zebras. The *Equus* kind of animal appears suddenly in the fossil record in North American deposits less than three million years old. This

Introduction

familiar creature evolved from an ancestor of quite different form—one that had toes flanking each of its hoofs, as well as much simpler molar teeth than the modern horse. Horses of the modern *Equus* type obviously evolved rapidly, and apparently for this reason their origin is not documented by known fossil evidence. This abrupt evolutionary birth of the modern kind of animal stands in sharp contrast to the stability of established horse species.

Thus, the new message offered by the ancient remains of humans, horses, and many other animals is that evolution has occurred episodically. Most change has taken place so rapidly and in such confined geographic areas that it is simply not documented by our imperfect fossil record. The resulting view of evolution has become known as the punctuational model, while the contrasting traditional view has been labeled the gradualistic model. The punctuational model is not incompatible with what we now know of modern life on Earth. There is good evidence that certain distinctive living species of animals have formed since the dawning of modern civilization in the Middle East.

The punctuational model might appear to represent a minor modification of the traditional scheme of evolution—an esoteric adjustment that should interest only specialized practitioners of biological science. In fact, its consequences reach much farther. The punctuational view implies, among other things, that evolution is often ineffective at perfecting the adaptations of animals and plants; that there is no real ecological balance of nature; that most large-scale evolutionary trends are not produced by the gradual reshaping of established species, but are the net result of many rapid steps of evolution, not all of which have moved in the same direction; and that sexual reproduction does not prevail in the world for the reasons that have traditionally been offered.

The punctuational model has another implication of particular interest to us, as humans. Because the human family does not consist of a solitary line of descent leading from an apelike form to our species, *Homo sapiens*, we are not as special as we would like to think. Had a perceptive being somehow passively watched human evolution for the three or four million years before our species and its immediate ancestors appeared, it could not have predicted our origin. Our anatomy and the very different anatomy of our stocky Neanderthal cousins are in many ways unpredictable from what went before. We function satisfactorily, but no better than many other configurations of bones and flesh that might have evolved in our place from the distinctive species *Homo erectus*, which was our evolutionary parent or grandparent. Our sharp chin, tall forehead, and weak brow are not the results of long-term evolutionary trends. They are apparently features unique to our species. They represent evolutionary sur-

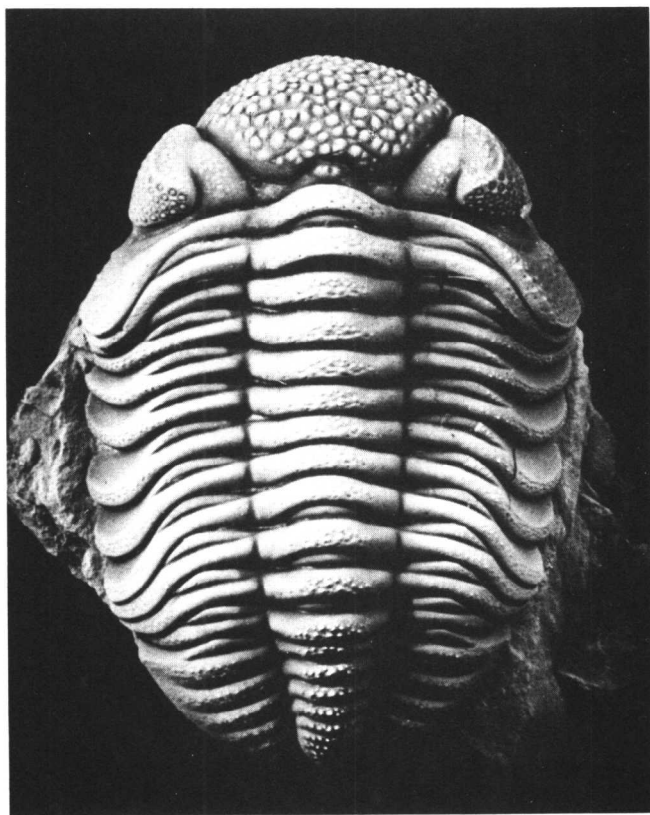


FIGURE 1.1

The Devonian trilobite *Phacops rana*, about 300 million years old, viewed from above. The compound eyes are clearly visible, and the animal is partially enrolled, like a pill bug.

prises, albeit ones that may have been favored by natural selection at a particular time and in a particular place. The gradualistic model is compatible with such reversals, but the punctuational model predicts that they should often be very abrupt and pronounced, as indeed they seem to have been in the evolution of our own family.

We thus have strong motives to understand evolution, one of the most important intellectual concepts of the Western world, and we have every reason to sit up and take notice when it appears that fossils—pieces of inanimate rock—reveal new and surprising things about our biological origins. Fossils played only a minor role in Darwin's conception of an evolutionary process,