

God's Utility Function

Humans have always wondered about the meaning of life. According to the author, life has no higher purpose than to perpetuate the survival of DNA

by Richard Dawkins

In his many books on evolution and natural selection, Richard Dawkins examines the topics not from the perspective of individual organisms (as Charles Darwin did) but instead from what he has termed "the gene's-eye view." The genes in living creatures today are, he claims, the "selfish" ones that ensured their own survival by enabling their hosts—what Dawkins calls "survival machines"—to live long enough to reproduce. Dawkins argues that the complexity of life can be explained by the extraordinary contest among genes for survival, rather than by any grand purpose in the universe.

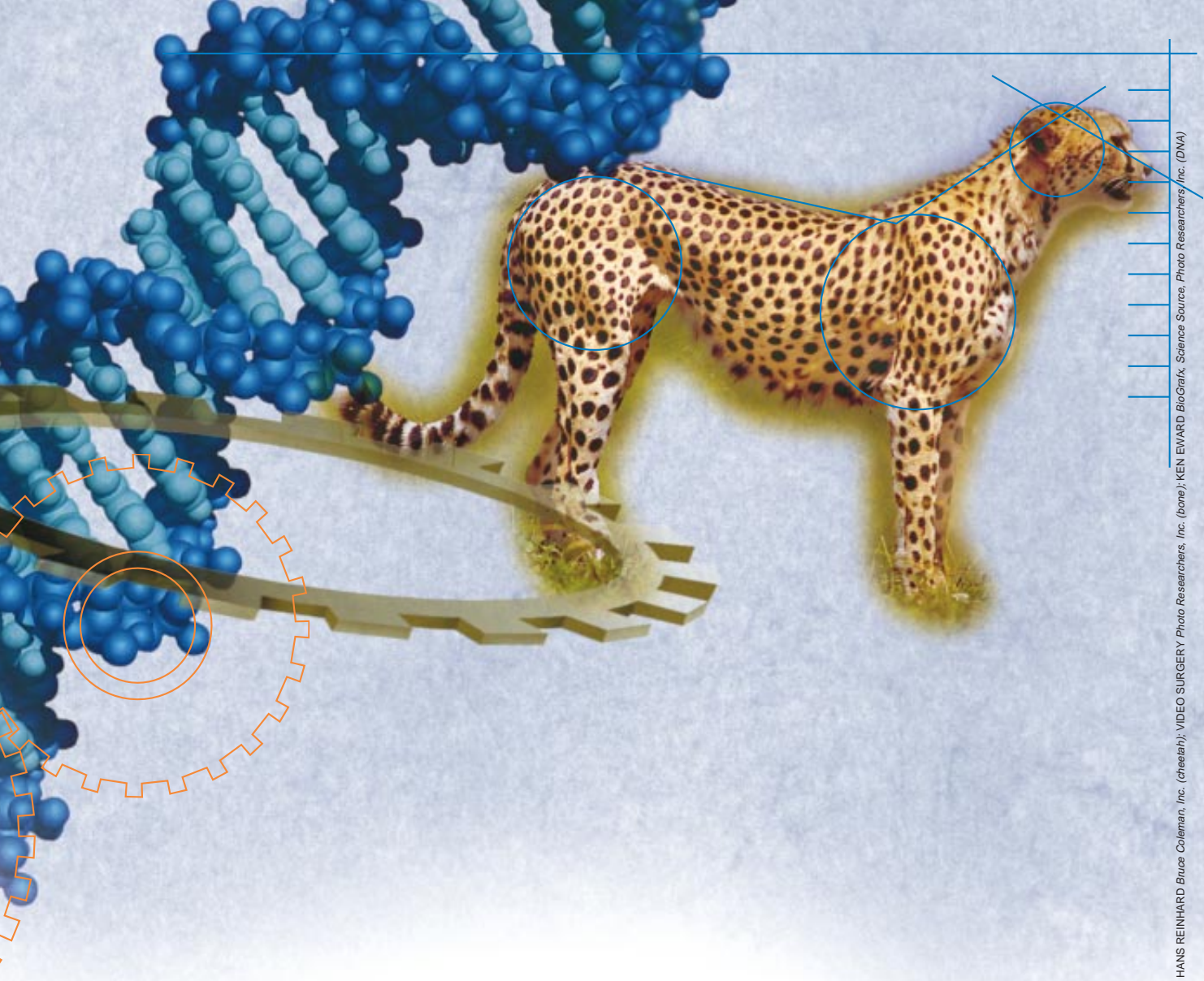
*In his recently published book, *River Out of Eden: A Darwinian View of Life*, Dawkins explains how the struggle of genes to replicate might account for some of the central mysteries of life, including "How did life begin?" and "Why are we here?" The article that follows is adapted from a chapter of *River Out of Eden* (*BasicBooks*, 1995).*

I cannot persuade myself," Charles Darwin wrote, "that a beneficent and omnipotent God would have designedly created the Ichneumonidae with the express intention of their feeding within the living bodies of Caterpillars." The macabre habits of the Ichneumonidae are shared by other groups of wasps, such as the digger wasps studied by the French naturalist Jean Henri Fabre.

Fabre reported that before laying her egg in a caterpillar (or grasshopper or bee), a female digger wasp carefully guides her sting into each ganglion of the prey's central nervous system so as to paralyze the animal but not kill it. This way, the meat stays fresh for the growing larva. It is not known whether the paralysis acts as a general anesthetic or if it is like curare in just freezing the victim's ability to move. If the latter, the prey might be aware of being eaten alive from inside but unable to move a muscle to do anything about it. This sounds savagely cruel, but, as we shall see, Nature is not cruel, only pitilessly

DIGITAL COMPOSITION BY TOM DRAPER





HANS REINHARD Bruce Coleman, Inc. (cheetah); VIDEO SURGERY Photo Researchers, Inc. (bone); KEN EDWARD BioGrafix, Science Source, Photo Researchers, Inc. (DNA)

indifferent. This lesson is one of the hardest for humans to learn. We cannot accept that things might be neither good nor evil, neither cruel nor kind, but simply callous: indifferent to all suffering, lacking all purpose.

We humans have purpose on the brain. We find it difficult to look at anything without wondering what it is “for,” what the motive for it or the purpose behind it might be. The desire to see purpose everywhere is a natural one in an animal that lives surrounded by machines, works of art, tools and other designed artifacts—an animal, moreover, whose waking thoughts are dominated by its own goals and aims.

Although a car, a tin opener, a screwdriver and a pitchfork all legitimately warrant the “What is it for?” question, the mere fact that it is possible to frame a question does not make it legitimate or sensible to do so. There are many things about which you can ask “What is its temperature?” or “What color is it?” but you may not ask the tempera-

ture question or the color question of, say, jealousy or prayer. Similarly, you are right to ask “Why?” of a bicycle’s mudguards or the Kariba Dam, but at the very least you have no right to assume that the question deserves an answer when posed about a boulder, a misfortune, Mount Everest or the universe. Questions can be simply inappropriate, however heartfelt their framing.

Somewhere between windscreen wipers and tin openers on the one hand, and rocks and the universe on the other, lie living creatures. Living bodies and their organs are objects that, unlike rocks, seem to have purpose written all over them. Notoriously, of course, the apparent purposefulness of living bodies has dominated the reasoning of theologians from Thomas Aquinas to William Paley. For example, Paley, the 18th-century English theologian, asserted that if an object as comparatively simple as a watch requires a watchmaker, then far more complicated living creatures must certainly have been

“SURVIVAL MACHINES,” as the author describes living creatures, are engineered by natural selection to propagate DNA. The cheetah constitutes one of the most dramatic examples.

divinely designed. Modern “scientific” creationists also support this “argument from design.”

The true process that has endowed wings, eyes, beaks, nesting instincts and everything else about life with the strong illusion of purposeful design is now well understood. It is Darwinian natural selection. Darwin realized that the organisms alive today exist because their ancestors had traits allowing them and their progeny to flourish, whereas less fit individuals perished with few or no offspring. Our understanding of evolution has come astonishingly recently, in the past century and a half. Before Darwin, even educated people who had abandoned the “Why” question for rocks, streams and eclipses still implic-



PAT GREANY USDA



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itly accepted the legitimacy of the “Why” question where living creatures were concerned. Now only the scientifically illiterate do. But “only” conceals the unpalatable truth that we are still talking about an absolute majority of the world’s population.

Engineering a Cheetah

Darwin assumed that natural selection favored those individuals best fitted to survive and reproduce. This statement is equivalent to saying that natural selection favors those genes that replicate through many generations. Although the two formulations are comparable, the “gene’s-eye view” has several advantages that become clear when we consider two technical concepts: reverse engineering and utility function. Reverse engineering is a technique of reasoning that works like this: you are an engineer, confronted with an artifact you have found and do not understand. You make the working assumption that it was designed for some purpose. You dissect and analyze the object with a view to working out what problem it would be good at solving: “If I had wanted to make a machine to do so and so, would I have made it like this? Or is

the object better explained as a machine designed to do such and such?”

The slide rule, talisman until recently of the honorable profession of engineer, is as obsolete in the electronic age as any Bronze Age relic. An archaeologist of the future, finding a slide rule and wondering about it, might note that it is handy for drawing straight lines or for buttering bread. But a mere straight-edge or butter knife would not have

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needed a sliding member in the middle. Moreover, the precise logarithmic scales are too meticulously disposed to be accidental. It would dawn on the archaeologist that, in an age before electronic calculators, this pattern would constitute an ingenious trick for rapid multiplication and division. The mystery of the slide rule would be solved by reverse engineering, using the assumption of intelligent, economical design.

“Utility function” is a technical term not of engineers but of economists. It means “that which is maximized.” Economic planners and social engineers are rather like architects and physical engineers in that they strive to optimize something. Utilitarians strive for “the greatest happiness of the greatest number.” Others avowedly increase their own happiness at the expense of the common welfare. If you reverse-engineer the behavior of one country’s government, you may conclude that what is being optimized is employment and universal welfare. For another country, the utility function may turn out to be the continued power of the president, the wealth of a particular ruling family, the size of the sultan’s harem, the stability of the Middle East or the maintenance of the price of oil. The point is that more than one utility function can be imagined. It is not always obvious what individuals, firms or governments are striving to achieve.

Let us return to living bodies and try to extract their utility function. There could be many, but it will eventually turn out that they all reduce to one. A good way to dramatize our task is to imagine that living creatures were made by a Divine Engineer and try to work



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DIVERSITY OF LIFE reflects the innovative techniques that DNA exploits to maximize its survival. For example, a cheetah's leg muscles enable it to chase gazelles; gazelles, however, are well equipped to outrun cheetahs. In this life-and-death struggle, both animals strive to guarantee their survival and that of their DNA. Parasitic wasps seek to maximize survival of their DNA by preying on caterpillars: a female wasp lays an egg in a caterpillar paralyzed by her sting; after hatching, the wasp larva eats the caterpillar alive. Physical characteristics used in mating rituals are as specialized as those for hunting. Many birds, such as the Himalayan pheasant, and fish, including the Oriental sweetlips, display a kaleidoscope of color to attract mates and ensure reproduction of DNA. Plants, too, compete with others for an opportunity to reproduce. Tropical rain forests stretch toward the sky as each tree seeks more sunlight and a better chance of spreading seedlings.



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out, by reverse engineering, what the Engineer was trying to maximize: God's Utility Function.

Cheetahs give every indication of being superbly designed for something, and it should be easy enough to reverse-engineer them and work out their utility function. They appear to be well designed to kill gazelles. The teeth, claws, eyes, nose, leg muscles, backbone and brain of a cheetah are all precisely what we would expect if God's purpose in designing cheetahs was to maximize deaths among gazelles. Conversely, if we reverse-engineer a gazelle, we shall find equally impressive evidence of design for precisely the opposite end: the survival of gazelles and starvation among cheetahs. It is as though cheetahs were designed by one deity, gazelles by a rival deity. Alternatively, if there is only one Creator who made the tiger and the lamb, the cheetah and the gazelle, what is He playing at? Is He a sadist who enjoys spectator blood sports? Is He trying to avoid overpopulation in the mammals of Africa? Is He maneuvering to boost David Attenborough's television ratings? These are all intelligible utility functions that might have turned out to be true. In fact, of course, they are all completely wrong.

The true utility function of life, that

which is being maximized in the natural world, is DNA survival. But DNA is not floating free; it is locked up in living bodies, and it has to make the most of the levers of power at its disposal. Genetic sequences that find themselves in cheetah bodies maximize their survival by causing those bodies to kill gazelles. Sequences that find themselves in gazelle bodies increase their chance of survival by promoting opposite ends. But the same utility function—the sur-

Nothing can stop the spread of DNA that has no beneficial effect other than making males beautiful to females.

vival of DNA—explains the “purpose” of both the cheetah and the gazelle.

This principle, once recognized, explains a variety of phenomena that are otherwise puzzling—among them the energetically costly and often laughable struggles of male animals to attract females, including their investment in “beauty.” Mating rituals often resemble the (now thankfully unfashionable) Miss World pageant but with males parading the catwalk. This analogy is seen most clearly in the “leks” of such birds as grouse and ruffs. A lek is a patch of

ground used by male birds for displaying themselves in front of females. Females visit the lek and watch the swaggering demonstrations of a number of males before singling one out and copulating with him. The males of lekking species often have bizarre ornamentation that they show off with equally remarkable bowing or bobbing movements and strange noises. The words “bizarre” and “remarkable,” of course, reflect subjective value judgments. Presumably, lekking male black grouse, with their puffed-up dances accompanied by cork-popping noises, do not seem strange to the females of their own species, and this is all that matters. In some cases, female birds' idea of beauty happens to coincide with ours, and the result is a peacock or a bird of paradise.

The Function of Beauty

Nightingale songs, pheasant tails, firefly flashes and the rainbow scales of tropical reef fish are all maximizing aesthetic beauty, but it is not, or is only incidentally, beauty for human delectation. If we enjoy the spectacle, it is a bonus, a by-product. Genes that make males attractive to females automatically find themselves passed down to subsequent generations. There is only one

utility function that makes sense of these beauties: the quantity that is being diligently optimized in every cranny of the living world is, in every case, the survival of the DNA responsible for the feature you are trying to explain.

This force also accounts for mysteri-

ous excesses. For example, peacocks are burdened with finery so heavy and cumbersome that it would gravely hamper their efforts to do useful work—if they felt inclined to do useful work, which, on the whole, they don't. Male songbirds use dangerous amounts of

time and energy singing. This certainly imperils them, not only because it attracts predators but also because it drains energy and uses time that could be spent replenishing that energy. A student of wren biology claimed that one of his wild males sang itself literal-

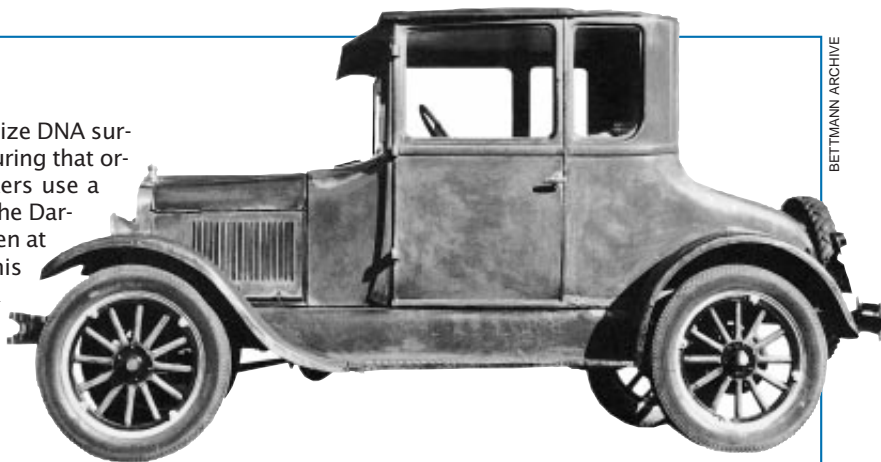
The Great Leveler

One way multicellular organisms maximize DNA survival is by wasting little energy on ensuring that organs survive indefinitely. Automobile makers use a similar approach when constructing cars. The Darwinian psychologist Nicholas Humphrey, then at the University of Cambridge, developed this particular analogy. Humphrey, in the book *Consciousness Regained: Chapters in the Development of Mind*, supposed that Henry Ford, the patron saint of manufacturing efficiency, once

...commissioned a survey of the car scrapyards of America to find out if there were parts of the Model T Ford which never failed. His inspectors came back with reports of almost every kind of failure: axles, brakes, pistons—all were liable to go wrong. But they drew attention to one notable exception, the *kingpins* of the scrapped cars invariably had years of life left in them. With ruthless logic Ford concluded that the kingpins on the Model T were too good for their job and ordered that in future they should be made to an inferior specification.

You may, like me, be a little vague about what kingpins are, but it doesn't matter. They are something that a motor car needs, and Ford's alleged ruthlessness was, indeed, entirely logical. The alternative would have been to improve all the other bits of the car to bring them up to the standard of the kingpins. But then it would not have been a Model T he was manufacturing but a Rolls-Royce, and that was not the object of the exercise. A Rolls-Royce is a respectable car to manufacture, and so is a Model T—but for a different price. The trick is to make sure that the whole car is built either to Rolls-Royce specifications or to those for the Model T. If you make a hybrid car with some components of Model T quality and some components of Rolls-Royce quality, you are getting the worst of both worlds, for the car will be thrown away when the weakest of its components wears out, and the money spent on high-quality components that never have time to wear out is simply wasted.

Ford's lesson applies even more strongly to living bodies than to cars because the components of a car can, within limits, be replaced by spares. Monkeys and gibbons make their living in the treetops, and there is always a risk of falling and breaking bones. Let's say we commissioned a



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MODEL T was not made to run forever, so it would have been foolish to waste money on indestructible parts.

survey of gibbon corpses to count the frequency of breakage in each major bone of the body. Suppose it turned out that every bone breaks at some time or another with one exception: the fibula (the calf bone that runs parallel to the shinbone) has never ever been observed to break in any gibbon. Henry Ford's unhesitating prescription would be to redesign the fibula to an inferior specification, and this is exactly what natural selection does, too. Mutant individuals with an inferior fibula, whose growth rules called for diverting precious calcium away from the fibula, could use the material saved to thicken other bones in the body and so reach the ideal of making every bone equally likely to break. Or these individuals could use the calcium saved to make more milk and so rear more young. Bone can safely be shaved off the fibula, at least up to the point where it becomes as likely to break as the next most durable bone. The alternative—the "Rolls-Royce solution" of bringing all the other components up to the standard of the fibula—is harder to achieve.

Natural selection favors a leveling out of quality in both the downward and upward directions until a proper balance is struck over all parts of the body. Seen from the perspective of natural selection, aging and death from old age are the grim consequences of such a balancing act. We are descended from a long line of young ancestors whose genes ensured vitality in the reproductive years but made no provision for vigor in later years. A healthy youth is crucial to ensure DNA survival. But a healthy old age may be a luxury analogous to the superior kingpins of the Model T.

—R.D.



GIBBON, too, was designed—by natural selection—with no indestructible parts.

E. R. DEGGINGER Animals, Animals

ly to death. Any utility function that had the long-term welfare of the species at heart, or even the individual survival of a particular male, would cut down on the amount of singing, the amount of displaying, the amount of fighting among males.

Yet when natural selection is also considered from the perspective of genes instead of just the survival and reproduction of individuals, such behavior can be easily explained. Because what is really being maximized in singing wrens is DNA survival, nothing can stop the spread of DNA that has no beneficial effect other than making males beautiful to females. If some genes give males qualities that females of the species happen to find desirable, those genes, willy-nilly, will survive, even though the genes might occasionally put some individuals at risk.

Humans have a rather endearing tendency to assume that "welfare" means group welfare, that "good" means the good of society, the well-being of the species or even of the ecosystem. God's Utility Function, as derived from a contemplation of the nuts and bolts of natural selection, turns out to be sadly at odds with such utopian visions. To be sure, there are occasions when genes may maximize their selfish welfare by programming unselfish cooperation or even self-sacrifice by the organism. But group welfare is always a fortuitous consequence, not a primary drive.

The realization that genes are selfish also explains excesses in the plant kingdom. Why are forest trees so tall? Simply to overtop rival trees. A "sensible" utility function would see to it that they were all short. Then they would get exactly the same amount of sunlight with far less expenditure on thick trunks and massive supporting buttresses. But if they all were short, natural selection could not help favoring a variant individual that grew a little taller. The ante having been upped, others would have to follow suit. Nothing can stop the whole game from escalating until all

trees are ludicrously and wastefully tall. But it is ludicrous and wasteful only from the point of view of a rational economic planner thinking in terms of maximizing efficiency rather than survival of DNA.

Homely analogies abound. At a cocktail party, everybody talks themselves hoarse. The reason is that everybody else is shouting at the top of their voices. If only everyone could agree to whisper, they would hear one another exactly as well, with less voice strain and less expenditure of energy. But agreements like that do not work unless they are policed. Somebody always spoils it by selfishly talking a bit louder, and, one by one, everybody has to follow suit. A stable equilibrium is reached only when

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everybody is shouting as loudly as they physically can, and this is much louder than they need from a "rational" point of view. Time and again, cooperative restraint is thwarted by its own internal instability. God's Utility Function seldom turns out to be the greatest good for the greatest number. God's Utility Function betrays its origins in an uncoordinated scramble for selfish gain.

A Universe of Indifference

To return to our pessimistic beginning, maximization of DNA survival is not a recipe for happiness. So long as DNA is passed on, it does not matter who or what gets hurt in the process. Genes don't care about suffering, because they don't care about anything.

It is better for the genes of Darwin's wasp that the caterpillar should be alive, and therefore fresh, when it is eaten, no matter what the cost in suffering. If Nature were kind, She would at least

make the minor concession of anesthetizing caterpillars before they were eaten alive from within. But Nature is neither kind nor unkind. She is neither against suffering nor for it. Nature is not interested in suffering one way or the other unless it affects the survival of DNA. It is easy to imagine a gene that, say, tranquilizes gazelles when they are about to suffer a killing bite. Would such a gene be favored by natural selection? Not unless the act of tranquilizing a gazelle improved that gene's chances of being propagated into future generations. It is hard to see why this should be so, and we may therefore guess that gazelles suffer horrible pain and fear when they are pursued to the death—as many of them eventually are.

The total amount of suffering per year in the natural world is beyond all decent contemplation. During the minute that it takes me to compose this sentence, thousands of animals are being eaten alive, many others are running for their lives, whimpering with fear, others are being slowly devoured from within by rasping parasites, thousands of all kinds are dying of starvation, thirst and disease. It must be so. If there is ever a time of plenty, this very fact will automatically lead to an increase in population until the natural state of starvation and misery is restored.

In a universe of electrons and selfish genes, blind physical forces and genetic replication, some people are going to get hurt, other people are going to get lucky, and you won't find any rhyme or reason in it, nor any justice. The universe that we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil and no good, nothing but pitiless indifference. As that unhappy poet A. E. Housman put it:

For nature, heartless, witless nature
Will neither care nor know

DNA neither cares nor knows. DNA just is. And we dance to its music.

The Author

RICHARD DAWKINS, an Englishman, was born in Kenya in 1941. Educated at the University of Oxford, he completed his doctorate in zoology under the Nobel Prize-winning ethologist Niko Tinbergen. After two years on the faculty of the University of California, Berkeley, Dawkins returned to Oxford, where he is now a reader in zoology and a fellow of New College. Dawkins is well known for his books *The Selfish Gene* and *The Blind Watchmaker*. His next book, *Climbing Mount Improbable*, will be published by W. W. Norton in the spring of 1996. Dawkins will soon take up the newly endowed Charles Simonyi Chair of Public Understanding of Science at Oxford.

Further Reading

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EVOLUTION. Mark Ridley. Blackwell Scientific Publications, 1993.
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