

Virovolution

*To the memory of Terry Yates, for the courtesy
and generosity of his help and the inspiration
that gave rise to this life-changing journey.*

FRANK RYAN

Virovolution

**The most important
evolutionary book since
Dawkins' Selfish Gene**



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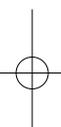
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contents

Acknowledgements	vii
Introduction: A Wind of Change	1
1: An Enigma from the World of Plagues	9
2: A Crisis in Darwinism	28
3: The Genetic Web of Life	50
4: The AIDS Dimension	72
5: The Paradox of the Human Genome	100
6: How Viruses Helped Make Us Human	130
7: The Implications for Medicine	155
8: The Autoimmune Diseases	178
9: Cancer	201
10: The Wider Dimension	223
11: Sex in the Evolutionary Tree	242
12: Are We Polyploid?	268
13: The Genie that Controls the Genes	292
14: The Coming Epiphany	319
15: At Journey's End	345
Glossary of Terms	357
References	362
Index	377



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Virolution

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Science knows no country because it is the light that illuminates the world.

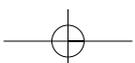
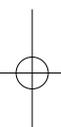
LOUIS PASTEUR

Like science, emerging viruses know no country. There are no barriers to prevent their migration across international boundaries or around the 24 time zones.

RICHARD M KRAUSE

A relatively small number of investigators have been pre-occupied with the biology of viruses ... and how they tick; these scientists are more sensitive to the ... evolution of their symbiotic relations with their hosts.

JOSHUA LEDERBERG¹



introduction

A Wind of Change

I am quite sure that our views on evolution would be very different had biologists studied genetics and natural selection before and not after most of them were convinced evolution had occurred.

JBS HALDANE¹

In the opening line of his celebrated book, *The Ascent of Man*, Jacob Bronowski declared that ‘man is a singular creature. He has a set of gifts which make him unique among the animals.’ Putting aside the now outmoded sexual conventions implicit in his terminology, our natural instinct is to believe he was right. Surely we humans are unique. We are unique in recognising, at sentient level, our own existence. We have risen above the other animals in the landscape so that, for good or for bad, we now shape and control that landscape. But does this intellectual uniqueness mean that we are so radically different that we should be set apart from all other life in our evolutionary origins, which have governed the very nature of our beings?

Virolution

When, on 12 February 2001, two rival organisations announced simultaneously that they had completed the first comprehensive analysis of the human genome, surely this would have confirmed any such purported uniqueness of our human nature. Here, laid bare, for the first time in our history, was the complete library of our genes, the make-up of the 46 chromosomes that make us human. Alas, of any purported uniqueness it registered little. Nevertheless, it was remarkable for what it did reveal.

The first surprise was the modest size of the human genome, at about 20,000 genes. We had anticipated that our human complexity would have demanded 100,000, or more. To put it into perspective, we have only ten times as many genes as a bacterium, a third more than a fruit fly and not many more than a nematode worm. It seems that, at least in quantity of genomic memory, we are not vastly more complex than these humble life forms, though our genome is far more complex in the way we convert genes to proteins, so we can code for a great many more proteins with the same number of genes. Most revealing of all was the confirmation of our common inheritance with other forms of life on Earth. For example, we share 2,758 of our genes with the fruit fly, 2,031 with the nematode worm – indeed, all three of us, human, fly, and worm, have 1,523 genes in common.

While some of my readers might feel humbled by this news, I suspect that Darwin would have been exhilarated because he would have realised that this shared inheritance could not have arisen by chance. We are familiar with the extreme accuracy of genetics in forensic science where a small piece of genetic coding can prove that a certain individual,

Introduction

and nobody else, committed a crime. To have 1,523 whole genes in common is rather more conclusive evidence – I could not even begin to calculate the order of the odds of this happening by chance, whether billions or trillions to one. And this touches upon the reasons why evolutionary biology is among the most fascinating and important of the sciences, and indeed generally of human endeavours: it alone seeks, through the application of logic and experiment, to understand the origins of life, from its beginnings in such humble and terrible surroundings as existed on our newborn planet, to the beautiful and beguiling diversity we see on our fecund blue world today.

There are other great mysteries in the universe, for example in the forces of astronomy and in the minuscule yet equally wonderful world of particle physics, yet no other scientific study sets out to explain how, for example, we shapers-of-the-landscape came to be. The religiously devout may disagree, in attributing life to the creation of an omnipotent creator, but this viewpoint does not derive from science but from the application of faith. In my view, religion and science are based on different belief systems, and they ask quite different questions of those belief systems, so that little is to be gained in such comparative argument. But in one respect I will highlight an aspect I believe to be important. Creationists, including those proposing the anti-evolutionary philosophy of intelligent design, will proclaim that evolution is based upon a theory – Darwin's concept of natural selection – so that, ultimately, the reality of evolution cannot be taken as proven. From this perspective, natural selection will never be capable of absolute proof, since a theory is a

Virolution

construct in logic, not fact. This view prevails among creationists in spite of the fact that scientists have subjected natural selection to remorseless experiment for some 150 years, and it has emerged ever victorious. Yet even here, at the very heart of such passion and division, I believe that a broader perspective is emerging, which is part and parcel of the wind of change blowing through evolutionary biology, and this is capable of offering the hard and irrefutable evidence needed.

Evolutionary theory has profound implications for society, as can be seen in the broad and diverse literature relating it to the humanities. Take the statement of the distinguished French biologist, Jacques Monod, who shared the Nobel Prize with fellow Frenchman, François Jacob, for work on the way living organisms control the production of proteins from their coding genes. In his book, *Chance and Necessity*, he made the telling statement... ‘Even today a good many distinguished minds seem unable to accept or even to understand that from a source of noise natural selection could quite unaided have drawn all the music of the biospheres.’ Monod’s book was published in 1970, ironically coinciding with first publication of the pioneering views of Lynn Margulis on the critical importance of symbiosis in the origin of nucleated cells, and of Susumu Ohno on the inevitability of gene and genomic duplication in the origin of animals and plants.

I’m an admirer of Monod and his contribution to biology. But in evolutionary terms his viewpoint was exclusively reductionist and selectionist. Like most of his contemporaries, he believed that evolution took place through the

Introduction

action of natural selection on a single source of genetic change, mutation. Since the contribution of mutation was essentially random, its role was non-creative – he even uses the term “informationless”. This is what he refers to as “noise”, a metaphor for random genetic change comparable to the static one hears on a radio. Only when the meaningless static – the random mutations – are moulded by natural selection, does meaningful sound emerge. I very much doubt that anybody has ever captured the zeitgeist of Modern Darwinism better. It is a seductive argument, beautifully amenable to the mathematical extrapolations of calculus in analysing selective fitness and population dynamics. How could it be wrong?

In fact it was not wrong – it was simply a part, and not the remarkable whole, of the story. The humanities have been heavily swayed by such reductionist thinking, which is often, if understandably, misquoted as “nihilistic” in the rebuffs of angry creationists. In this book I shall paint a very different perspective of evolution than selection working on informationless noise. The core message of this book is that mutation – what Monod has so brilliantly conceptualised – is not the exclusive source of genetic, or, for that matter, genomic variation. It is my intention to prove, from an entirely scientific standpoint, that natural selection alone could not have given rise to the evolution of life, and its subsequent diversity, for it depends on a number of driving forces, each of which is an important source of heritable genetic change, and without which selection would achieve nothing. Great evolutionary forces, such as symbiosis and hybridisation, are of vital importance to the variation that Darwin so desperately

Virovolution

needed, and they invoke a creativity that is very different from, and far more powerful than, meaningless static. Indeed, they bring to their respective genomic unions novel combinations of meaningful pre-formed genes, to create virgin genomes with enhanced potential for survival. Our understanding of these other forces of evolution has been growing over the last decade or two, until, today, we can see that they too have played, and are still playing, important roles that taken together are equal with, and essentially complementary to, natural selection. This important and rapidly growing field of knowledge has never been drawn to public attention. In this book I shall show how these various driving forces are not theory but fact, which can be confirmed and thus proven with the tools of modern science – indeed, they can be confirmed, repeatedly and predictably, with far greater certainty than that of the forensic scientist with his or her DNA confirmation of guilt or innocence.

Through this new window of exploration, I shall set out to prove beyond all reasonable doubt that evolution is real and ongoing.

The most astonishing implication of this new perspective is the light it throws on our own human evolution, which is proving to be stranger, a mystery more fantastic than anybody could have predicted even a generation ago. Moreover, the new evolution is eminently practical, not only for the light it sheds on our human origins but also for the real understanding it offers in terms of our embryological development, our physiology, genetics and internal chemistry. This is of great personal interest to me, both as a physician and as an evolutionary biologist, since it brings into focus key lines

Introduction

of research and thinking I have been developing over the course of many years. In the world of modern medicine, with its growing understanding at the molecular level and its increasing potential for genetic therapy, we need to know how our normal genes work as part of the machinery of the nucleus and its component chromosomes, which, all added together, make up the complex whole of our human genome. To know this is to deconstruct the mechanisms that made it. How else can we achieve this other than through understanding the mystery of our human evolution?

In *Virovolution* I invite you to accompany me on rather an unusual journey – a new and, I believe, highly original exploration of the genetic and genomic forces that constructed our human genome. For me, as a doctor as well as an evolutionary biologist, it has been gratifying to discover major new implications for medicine along this journey, insights that offer important understanding of the genetic underpinning of a great many important and common diseases, including cancer, the autoimmune diseases, multiple sclerosis, and mental illnesses, such as schizophrenia. Indeed, for me the journey also has an additional personal interest, one that began with a more conventional, if harrowing, interest in the nature of plagues, but which, thanks to the inspiration and assistance of informed colleagues, led me to follow new lines of scientific investigation and then to propose some relevant ideas of my own. I hope you will enjoy the vignettes about how this happened and that you will find the new ideas stimulating in themselves as well as helpful to understanding. Welcome then to an exciting odyssey, one you may find exotic, even a little scary at times, but at journey's end I believe that



Virovolution

you will be thrilled, and perhaps even a little awed, by the powerful forces that made us, and that are still actively working within us, as we continue to evolve as a species.

