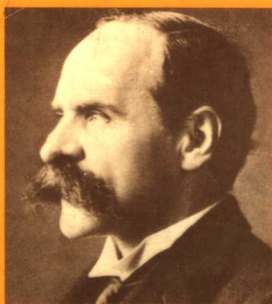
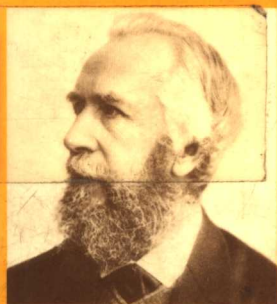
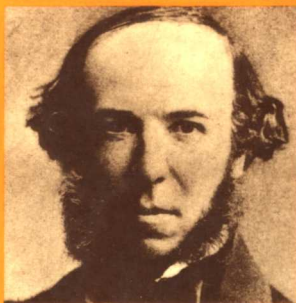
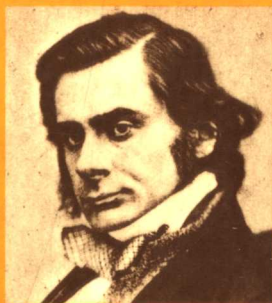
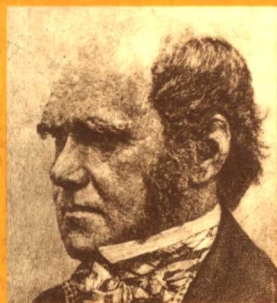


PETER J. BOWLER

EVOLUTION

The History of an Idea



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PETER J. BOWLER

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Preface

Because the structure of this book is rather unconventional, most of this preface will be taken up with an explanation of why it has been written this way. The book is a survey of the history of evolutionism, presented not as an academic monograph but as an introduction accessible to someone with no background in either biology or history. It is not, however, a popularization in the sense of turning history into bedtime reading. It is aimed at those with a serious interest in the theory of evolution and its implications, but who have not tackled the subject in any detail before. Primarily, in fact, it is intended as a textbook for university courses in the history of science, although I hope that it will prove of value to professional biologists and historians looking for a compact guide to the field. Because the potential readership is so diverse, specialists from one side or the other will have to bear with the text when it describes what seems to them a trivially obvious point—it may not be so obvious to someone on the other side of the fence.

A number of books surveying the history of evolutionism are already in print, some of them of excellent quality. But most are a couple of decades old, and none seems to have been written as a simple guide to how historians are tackling the issues involved. Let me set out what I believe to be the essential characteristics of a book written for nonspecialists, including university students.

First, the book must be organized to allow a systematic introduction to the issues, taking nothing for granted. This is particularly the case in the history of science, where many of those who become interested do not have scientific backgrounds. A nonscientist may not understand, for instance, the principles of the Linnaean nomenclature—and unless he is told exactly what is involved this will remain a puzzle to him whenever he encounters it. In

addition, the historical issues must be presented so that the nonspecialist (in this case the scientist himself) can appreciate the different ways of looking at them. I have not hesitated to express my opinion on disputed issues, but I have tried to describe the alternatives and suggest where further information about them can be found.

Second, an introductory book must be comprehensive. It must cover all topics that could be of interest to anyone studying the field. This is especially true when the book is to be used for introductory level university courses, where something like the traditional idea of a textbook is required. So this is *not* a book on the Darwinian revolution alone. It is a history of “evolution” using that term in its widest possible sense to denote any theory postulating a natural process for the development of life on earth. Much important work was done in geology and natural history before the *Origin of Species* appeared, and one cannot properly understand the impact of Darwin’s theory without some grounding in the earlier developments. Conversely, the post-Darwinian situation must be dealt with as well. Trying to teach nonscientists about the impact of evolutionism without introducing them to the events leading up to the “modern synthesis” is ridiculous. At all stages, the relationship between the scientific theories and the culture in which they appeared needs to be discussed.

The penalty for trying to provide comprehensive coverage of so wide a field is that the amount of space available for each topic is limited. This is why I have abandoned the normal academic practice of giving extensive quotations, footnotes, and so forth to flesh out the narrative. I also have pared down to a minimum information on the lives and backgrounds of the scientists involved. The main purpose of this book is to introduce the ideas themselves, in all their complexity, in as straightforward a manner as possible. There are many books that provide such background material on the individual personalities, including the *Dictionary of Scientific Biography* (Gillispie, ed., 1970–80). I do not believe, in any case, that students at the introductory level are interested in such background or in the academic conventions. For them, the important thing is to get over the basic ideas as clearly as possible. In a teaching situation, the lecturer himself can supplement the text book with extra material in those areas where he wishes to specialize.

This brings me to a third point: the book must serve as a guide to further reading. I anticipate that many professionals will find this book useful precisely because of its bibliography. For students preparing term papers the bibliography will also prove invaluable. It might be objected that the material cited is too advanced for new students, but we have a responsibility to guide such students toward further reading. I hope that the references in the text will allow them to find the items in the bibliography most relevant to their needs. It would be easy for lecturers to provide their students with an additional guide to the bibliography. More advanced students approaching

the subject for the first time also should find the bibliography useful. In the history of science, courses up to and including the graduate level are often taught to students with no previous backgrounds. Such students are placed in a difficult position, because they must absorb the basic points and then pass straight on to more advanced reading. I hope this book will ease their burden.

My original intention was to provide each chapter with its own bibliography, which might have seemed less intimidating to the uninitiated. This plan was abandoned because the amount of duplication would have significantly increased the cost of typesetting. I also had intended to list primary and secondary sources separately, but this proved impossible for a single bibliography, because the distinction becomes unworkable when dealing with twentieth-century science. Wherever possible, I have tried to cite translations of works published originally in a foreign language. For primary sources printed before 1900, I have concentrated on editions that have been recently reprinted and should be more widely available. The secondary sources concentrate on classics in the field, plus the specialized literature of the last few decades. I am grateful to my departmental secretary, Mrs. Hilary Joiner, who did the original typing for the bibliography.

As an introduction to the development of perhaps the most controversial of all scientific theories, this book is meant to help bridge the gap between the "two cultures" that still divide our society. The history of science is one of the few areas in which students from both the humanities and the sciences come face to face with each other, and can appreciate that there is a genuine relationship between what each is doing. Professional historians of science have a responsibility to ensure that suitable reading material is available to help in this reconciliation, without trivializing the issues through overpopularization. Yet despite constant calls for more to be written for the non-specialist audience, most of us continue to produce our highly technical articles and monographs. This is my own effort to relate the issues I am familiar with at a level comprehensible to the nonspecialist. Whether or not the book is a success, the goal of providing this kind of literature is vital if the history of science is to serve its true function.

In its last two chapters, the book gives some background on the debates that currently are raging over the mechanism of evolution and the teaching of evolution in the schools. Scientists may be interested to see how some aspects of the modern debates raise issues that have been controversial throughout the growth of evolution theory. A few years ago, it would have been difficult to write a history of evolutionism except from the perspective that the modern form of Darwinism represents a triumphant climax to the process. Now, we see that the basic issues were not settled quite so conclusively. I do not expect scientists to derive any technical insights from reading about the work of their predecessors, but they may gain a better insight into the nature of the fundamental issues raised by what they are doing. On the question of creation-

ism, I have expressed myself rather more forcefully than elsewhere in the book. The historian has as much right as anyone to comment with authority upon a system that would, in effect, return us to a theoretical position last taken seriously by working naturalists in the early eighteenth century. Yet I have suggested also that scientists themselves may gain a better understanding of their own position when they acknowledge the complex status of scientific theories in general and evolution theory in particular.

My qualifications for writing this kind of book are twofold. First, I have spent a number of years teaching the history of evolutionism at various levels in universities in three different countries (Canada, Malaysia, and the United Kingdom). This, I hope, has given me some insight into the difficulties of presenting the essence of complex intellectual developments to students unfamiliar with the field. Second, I have published—originally by accident and later by design—research in most areas of the history of evolutionism from the eighteenth to the early twentieth centuries. Although there are others more competent than myself in any one area, few historians of science will have had direct experience in so wide a section of the time period that must be covered. The one area I am not directly familiar with is modern biology, including the material of the last two chapters. I have done my best to present a layman's introduction to modern Darwinism and its opponents. I hope that I have not oversimplified or misconstrued any important points, or misrepresented the views of those who are currently engaged in the debates.

My own intellectual debts are too numerous to record here in detail. It was Robert Young who first aroused my interest in the origins of modern evolutionism, but since then I have benefited from the thoughts of a host of scholars who are represented in the bibliography. Particular mention must be made of the two referees who read the original draft of the manuscript: John C. Greene and Malcolm Kottler. From their very different perspectives they tore the whole thing apart and advised me on how to put it back together again in a much improved form. They also advised on a host of detailed points of information and interpretation. Needless to say, where opinions are expressed they are my own, and any remaining mistakes are my own responsibility.

PETER J. BOWLER

The Queen's University of Belfast
September 1982

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The Idea of Evolution: Its Scope and Implications

For historians of science, the “Darwinian Revolution” has always ranked alongside the “Copernican Revolution” as one of those episodes in which a new scientific theory symbolizes a wholesale change in cultural values. In both cases, fundamental aspects of the traditional Christian world view were replaced by new interpretations of the universe. The medieval cosmology had pictured the earth as the center of a hierarchical cosmos stretching up through the perfect heavens to the abode of the Almighty. Because the physical universe was the stage on which the spiritual drama of man’s creation, fall, and redemption was played out, his location upon the central body seemed only natural; and this fitted the commonsense notion that the heavens rotate around a stationary earth. Copernicus taught instead that the earth is merely the third planet orbiting around the sun. Although he wished thereby to display the true harmony of the universe, his followers realized that by breaking down the barrier between the earth and the heavens he had created a new, nonhierarchical universe operated by fixed laws of dynamics. Man was not the center of everything; he was simply the inhabitant of a single planet orbiting around what soon was recognized as an insignificant star, lost in the immensities of space. The heavens might still declare the glory of God, but it had become harder to believe that they did so for the benefit of man alone.

Yet one could still believe that man was spiritually far from insignificant. To the Christian, man remained unique in his ability to perceive the moral dilemma of his existence. He was still master of a world apparently designed to support him as lord of creation, the highest link in a “chain of being” that united all living things into a natural hierarchy. Surely no natural process could explain the existence of such an orderly system of life or of the spiritual faculties of man himself. The Book of Genesis assures us that everything was

created by divine will in a period of only six days, with man as the final act of creation. The events of the Darwinian revolution—which actually began long before Darwin was born—undermined the traditional belief in man's innate superiority. As geologists investigated rocks, it began to appear that Genesis was not a good guide to the earth's history. There were vast periods of time before man appeared on the scene, when it was inhabited by strange creatures unlike any known today. Was it possible that natural forces alone had created this great sequence of living things ignored by the biblical account? And if so, must not man himself become merely the last of these natural products, no longer lord of creation but just a superior ape? Copernicus demoted man from his central position, but Darwin's theory required a complete reinterpretation of our spiritual role in creation.

Such changes were not achieved without arousing considerable resentment from those committed to the old world view. The trial of Galileo in 1632 revealed the extent to which the Catholic church was determined to resist Copernican astronomy. Yet in this case opposition soon died down, and after 1700 no one seriously challenged the new cosmology. Opposition to Darwinism, however, shows no sign of dying down even today. There are still powerful forces at work in our society that compel people to believe in a God who is personally responsible for the creation of man. For those who accept a fundamentalist interpretation of Christianity, this means that the creation story of the Bible must be literally true—and hence that evolution must be opposed as the most extreme manifestation of subversive atheism. In 1925, a similar wave of fundamentalism led to the passing of Tennessee's notorious "Butler Act" that forbade the teaching of evolution in schools, and to the "monkey trial" of John Thomas Scopes for contravening this regulation. The resulting publicity undermined this first attempt to oppose the spread of evolutionism, but now Darwinism is being challenged again by creationists who insist that their own position is just as valid even in the scientific sense and should be given equal time in schools. Whatever the merits of scientific creationism, the real purpose of this movement is to stem the tide of what is perceived as atheistical Darwinism. Clearly, the Darwinian revolution has not yet reached its final conclusion.

The enthusiasm of modern creationists can all too easily lead us to forget that the relationship between science and religion not always has been one of open warfare (Barbour, 1966, 1968; Peacocke, 1980; Russell, 1973). On the contrary, scientists often have been concerned to ensure that their ideas are consistent with some form of religious belief. It even can be argued that Christian values have played a vital role in the development of modern science (Jaki, 1978a). The belief that a wise Creator would build an orderly universe intelligible to man may have encouraged growth of the scientific concept of natural law. Christianity's essentially *historical* view of man's spiritual development may have provided the essential foundation for build-

ing evolutionary concepts. There certainly have been some religious thinkers who positively welcomed the theory of biological evolution. As long as the Bible story can be accepted as a revelation about the *purpose* of creation, rather than a detailed history of how it actually happened, evolution becomes the process whereby the divine purpose is achieved (Teilhard de Chardin, 1959). Some scientists are suspicious of the attempt to see a spiritual purpose in the biological process of evolution, but for many other thinkers this is precisely what makes the idea of evolution so exciting.

Scientists who repudiate any attempt to find a religious meaning in evolution would argue that the theory is simply a product of the objective study of how nature works, to which no moral or spiritual values should be attached. Science may have been influenced by religious thought in its infancy, but over the last few centuries the rise of modern science has represented the emancipation of Western man from the bondage of ancient superstitions. Evolution is the inevitable product of the decision to treat even the origin of mankind as a subject open to rational investigation. Yet this image of science as a purely objective search for knowledge has its own moral and cultural values. Creationists would argue that it is precisely in its efforts to reduce man to the status of an animal under the control of only natural forces that modern science reveals the materialistic philosophy underlying its activities. Other critics would agree that in the area of "social Darwinism" we see the scientific theory as an outgrowth of the policy of competitive individualism that has dominated our society since the rise of capitalism (Montagu, 1952; Young, 1971b). Evolution theory in particular and science in general thus can be regarded either as illuminations of the traditional concept of a divinely purposeful universe or as the source of an alternative philosophy by which some elements in our society have chosen to live. In either case, it is clear not only that the scientific theory itself can have wider implications but also that the supposed objectivity of the scientific method may be seen as part of a wider philosophy. Because of its immediate implications for human nature, evolution theory focuses those crucial questions about the relationship between knowledge and values that may underlie the prominent role science now plays in the world. A study of the history of evolutionism may help us to come to grips with these controversial issues.

Before we can undertake such a study, certain points must be clarified to give us a framework for understanding the rise of modern evolutionism. First, we must be able to recognize the full range of issues that distinguish the modern theory of evolution from the traditional religious view of nature. We also must be able to see how certain aspects of the traditional view could be preserved or even reinforced by some interpretations of the evolutionary approach. To do this we need to appreciate the complexity of the basic idea of evolution, which can be expanded in a number of different directions, each with its own implications at a wider level. Finally, we must look more closely

at the problems the historian faces as he tries to chart the rise of scientific evolutionism. In particular, these problems arise from the tension between the normal view of science as an objective search for knowledge and the suspicions of many critics that scientific theories are themselves value-laden contributions to philosophical and ideological debates.

THE OLD AND THE NEW WORLD VIEWS

The theory of biological evolution is really only part of a whole new approach to the study of the earth's past that has been developed over the last few centuries. Long before Darwin tackled the question of the origin of new species, geologists and cosmologists had begun to challenge the world view of medieval Christianity by postulating that the earth itself and even the universe as a whole have changed significantly over a vast period of time. Only within this new vision of an evolving *physical* universe did it become possible to imagine that living things also might be subject to natural change. The essence of the modern scientific viewpoint is that all features of the natural world, cosmological, geological, and biological, can be explained as the result of natural forces operating over long periods of time. Within this general program we can distinguish several basic issues that form the challenge to the traditional world view.

1. **The Expansion of the Time-Scale.** The traditional universe was extremely short-lived, since the six days of creation were supposed to have occurred only a few thousand years ago. In the seventeenth century, Archbishop James Ussher tried to calculate the date of creation by working back through the biblical patriarchs to Adam, and fixed the year as 4004 B.C. John Lightfoot, vice-chancellor of Cambridge University, declared that the final act by which man was created took place at nine o'clock on the morning of Sunday, October 23, 4004 B.C. Modern creationists do not fix the date quite so precisely but still insist that the earth was formed only a few thousand years ago. By the standards of modern science these estimates are trivial: geologists and cosmologists now put the earth's age at between four and five billion years. This vast extension of the time scale took place gradually, as geologists learned more about the extent of the changes that have taken place on the earth's surface. Frequent efforts were made to limit the amount of extra time required by geological theory, but already by Darwin's time no educated person doubted that the earth was at least some millions of years old. (The creationist challenge on this issue is strictly a twentieth-century phenomenon.) The whole issue was made particularly sensitive by the fact that paleontologists found no evidence for the existence of man except in the most recent geological past, thus reducing human history and prehistory to but a moment in the vast panorama of the earth's development.

2. The Concept of a Changing Universe. The traditional world view was essentially static. In the six days of creation, God formed the world just as we see it today, including the plants, animals, and man himself. Modern creationists recognize that some geological formations may have been laid down by Noah's flood but still believe that living things have remained unchanged since the creation. In the organic world at least, the traditional view assumes that there *cannot* be any change, because the forces of nature only can maintain the original forms created by God—they are not by themselves creative. This assumption was not derived purely from biblical authority but was backed up by the synthesis of Christianity with the philosophy inherited by the medieval world from the ancient Greeks. The views of Aristotle in particular were regarded as an important foundation of the belief that each species has a typical form maintained by the process of reproduction from one generation to the next. The hierarchy of natural forms stretching from the most primitive up to man—the “chain of being”—represented a complete and hence absolutely fixed plan of creation. By contrast the modern view assumes that we live in a continually changing world, although the processes involved may be so slow that we do not notice them. Geology teaches us that the earth itself has passed through immense changes, while the fossil record reveals a series of extinct populations thought to be linked by evolution.

3. The Elimination of Design. The intention of creationism is not just to preserve a role for direct supernatural intervention in the origin of species but also to uphold the belief that each form of life has been designed by its Creator. In the classic form of the “argument from design” popular among naturalists until the early nineteenth century, the complexity of each specific form and its careful adaptation to the organism's way of life was held to be direct evidence of the Creator's wisdom and benevolence. Unaided nature never could have produced such structures; therefore, divine will had to be invoked as the only reasonable explanation of their existence. The belief that the structure or development of natural forms can only be explained by the *purpose* they are supposed to fulfill is known as “teleology.” The whole thrust of modern evolutionism has been to eliminate the need for a supernatural purpose in accounting for the present structure of living things. Darwin conceived his mechanism of natural selection to show that everyday forces of nature can adapt each species to its everchanging environment, without the need to suppose that the process is intended to achieve some predetermined goal. At an even more basic level, modern biologists also believe that natural processes can account for the origin of life from nonliving matter, by a process of “chemical evolution” leading to ever more complex physical structures that eventually take on the properties of life.

It is important to note that the argument from design can exist independently of the biblical creation story. Many nineteenth-century paleontologists

accepted the supernatural origin of new species and invoked the argument from design, although they believed that production of new forms had occurred at various stages in the earth's history. At a rather more subtle level, it is also possible to argue that the Creator *intended* the present structure of the earth to emerge from the original form in which He created the universe. In Descartes' interpretation of the "mechanical philosophy," the earth was formed by natural means from matter distributed in space—but because God created both the original distribution and the laws that govern the behavior of matter, He had clearly foreseen the end product and could thus be said to have designed the evolutionary process itself. Even Darwin accepted the concept that God had established the general laws by which life evolves, although he was forced to concede that the details of what happened were not the result of divine forethought. The real problem with natural selection, though, was that the "survival of the fittest" in a universal "struggle for existence" did not sound much like the kind of mechanism a benevolent God would choose to achieve His ends.

4. The Elimination of Miracles. The Genesis story of creation is clearly meant to uphold the belief that the Almighty not only designed all things in the universe but played a direct and personal role in supervising their formation. The biblical concept of miracle, however, does not confine the Creator's activity to the beginning—it allows Him to intervene from time to time throughout the continuing history of the world. Paralleling this, we have already noted that some early paleontologists were willing to admit divine intervention at the beginning of each geological period to account for the appearance of new species. Biological evolution, however, is intended to exclude any role for supernatural intervention in the world, because it assumes that natural forces by themselves are sufficient to create new species. In the eyes of Darwin and his followers, it was only by accepting this policy of "naturalism" that the question of the origin of species could be opened up to scientific investigation. To appeal to the supernatural as soon as one reached the limits of existing natural explanations was to close off the route to any further research that might generate more satisfactory hypotheses. Miracles are by definition arbitrary violations of the normal laws of nature and as such cannot be studied by the methods of science. To admit their occurrence in order to explain the origin of certain structures in the world is to concede that a phenomenon lies forever beyond our comprehension—unless we accept the dictates of supernatural revelation.

The elimination of the supernatural was, however, no more straightforward than the elimination of design. The mechanical philosophy mentioned earlier eliminated the need for supernatural agencies except at the very beginning of the universe, but retained design by supposing that the Creator intended the laws of nature to produce the results we observe. This view compared the universe to a gigantic piece of clockwork, built by the "clock-

maker God" to run on inexorably toward its intended goal. There would be no need for God to concern Himself with His creation once it was formed—the religious philosophy known as "deism." Many religious thinkers, by contrast, believe that God must be involved with the universe at all times—the philosophy of "theism." It even may be supposed that the laws of nature continue to operate only because they are upheld by His will. In this case it will be less easy to make a clear distinction between laws of nature and miracles, because both equally are manifestations of divine power, one operating continuously, the other at irregular intervals. Some nineteenth-century scientists tried to argue that there must be special "laws of creation" by which God continues to shape the development of life, laws that could anticipate future goals and work toward them because they embodied divine foresight. To Darwin, such a concept of law was worse than a miracle, because it allowed the nonmechanical aspects of the supernatural to interfere continually with the regular operations of nature. For science to be possible, it was necessary to conceive the laws of nature so that they operated solely in a mechanical fashion, allowing the past (but not the future) to control the present by the normal rules of causality. To introduce God's foresight as the explanation of an evolutionary trend was just as much an abrogation of the scientist's duty to search for natural causes as was the more simpleminded appeal to miracles.

5. The Inclusion of Man within Nature. The Bible tells us that man was the last creation, formed in the image of God and given dominion over the rest of nature. To emphasize this superiority, Christianity assumed that of all the animals man alone was given a soul transcending the life of the physical body. Man thus stood above nature instead of being part of it. The theory of evolution emphasizes man's position as a member of the animal kingdom. He may possess characteristics developed far beyond those of any other species, but he is joined to the rest by a process of development in which no totally new element can have been introduced suddenly. This raises crucial questions for anyone who wishes to emphasize the role of man's higher faculties, whether or not they are seen as the product of a distinct spiritual element in human nature. Can our moral and ethical beliefs be explained away as the result of natural evolution, or do they show that in man, at least, nature has produced a being capable of transcending the struggle for existence? The unpleasant implications of social Darwinism were a direct consequence of the belief that all human characteristics depend on the processes of natural evolution. Similar issues again have been raised by introducing sociobiology to explain apparently altruistic behavior of animals in terms of natural selection—does this imply that man can be treated in the same way? Not only religious thinkers but also many social scientists oppose the attempt to explain human nature solely in terms of biology and insist that man has characteristics that lift him to a higher level of activity. The only possible way to accept the evolutionary link between man and the animals, yet preserve a spiritual component in