The Blind Watchmaker Study Guide

The Blind Watchmaker by Richard Dawkins

BOOKRAGS

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Plot Summary

Richard Dawkins is Professor of the Public Understanding of Science at Oxford University and he is the author of seven books, including The Selfish Gene. This book, The Blind Watchmaker, was originally published in 1987 and was reissued as a new edition in 1996. In it, Dawkins's objective is to counter the current arguments against Darwin's theory of evolution and, specifically, to educate the public in how the theory of evolution by natural selection explains the complexity and beauty of design of living organisms found in the world today.The title of the book and the initial motif is a famous treatise by the eighteenth-century theologian William Paley whose contention is, as is also that of many fundamental Christian groups and the so-called creationists, that the creation of life on planet Earth is the work of an Intelligent Designer. The subtitle of the book is Why the Evidence of Evolution Reveals a Universe Without Design.

Dawkins discusses the design and complexity of many objects in nature but concentrates, as Paley did, on the human eye and echolocation by bats. He explains how gradual evolutionary development in the natural world can easily match the most sophisticated designs of human scientists. He then goes on to describe his own computer experiments, where he emulates the process of natural selection, and examines, in detail, the working of genes and their associated DNA coding and replication to explain the mechanism of evolution.

Dawkins develops an objective and realistic appraisal of the statistics involved in miracles and the probability of life existing on other planets in the Universe. He shows the reader how to compute the statistical probability that humans are not the only form of intelligent life in the Universe and discusses theories as to how life originated on planet Earth.

In the chapter entitled Explosions and Spirals, Dawkins explains in detail how the flamboyant peacock's tail came about through the mechanism of positive feedback, and he expounds on how the various competitive scenarios between different species control the outcome of their evolution.

The incomplete fossil record, which is used to trace the evolution of different species, is dealt with in his chapter on Stephen Jay Gould's theory of punctuated equilibrium and leads to an exposition of taxonomy and the classification of all forms of living creatures. He touches on coelacanths and the Loch Ness monster and the difficulty in classification posed by such intermediate species such as archaeopteryx.

Finally, in the last chapter, Dawkins examines all the theories of life on earth, theories that can be considered as rivals to the Darwinian theory of evolution by natural selection. From Lamarckianism, through mutationism and neutralism to creationism, Dawkins makes a detailed scrutiny of each theory and finds none even come close to Darwin's theory in explaining the complexity and design of natural life as exists, today, on planet Earth.

Characters

William Paley

William Paley was an eighteenth-century theologian who published, in 1802, a treatise entitled Natural Theology - or Evidences of the Existence and Attributes of the Deity Collected from the Appearances of Nature. In this treatise Paley incorporates the best biological scholarship of his day to describe, with beautiful and reverent descriptions, the dissected machinery of life. His best example is the description of the human eye as a carefully designed optical instrument, and he concludes that, just as the telescope is an instrument designed to aid the eye in looking at distant objects, so too is the eye. Both instruments must have had an intelligent designer.

At the beginning of Paley's treatise, he presents a famous analogy where he contrasts the stones on the ground with a watch that he discovers lying there. He draws comparisons between the natural physical objects such as the stones with the watch, whose precisely machined springs and cogwheels are assembled in such a fashion that he concludes that there must have been an "artificer" who comprehended and designed its use. Paley asserts that denying the existence of an intelligent designer of the watch is what an atheist does when he denies the existence of God in contemplation of the beautiful intricacies and complexities found in nature.

Paley and Darwin, who followed him with his publication of the Origin of the Species in 1859, both recognized that the complexity and design of living creatures required an explanation. Paley's passionate and sincere attribution of the beauty of the natural world to the existence of a God was superseded by Darwin's theory of evolution by natural selection.

In the Blind Watchmaker, Richard Dawkins extends Paley's exposition to show that evolution by natural selection, which Darwin discovered, is an undirected, automatic process, which results in the existence and apparently purposeful form of all life today. In effect, as Dawkins asserts in the title of his book, the watchmaker at work in nature is blind.

Hugh Montefiore

Hugh Montefiore is the Anglican Bishop of Birmingham and is an unequivocal believer in the existence of the Christian God. He believes in evolution but not in natural selection as a mechanism for achieving the results in nature. His arguments, which Dawkins labels "the Argument from Personal Incredulity", include his disbelief that natural selection could explain the complexities of animal behavior. Unfortunately, the Bishop uses the white coloration of the fur of the polar bear to question natural selection because, if, in his words, the polar bear is dominant in the Arctic, why should it need to

camouflage its presence. This ignores the obvious fact that the polar bear might want to conceal its presence from its prey.

Montefiore consults the works of Arthur Koestler, Fred Hoyle, and Karl Popper among others. He like, these other authorities, seem to misunderstand the nature of natural selection as being random, which it definitely is not. In his book The Probability of God, the Bishop of Birmingham gives thirty-five examples of what biologists might find difficult to explain in terms of the theory of natural selection. As Dawkins points out, most of the examples, while not as easy to refute as that of the color of a polar bear's fur, do not overly tax the modern biologist. Nevertheless, the point is that, even if examples were found that are beyond the modern scientists' ability to explain, this would reflect on the analytical abilities of the scientist, rather than give a reason to completely discard the whole theory of evolution by natural selection.

Montefiore and his colleagues approach slightly more firm ground in their objections to natural evolution when they move beyond sheer, naked incredulity to discuss the statistical probability of events for which natural selection is ascribed as the cause. Again, these arguments are based on the misunderstanding of natural selection as being random in a statistical sense. Mutation is random, natural selection is the very opposite. The argument that the whole perfect world of interlocking animal behavior had to be achieved simultaneously and, therefore, is statistically improbable, ignores the fact that gradual, incremental, evolution is the fundamental process by which natural selection works.

Chevalier de Lamarck

Chevalier de Lamarck was an eighteenth-century French intellectual who proposed a theory of evolution before Darwin ever published his ideas. His proposed mechanism for evolution was the best that had been made up to that time and there is no reason to suppose that if he had been alive when Darwin's ideas were published he would not have accepted them.

Lamarck's writings contained a strong element of mysticism and he included ideas about progress and the "ladder of life", and in the idea that animals strove to evolve. Today's "neo-Lamarckians" no longer include these ideas in their theory of evolution, which is based on two main concepts. The first concept is the inheritance of acquired characteristic and the second is the principle of use and disuse.

Lamarckian theory holds a strong emotional appeal to many people. George Bernard Shaw made a passionate advocacy of the inheritance of acquired characteristics. T. D. Lysenko was also a fervent believer in the inheritance of acquired characteristics, and he was appointed director of the Institute of Genetics of the Soviet Union, and consequently these theories of genetics were the only ones which were allowed to be taught in Soviet schools for a generation.

In the English speaking world today, Lamarck is known only because of the erroneous mechanism he proposed for evolution; whereas, in fact, he should be acknowledged as someone, who, way ahead of his time, foresaw evolution as a viable theory for the explanation of natural life.

Stephen Jay Gould

Stephen Jay Gould is an American paleontologist who is a prolific writer and whose book The Panda's Thumb is praised by Dawkins. He and his colleague Niles Eldridge proposed a theory of punctuated equilibrium in 1972. This theory and their writings have been seized on by the media as being opposed to neoDarwinian theory. Dawkins spends much effort in proving that this theory is actually in conformance with classical Darwinian theory. His main criticism is that Gould and Eldridge have succumbed to the allure of the media and allowed distortions of their ideas to be popularized without any successful refutation on their part.

Edward O. Wilson

Edward O. Wilson is the world's foremost authority on ants and is the author of Sociobiology. Dawkins quotes him at length when he describes his own experience watching driver ants in Panama and when he compares the convergent evolution of driver ants in Panama and army ants in Africa.

David Hume

David Hume was a Scottish philosopher who, one hundred years before Darwin, questioned the use of the complexity in design in nature for proving the existence of a God. He was not able, however, to propose an alternative explanation of biological design. Darwin enrolled in Hume's university of Edinburgh forty years after Hume's death and subsequently provided the world with the means to be an intellectually satisfied atheist.

Gregor Mendel

Gregor Mendel worked in isolation in a monastery in the last century and independently developed the theory of particulate inheritance. His work was not recognized until after his death. He showed that organisms do not blend the inheritance from both parents but do so in a binary, or digital manner. The leading followers of Mendel's theory of particle genetics, at first, thought this disproved Darwin's theory. It was the work of R.A. Fisher who showed that, in fact, Mendel's theory is a prerequisite to Darwin's theory of evolution by natural selection.

R. A. Fisher

Sir R. A. Fisher, who is considered to be one of the founding father's of modern neo-Darwinism, solved the apparent dilemma of supposed blending of inherited traits by developing the concept of particulate inheritance and showing that Mendelean inheritance theory is an essential foundation of Darwinian theory. He published his ideas in his book The Genetical Theory of Natural Selection in 1930.

Sol Spiegelman

In the 1960s, Sol Spiegelman and his colleagues in America performed experiments on test tubes of RNA molecules, which led to the replication of E. coli bacteria without seeding by the DNA molecules.

Graham Cairns-Smith

Graham Cairns-Smith is the originator of an "inorganic mineral" theory of the origin of life. Cairns-Smith is a Glasgow chemist who has published several books elaborating his theory, the latest being Seven Clues to the Origin of Life, which was published in 1985.

Other workers in the field, following the "primeval soup" theories, have also accepted that clay minerals might have played a part in the origin of life.

Leigh van Valen

Leigh van Valen is an American biologist who gave the name of "The Red Queen Effect" to the principle of zero change in success rate no matter how great the progress in evolution. The name is derived from the account in Through the Looking Glass, where the Red Queen seizes Alice by the hand and runs through the countryside, all the while staying in exactly the same place.

Malte Andersson

Malte Andersson is the Swedish researcher whose work with widow birds in the wild in Kenya showed that male birds with elongated tail feathers had four times the success rate of mating with females than those whose tails were of a normal length. His work consisted of capturing a collection of widow birds and cutting some tail feathers and pasting the excess feathers on other birds' tails with Super Glue.

G. Nelson & N. Platnick

G. Nelson and N. Planick are from the American Museum of Natural History in New York. They belong to a group of taxonomists who go under the name of "transformed claddists". In their writings they claim to have tested Darwinism and found it has failed the test. They may have meant that ancestral species are difficult to represent in cladistic classification, but their opinions have provided a boon to creationists and other opponents of evolution by natural selection.

Motoo Kimura

Motoo Kimura is the Japanese geneticist who, while agreeing that natural selection is responsible for all adaptation, proposes the concept that mutations at the molecular level are neutral. In doing so, he asserts that most evolutionary change is not adaptation.

Gabriel Dover

Gabriel Dover is the Cambridge geneticist who believes that all evolution can be explained without natural selection but who does concede that there may be some truth in natural selection. His idea is that a species evolves into another form, which then goes off into the world to find an environment where its newly evolved attributes will serve for its survival. This, of course, is diametrically opposite to natural selection where the changing environment imposes forces which result in evolution.

Darwin

Richard Dawkins's book the Blind Watchmaker is all about Darwin's theory of evolution; however, in the book, apart from exposition of the theory, the reader learns very little about the man himself and his personal life which led him to the publication of his ideas which have changed the world ever since.

He published The Origin of the Species in 1859, he attended the University of Edinburgh forty years after the death of David Hume, and he had a grandfather, Erasmus, who advocated the theory of evolution along with the Chevalier de Lamarck.

Objects/Places

Paley's Watch

Paley's watch was the primary object used by the Reverend Paley in his analogy to support the idea of an intelligent designer for all life.

Mont Blanc

Mont Blanc, the mountain in Switzerland, was used by Richard Dawkins to characterize a unique collection of non-living things.

The Human Eye

Both Paley and others have used the human eye as an example of the epitome of design complexity in the natural world.

Bats Echolocation

The echolocation mechanism of bats is used by Richard Dawkins as an example of good engineering design in natural creatures. He compares it favorably to the artifacts of human engineering in radar and sonic location.

Doppler Effect

The Doppler effect is named after its discoverer. It is the change in frequency observed when either the source or receiver of sounds changes location during the transmission.

Polar Bears

Polar bears, or rather the color of their fur, is mistakenly used by Hugh Montefiore to refute the principle of natural selection.

Spider Webs

The intricacy of spider webs is used by Montefiore, the Bishop of Birmingham, to support his belief of a Christian God.

Recursive branching computer programs

Richard Dawkins devised two computer programs which he called Development and Reproduction to model the process of evolution. Both programs use the principle of recursion.

Biomorphs and Biomorph Land

Dawkins calls the graphical entities, which are produced by his computer programs "Biomorphs", and the nine dimensional space in which they mathematically exist he calls "Biomorph Land".

Bombardier beetle

The bombardier beetle, which squirts a "lethal mixture of hydroquinone and hydrogen peroxide into the face of its enemies", is used by the author of The Neck of the Giraffe to support the improbability of this defense mechanism happening by chance because the mixture of these two compounds was believed to be spontaneously explosive. In fact, a catalyst is injected to make the mixture work.

Flat fish

The radically different construction of the two types of flat fish in the ocean, those with flattened wing shapes like skates and rays, and those with two eyes on the same side of the head, are examples of different evolutionary design.

Cicadas

The thirteen-year and seventeen-year cicadas are examples of how convergent evolution has happened in the two different races of these two different species.

Gondwanaland and Laurasia

Gondwanaland was the huge southern continent from which South America, Africa, Madagascar, India, Antarctica, and Australia were formed by the mechanism of plate tectonics and continental drift about one hundred million years ago. Laurasia was the similar northern continent from which emerged North America, Greenland, Europe, and Asia.

Ants

The occurrence of two different species of ants both with similar behaviors and modes of existence and both living on separate continents are proof of convergent evolution. These species are the driver ants of South America and the army ants of Africa.

Protoplasm

In old theories, the basic constituent of living creatures, as compared to inanimate objects, was considered to be "protoplasm". At one stage the globigerina ooze found at the bottom of deep oceans was considered to be pure protoplasm.

DNA and RNA

DNA and RNA are the two main types of polymers found in living cells. They are made up of chains of molecules called nucleotides.

Histone-H4 DNA

Histone-H4 DNA is an example of archival DNA, which is found in organisms as different as peas and cows. It has existed, with only minute changes, since the time of the common ancestor of both peas and cows, or about two thousand million years.

RNA Replicase

RNA Replicase is the name of the mechanism by which RNA molecules can replicate without the inclusion of the DNA molecule.

Q-beta viral RNA

Q-beta viral RNA is the variety of RNA produced in the laboratory by degeneration from larger Q-beta molecules and which is better suited to the environment provided by E. coli cells.

Spontaneous Generation Probability

The Spontaneous Generation Probability number (SGP) represents the statistical probability that "life will originate on any randomly designated planet of some particular type".

Primeval soup theories

The theories as to the origin of life on the planet, which use as a mechanism an organic mixture from which the building blocks of evolution emerge, are called "primeval soup" theories.

Cairns-Smith's clay theory

The theory promulgated by Cairns-Smith, that life originated from inorganic materials containing silica, is called the Cairns-Smith clay theory.

Eukaryotic cells

Eukaryotic cells are all those which do not include cells originating from bacteria.

Feedback

Feedback is the name given to the mechanism whereby part of the output from a process is fed back to control the process. If the feedback dampens the process it is called negative feedback. If the feedback increases the rate of the process it is called positive feedback. Positive feedback leads to uncontrolled growth.

Peacock's tail

The gloriously exaggerated peacock's tail bears the stamp of positive feedback and is the product of unstable, explosive growth in the evolution of the bird, which exists today.

Watt governor

The Watt governor is an example of a negative feedback control mechanism. It is found in steam engines.

Widow birds

The long tailed widow bird of Kenya attracts harems of females and, like the peacock's tail, is an example of positive feedback at work in evolution by natural selection.

Punctuated Equilibrium

Punctuated Equilibrium is the name of the collection of theories, first published by Stephen Jay Gould and Niles Eldridge to account in the gaps in evolutionary development as evidenced by the fossil record.

Airliners

Dawkins uses the Boeing 747, the DC8, and Stretched DC8 as examples to illustrate the difference between different levels of mutations. The Stretched DC-8 is an example of a normal mutation as it is a modification of an existing design, whereas the 747 and DC-8 are examples of macromutations being of much larger effect.

Antennapaedia

Antennapaedia are fruit flies where the normal embryo development has changed so that the antennae become legs. This mutation occurs because of an error in copying the DNA; it is a macromutation. These insects cannot survive in the real world.

Coelacanth

The coelacanth are a large group of fish whose fossils date back to more than 250 million years ago and have unusual leg-like fins. Thought to be extinct, a few living specimens have been caught since 1930. They are truly living fossils having changed very little since the time of their fossil ancestors.

Archaeopteryx

Archaeopteryx is a famous fossil, which has partial characteristic of a bird and partially those of non-birds. It thus forms a problem for taxonomists who wish to classify it.

Loch Ness Monster

The Loch Ness Monster is thought to be a plesiosaur, which has avoided extinction and lives in Loch Ness in Scotland.

Taxonomy

The theories and classification schemes in taxonomy, the branch of science involved with the classification of objects are: Cladists, Phyletecists, Pheneticists, Numerical Taxonomists, and Transformed Cladists

Rival theories

The main theories, which might be considered rivals to Darwinism, are: Lamarckism, Neutralism, Mutationism, Molecular drive, and Creationism.

Themes

Probability

As the title of Dawkins's book suggests, the basis for the evidence of a world without design is rooted in probabilities. The first chapter is entitled Explaining the Improbable, and in it Dawkins analyses the statistical probabilities of spontaneous creation of complex objects such as airliners and human eyes. He uses the combination lock on his bicycle as an example to educate the reader in elementary statistics in random numbers. Of course the main point about natural selection, as Dawkins points out in several places in the book, is that it is not random at all. It is the mutations, which are subjected to natural selection, that are random.

In Chapter 6 Dawkins discusses Origins and Miracles, and the main topic is the problem of how life originated on the planet Earth. In doing so he considers the probability of similar life occurring on other planets in the Universe. As he suggests, the reader may not be able to comprehend the probabilities of this happening, but that is no reason to abandon the idea of statistical probability in favor of an emotional decision to declare an event either possible or impossible.

Dawkins accomplishes this task by inventing a number, which he labels the Spontaneous Generation Probability, or SGP. By assigning an acronym to the probability of the event, he succeeds in establishing an objective and rational way to discuss the idea. The SGP is based on the number of stars, planets, galaxies, and constellations in the universe. These are obviously huge numbers and can only be estimated by astronomers. This technique is extended to include the probability of life arising on a planet once per solar system, the probability of life arising if life arises at the rate of one per galaxy, and the same measure for the universe, gives three more numbers, the Solar System Number, the Galaxy Number and the Universe Number. If there are approximately one hundred billion billion planets in the universe, there are now numbers with which to assess the probability of an event such as the spontaneous origination of life on a planet, instead of declaring the event to be probable or improbable.

The same technique can be used to analyze the likelihood of a miracle happening. In this case the example is that of a marble statue of the Virgin Mary, which waves its hand. Now molecules in marble continuously jostle each other in a random fashion, but the motion cancels out and the hand of the statue remains still. However, if all the molecules change the direction of their motion at the same time it is possible for the statue to wave at the spectators. The odds against such a rare event are so great that it would take a lifetime just to write it down, but the point is that it is possible to calculate a way into regions of miraculous improbability.

The Media

In the world of evolutionary theory the ideal arena for discussion would be the supposedly calm and hallowed halls of academia, but time and again Dawkins refers to the publicity and reception of ideas by the media as being a point at which he takes exception. In the case of Stephen Jay Gould and their explanation of the gaps in the fossil record, Dawkins goes out of his way to construct a parable about Biblical history and the speed of the migration of the Israelis across the Sinai desert. The point of the parable is the fact that "two eloquent young historians" burst on the scene and begin teaching a new interpretation of the speed of migration. This must surely reflect Dawkins's own attitude towards the proponents of the theory of "punctuated equilibrium". His criticism of their writings is that, instead of reinforcing the theories of Darwin, they chose to sell their ideas to the journalists as being radically opposed to Darwin's theories and opposed to neo-Darwinian synthesis. As Dawkins points out in his analysis of punctuated equilibrium, it is, in fact, largely in conformance with classical Darwinian theory, the main point of discussion is the time periods between the sudden appearance of new species and geologic eras.

As Dawkins acknowledges, Eldridge and Gould speak out with eloquence and power, but their message is sometimes too subtle for the general public, which concludes that there is something fundamentally wrong with Darwinism. Dawkins goes on to point out that both Gould and Eldridge have shouted their complaints at the misuse of their words, but to no avail. Dawkins recounts how he himself has experienced this distortion of his own words in a political setting.

The reader cannot help contrasting this emphasis on what the uninformed media and public think with the calm, insulated, studies of Mendel in his monastery, the significance and importance of whose work was only recognized many years after his death.

Cultural Evolution

In the chapter on Explosions and Spirals, Dawkins describes the evolution of language as being a case where progress is not necessarily applied to growth. He cites the numerous islands of the Pacific as providing a workshop for studying the evolution of languages. He points out that the pattern of language evolution in these islands is analogous to the differences in finches that Darwin observed in the Galapagos Islands and which was the inspiration for his theory of evolution. This extension of the evolutionary process to non-biological subjects is addressed more directly when Dawkins describes the phenomenon of popular music and its growth and propagation. He labels this evolution of one particular aspect of culture as being a strong analogy to sexual selection.

The runaway sales of hit records after they have reached a critical point and the way that record companies and music publishers manipulate the sales figures which are the driving force of the sales and not the intrinsic worth of the music is well described. As

Dawkins points out, this phenomenon has all the earmarks of the positive feedback in R. A. Fisher's runaway evolution. In describing this phenomenon and the similar one of book publishing, Dawkins repeats his warning that analogies should not be taken too far.

Notwithstanding Dawkins's warning, an imaginative reader might carry the pop music analogy even further to include the ideas and theories of evolution itself, the associated ideas of the existence of a God and the cultural models and beliefs embodied in religion. The chapter on Doomed Rivals deals with competing theories of evolution, the origin of life on Earth, and the justification for belief in the existence of a God. If these are considered but as species of cultural entities, a reader might imagine that the "correct" theory will survive because of the human cultural environment in which it attempts to survive and flourish. Dawkins and his colleagues are all limited in their scope to the Judaeo-Christian culture, but there are many other cultures in existence on planet Earth and, just as their genes are subject to the same laws of evolution as the inhabitants of the English speaking world, their ideas on religion and God might also be valid competitors to the Western species of religion.

The evolution of religion, and particularly the deity concept, can be traced via the fossil record of rock carvings, stone monuments, and historical texts, from the animist gods of post Neanderthal man, through the sun worship of the ancient Egyptians to the appearance of monotheistic religions such as Buddhism and Christianity, and finally to the less primitive concepts of Zen and the Tao. If a deity concept is to survive the gradual evolution of the environment of the human race from a planet-bound social insect to a traveler in space, surely the ideas emerging from his cranial activities will have to evolve simultaneously.

Style

Perspective

Richard Dawkins is Professor of the Public Understanding of Science at Oxford University. He is the author of seven books, including The Selfish Gene. This book, The Blind Watchmaker, was originally published in 1987 and was reissued as a new edition in 1996. Dawkins's avowed intention is to refute the denials of the truth of evolution and to educate the public in the real explanation of the complexity and beauty of design of living organisms found in the world today.

The intended audience is the general public who are either interested in the Darwinian theory of evolution or are those who need to be educated as to the true and detailed evidence of the general account of the theory of evolution.

The title of the book and the initial motif is the famous treatise by the eighteenth-century theologian William Paley entitled Natural Theology - or Evidence of the Existence and Attributes of the Deity Collected from the Appearances of Nature. The central theme of this treatise and many others emanating from fundamental Christian groups and so called creationists is the concept of the "Intelligent Designer" at work in the creation of life on planet Earth. The subtitle of the book is Why the Evidence of Evolution Reveals a Universe Without Design.

Tone

The tone of the book is that of professorial exposition, in a pleasant and conversational tone given in the first person. Throughout the book Dawkins expresses respect and objectivity towards the advocates of the positions and theories, which he is attempting to persuade the reader, are fundamentally false. Occasionally, however, his acerbic wit borders on the sarcastic when he is dealing with elementary and often ludicrous errors on the part of the people he is criticizing. This is particularly true when he comments on the eminent scientific staff of the Natural History Museum in New York who have gone public in their unsubstantiated declaration of the failure of Darwinian theory. In the same vein, he spends a lot of time dealing with the successfully published works of Stephen Jay Gould, who advocates the theory of Punctuated Equilibrium. Dawkins makes a masterful justification for the position that the elements of this theory do, in fact, fall within the boundaries of classical neo-Darwinism.

In his detailed explanation of the technical aspects of statistical probabilities, Dawkins is excellent, especially when dealing with the probabilities of life originating in other parts of the universe. His tendency for digressions, however, for which he asks the reader's indulgence, can be a little disconcerting. The reader might wonder whether six paragraphs spent on a detailed description of the Watts steam governor as an exposition of negative feedback could not have been shortened. Again, the specific

objective of the dialog between a real-life Darwinian and the caricature thereof is a little vague, and the all-important summary in the last chapter is lost in a general discussion of the postulates of creationism.

Structure

The book is divided into eleven chapters, each with a pertinent and descriptive chapter title. Each chapter is also prefaced with very interesting grayscale reproductions of what appear to be paintings. These illustrations seem to be related to the content and material being presented in the chapter; for example, the bat at the start of chapter two deals with echolocation in bats. Unfortunately, the paintings are neither annotated nor attributed, which maybe an oversight on the part of the editor, but nevertheless leaves an unsatisfied curiosity on the part of the reader. On the other hand, the graphic illustrations showing the output of the computer programs devised by Dawkins are extremely effective and dramatically illustrate his creation of "biomorphs".

In the preface to the 1986 edition, Dawkins refers to chapter twelve, which dealt with extra-terrestrial aspects of evolution, which was apparently excised from the book before its publication. Perhaps this is why the conclusions for the whole book lack any form of summary and appear to have been tacked on to the last part of chapter eleven and do not convey the impact a more thorough summary and conclusion might have provided.

The standard of Bibliography and Index are professional and thorough and no explanatory notes are needed for the text.

Quotes

"'That the watch must have had a maker: that there must have existed, at some time, and at some place or other, an artificer or artificers, who formed it for the purpose which we find it actually to answer; who comprehended its construction and designed its use.'" Chap. 1, p. 8

"Paley's argument is made with passionate sincerity and is informed by the best biological scholarship of his day, but it is wrong, gloriously and utterly wrong." Chap. 1, p. 9

"Natural selection, the blind, unconscious, automatic process which we now know is the explanation for the existence and apparently purposeful form of all life, has no purpose in mind. It has no mind and no mind's eye. It does not plan for the future. It has no vision, no foresight, no sight at all. If it can be said to play the role of watchmaker in nature, it is the blind watchmaker." Chap. 1, p. 9

"Unlike some of his theological colleagues, Bishop Montefiore is not afraid to state that the question of whether God exists is a definite question of fact." Chap. 2, p. 54

"The actual animals that have ever lived on Earth are a tiny subset of the theoretical animals that could exist. These real animals are the products of a very small number of evolutionary trajectories through genetic space. The vast majority of theoretical trajectories through animal space give rise to impossible monsters. Real animals are dotted around here and there among the hypothetical monsters, each perched in its own unique place in genetic hyperspace." Chap. 3, p. 104

"I waited for the queen. Finally she came, and hers was an awesome presence. It was impossible to see her body. She appeared only as a moving wave of worker frenzy, a boiling peristaltic ball of ants with linked arms. She was somewhere in the middle of the seething ball of workers, while all around it the massed ranks of soldiers faced threateningly outwards with jaws agape, every one prepared to kill and to die in defense of the queen." Chap. 4, p. 154

"Amazingly, only about 1 per cent of the genetic information in, for example, human cells, seems to be actually used: roughly the equivalent of one volume of the Encyclopaedia Britannica. Nobody knows why the other 99 per cent is there." Chap. 5, p. 164

"I am genuinely sorry, for I am heartily thankful that we have escaped from the small-mindedness of the medieval church and I despise modern astrologers, but I am afraid that the rhetoric about backwaters in the previous paragraph is just empty rhetoric. It is entirely possible that our backwater of a planet is literally the only one that has ever borne life." Chap. 6, p. 202

"The conclusion to this part of the argument is that we can calculate our way into regions of miraculous improbability far greater than we can imagine them as plausible." Chap. 6, p. 228

"Our fundamental assumption must be that genes are selfish entities, working for their own propagation in the gene pool of the species. But because the environment of a gene consists, to such a salient degree, of other genes also being selected in the same gene pool, genes will be favored if they are good at cooperating with other genes within the same gene pool. This is why large bodies of cells, working coherently towards the same cooperative ends, have evolved. This is why bodies exist, rather than separate replicators still battling it out in the primordial soup." Chap. 7, p. 274

"Try to persuade yourself, as they tried to persuade me when I was an undergraduate, that the peacock's fan is a mundanely functional organ like a tooth or kidney, fashioned by natural selection to do no more than the utilitarian job of labeling the bird, unambiguously as a member of this species and not that." Chap. 8, p. 282

"Islands that are near each other obviously have a higher rate of word flow between them, via canoe, than islands that are far from each other. Their languages also have a more recent common ancestor than the languages of islands that are far apart. These phenomena, which explain the observed pattern of resemblances between near and distant islands, are closely analogous to the facts about finches on different islands of the Galapagos Archipelago, which originally inspired Charles Darwin. Genes island-hop in the bodies of birds, just as words island-hop in canoes." Chap. 8, p. 311

"Moreover, Eldredge and Gould originally introduced their theory, not as radically and revolutionarily antipathetic to ordinary, 'conventional' Darwinism - which is how it later came to be sold - but as something that followed from long-accepted conventional Darwinism, properly understood." Chap. 9, p. 337

"Molecular biology suddenly opened a new treasure chest of resemblances to add to the meager list offered by anatomy and embryology. The 64 identities (resemblances is too weak a word) of the shared genetic dictionary is only the start. Taxonomy has been transformed. What were once vague guesses of cousinship have become near-certainties." Chap. 10, p. 385

"If we want to postulate a deity capable of engineering all the organized complexity in the world, either instantaneously, or by guided evolution, that deity must already have been vastly complex in the first place. The creationist, whether a naïve Bible-thumper or an educated bishop, simply postulates an already existing being of prodigious intelligence and complexity. If we are going to allow ourselves the luxury of postulating organized complexity without offering an explanation, we might as well make a job of it and simply postulate the existence of life as we know it!" Chap. 11, p. 453

Topics for Discussion

In chapter one, Dawkins uses Mont Blanc as a set of randomly gathered rocks to define the fundamental difference between living and inanimate objects. In chapter six, Origins and Miracles, he describes the theories of Cairns-Smith as to how life on Earth might have originated from clays and silicates. Is there not a contradiction here? If rocks can be the source of the origin of life they obviously cannot be examples of inanimate objects. Discuss.

In chapter eleven, Doomed Rivals, Dawkins makes light of the theory that a plesiosaur, the Loch Ness Monster, still exists in the deep waters of a Scottish loch. Contrast his views with the actual facts of the discovery of a living coelacanth off South Africa in 1938. Is this not a similar case? Discuss.

Genetic hyperspace as described in chapter three is where all the creatures that could have existed are gathered. Dawkins also talks about "trajectories" in genetic hyperspace. If trajectories are two way vectors, does that not conflict with the concept of evolution being one way? Could a species not evolve into its ancestor?

The problem posed by a continuous fossil record is that the intermediate forms of a species are permanently recorded, for example archaeopteryx, which is part way between a dinosaur and a bird. On page 374, Dawkins describes the reliance of Christian-inspired, legal, and ethical values as being based on species bound systems. Dawkins states that all these methods of thinking are "saved from awkward ambiguity" because all intermediate species are now extinct. Discuss whether there are fundamental flaws in Western, moral, and ethical philosophies which rely on exact and discrete species definition.

Given wonderful fossils like Archeopteryx and the beautiful complexity of human organs such as the brain and the eye, why could not human beings evolve to have wings like angels? What prevents human beings from developing wings? Are there limitations to the forms that evolution can produce, Dawkins states his position on page 443. Discuss.

If Punctuated Equilibrium can be shown to fall in with the general tenets of classical neo-Darwinism, why is Dawkins so critical of Stephen Jay Gould's writings, especially when he praises Gould's for his book, The Panda's Thumb? Discuss the place of punctuated equilibrium in the theory of evolution.

Dawkins, as an apologist for Darwinian theory, discusses the theories of origin of life on Earth, but as he admits, these remain theories. Is his belief in the explanation of the origin of life not an act of faith similar to the belief systems of the creationists? Discuss.

The extinction of many species is recorded in the fossil record, and astronomers have described the inevitable end of the solar system, of which Earth is merely a planet, and its host galaxy. Should there not have been a chapter entitled the End of the Species to match Darwin's The Origin of the Species?

Given the similarities between cultural evolution and the evolution of things like human languages, would it be reasonable to regard the concept of God as an evolving cultural entity? If so, into what would this concept likely evolve? Discuss.