The Mathematical Universe – An Alphabetical Journey Through the Great Proofs, Problems and Personalities

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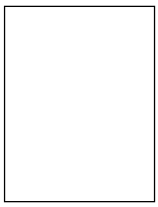

The Mathematical Universe – An Alphabetical Journey Through the Great Proofs, Problems and Personalities
William Dunham, John Wiley & Sons, Inc., 1994, p. 314 $16.95

Dunham has done it again! The author of the well known *Journey Through Genius* [1] has written yet another riveting book on mathematics and mathematicians. The earlier book was a journey into the world of mathematics through some of its great theorems; this time we are led into the universe of mathematics alphabetically. Of late, there have been several books written with the aim of exposing the layperson to mathematics. There seem to be two reasons for this. First, the noble reason of sharing the beauty and power of mathematics with the uninitiated, and second, the more practical one of ensuring that the tax payer continues to support research in mathematics, much of which he may have no use for and may not even understand! Whatever the reason, the spin off seems to be that, more often than not, we get well written books on mathematics.

[1] See K R S Sastry's review of this book in the August 1996 issue of *Resonance*.

Given the difficult task that Dunham has set himself – of giving an insight into mathematics – he has done an excellent job. Seeing the subtitle 'An Alphabetical Journey ...' one is tempted to think that the book goes 'A' for 'Archimedes, 'B' for Bernoulli and so on till we reach 'Z' for Zeno (do you know any great mathematicians starting with Y ?). However, Dunham has chosen a different path. He has decided to use the alphabets to decide on not only mathematicians but also topics and issues in mathematics. This leads Dunham to choose 'A' for 'Arithmetic', 'P' for the 'Prime Number Theorem' and 'W' for 'Where are the Women?' and so on. Although some of his choices seem highly contrived like 'K' for 'Knighted Newton', having accepted the restrictions the alphabet places on the choice for the title, Dunham manages to weave an intricate and coherent tale. He has chosen the topics in such an order that he is able to build up the required background to introduce a new topic, so that the book reads very easily and smoothly. The only glitch in terms of readability is (perhaps the fault of the publisher) very often the figure which goes with the explanation of a certain concept is on a different page, and one has to keep turning a page or two to follow the argument.

We now move on to a brief discussion on the contents of the book. Between the alphabets 'A' and ' Z', Dunham manages to cover a fair amount of mathematics. It is also interesting that he manages to do this with very little overlap with the mathematical content of his previous book. In number

theory (chapters A,E,F,O,P and J) he gives a thorough discussion on primes, from proving that there are infinitely many, to a feel for their distribution via the prime number theorem. He discusses famous problems like Fermats' last theorem (which was not yet settled when the book was published) and the twin prime conjecture. In Geometry (chapters C, E, G, H, I, O, S, T, X, Y and Z) he goes from elementary results like proving that the area of a circle is πr^2 to giving us a feel for why it is impossible to trisect an angle using only a straightedge and a compass. In chapter H he gives two different proofs of the Pythagoras theorem, one from the Chinese text *Chou Pei Suan Ching* and the other due to James Garfield, a former US President! Though this may surprise us looking at the politicians of our age, there seem to have been a few Presidents of the US who had an affinity for mathematics (Washington, Lincoln, Ulysses Grant and Garfield). He also discusses the isoperimetric problem, the Cartesian coordinates and the complex plane. In fact, chapter Z is one of my favourites, where he gives a very readable account on how complex numbers came into being. Apart from very classical topics, he also gives a brief introduction to probability theory (discussing the law of large numbers in the chapter entitled Bernoulli trials), calculus – both differential and integral, and issues in the foundations of mathematics (Russell's paradox). Chapter U is devoted to applications of mathematics.

In the process of developing concepts, we meet a variety of mathematicians –great ones like Archimedes, Euler, Gauss, Newton and Hilbert and some lesser gods like Bernoulli and Fermat. We enter their lives and are made to understand to some extent why these people were extraordinary. Dunham bemoans the fact that while most educated people would be able to recognize the names of Rembrandt and Bach, very few would have heard of Euler, whose work is no less astounding and beautiful.

While reading about the lives of great mathematicians, I have always wondered how it is that people like Newton, Bernoulli, Cauchy and many others who have had such extraordinary insight into mathematics had such little insight into their own psyche. In fact Dunham has the letter 'M' devoted to the rather tricky topic of 'Mathematical Personality', where agreeing with Polya, he tries to establish that mathematicians are both absentminded and eccentric!

Apart from mathematics and mathematicians, Dunham also ventures into some sticky ground, when he takes on topics like 'Where are the Women?' in chapter 'W'. Here he tries to examine why there have been very few women in the field of mathematics. He also takes on the issue of Eurocentrism[2], while dealing with the origins of mathematics in chapter 'O'. Although he does a decent job of giving non European origins their due, he could have perhaps devoted a larger part of his book to discussing not only classical contributions but also some more modern ones from these parts.

Needless to say, I strongly recommend that all students of mathematics read this book. For the lay person, this is an excellent exposure to mathematics. For the undergraduate student this book serves as an introduction to many beautiful results in mathematics and also an opportunity to learn about the rich history and human drama behind these facts. For the professional mathematician there are several historical facts and anecdotes, which would enrich his teaching enormously. One looks forward to Dunham writing another book taking on mathematics from this century and explaining it to a novice. Dunham has definitely managed to convey Sonya Kovalevskaya's feeling that mathematics "... is a science which demands the greatest imagination."

[2] See R Sridharan's review of the book *The Crest of the Peacock, Non-European roots of mathematics* by George Gheverghese Joseph in the June 1996 issue of *Resonance*.

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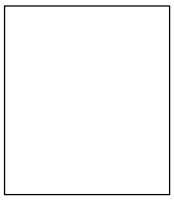
River Out of Eden[1]

Darwin Goes Digital: Old View, New Metaphor

J A Santosh



River out of Eden:
A Darwinian View of Life
Richard Dawkins
Phoenix, Orion Books, London, 1995.
p.196, UK £5.99

Two decades ago, Richard Dawkins unleashed *The Selfish Gene*, an intensely compelling book that reduced organisms to insignificant puppets animated by primeval strings of selfish genes. Just as Samuel Butler observed that a chicken was an egg's way of making another egg, Dawkins suggested that an organism existed only because genes had to make more genes. Organisms were mere carriers of genes from one generation to another. The logic was simple – all bodies die, all genes don't. Genes would survive and march the passage of geological time if they were good at building bodies capable of reproducing to leave more copies of those genes that would make more bodies to make more genes, ... *ad infinitum*. The concept progressed further in the sequel, *The Extended Phenotype*, which proposed that genes do not just manipulate bodies, but extend their control over the world around them shaping it to meet their own reproductive end. It was only incidental that the replicating molecules were packaged for transportation through time in multicellular throwaway wrappings called organisms!

[1] Note that the author of this book was erroneously mentioned as Stephen Jay Gould on p.77 of the January 1977 issue of *Resonance*. *Editor*

Dawkins, arguably the most forceful popular writer of neo-Darwinism, expounds his views with eager passion and unassailable logic. With the possible exception of the more rhetorical Stephen Jay Gould, he has done more than anyone to popularize the field of evolutionary biology. With its emphatic advocacy and clear reasoning, *River Out of Eden* is vintage Dawkins. Though, at first glance, the militant vigour of his former works appears a little toned down, the severity with which rival theories and ideas are admonished might suggest otherwise.

If you have not read Dawkins yet, this is a good book to start with before you move on to his meatier works. The book is smaller than any of its predecessors and is less technical. It stands, without doubt, at the popular extreme of the spectrum of all his writings. Devoid of jargon, the language is simple but yet maintains the emphasis and persuasion so typical of Dawkins. Further, the book assumes no advanced knowledge of biology, and examples abound to drive home the concepts. Those already familiar with Dawkins' concepts, will find this a nostalgic reinforcement of the gene's-eye view of life with varied and new substantiation. This book certainly has the potential to accommodate a wide readership ranging from the curious layman, through the novice biology-student, to die-hard evolutionary biologists.

Although Dawkins has conceptually nothing new to say, the book's central metaphor of the river is appealing in its simplicity and lucid in purpose. Introducing the analogy in the first chapter, *The Digital River*, from which the book borrows its title, Dawkins begins, "There is a river out of Eden, and it flows through time, not space. It is a river of DNA...." The analogy of the river to compare the flow of genetic information in species through time and through bodies serves well, on most counts. All individuals of a species have the same river flowing through them and new species come into existence when the river forks into two branches (caused by, say, geographical isolation of a population). Initially, the branches may remain close to each other allowing waters to mix (inter-breeding between individuals of the two populations), but if the rivers diverge further they may get too far to mingle (reproductive isolation). Some branches may dry up on the sands of extinction. Dawkins discusses the difference between analog and digital systems in their fidelities of information transfer, and maintains that Darwinism can be sustained only by a genetic system that is digital.

The second chapter, *All Africa and Her Progenies,* details the logic of the existence of *Mitochondrial Eve*. For those, like me, more familiar with that phrase than the concept, this is an excellent place to understand the deduction. Using the example of the rate of change in the nucleotide sequence of the protein cytochrome *c*, calculation of evolutionary distances between species is

discussed with such simplicity, that the rationale of using molecular clocks becomes glaringly obvious. *Do Good by Stealth*, the third chapter, is partially an attack on creationism (no book by Dawkins is complete otherwise). Creationists commonly attack gradualism in evolutionary theory by arguing that complex structures, organs or behaviour-patterns that exist in nature could have arisen only instantaneously (created), as intermediate half-formed stages would have been useless. Using examples of orchids, man, sticklebacks, gulls and turkeys, Dawkins obliterates that notion and points to plausible pathways to the evolution of the eye, bee-dances and wasp-shaped orchids. The fourth chapter, *God's Utility Function*, explains how a gene-centered view shows that nature is neither cruel nor caring, but only indifferent, to the phenotype. The utility function (an economist's term meaning 'that which is maximized') of life is 'DNA survival'. The last chapter, *The Replication Bomb*, talks about the possible origin and future of self-replicating molecules. Dawkins takes us through the many thresholds that life has passed through during the course of evolution, and suggests a possible crossing of the next threshold of inhabiting the solar system through space travel. All in our genes!

The river metaphor contains a trivial inconsistency. New branches *leave* Dawkins' evolutionary river as it flows through time and these may eventually have other branches *leaving* them. Many real branches of water (tributaries) often do not branch away from a river; they start off by themselves, get bigger before *joining* a main river which might *join* a bigger river. The River Out of Eden flows in the reverse direction! As a metaphor, The Tree of Life, more deeply rooted in history, might still stand taller.

In conclusion, *River Out of Eden* is a simple summary of Dawkins' central proposition that genes are the only units that really matter in evolution and that they transcend the significance of the organism. The book hints at a unifying theory of evolution which argues that all of life's grandeur boils down to the process of digital-information transfer. Dawkins at his reductionist best. If you like work-outs at cerebral gyms, this book has weight.

Suggested Reading

Gould S J. Caring groups and selfish genes. In Gould S J. *The Panda's Thumb*. W W Norton. New York, 1980.

Gould S J. What happens to bodies if genes act for themselves? In Gould S J. *Hen's Teeth and Horses Toes.* W W Norton. New York, 1983.

Dawkins R. *The Blind Watchmaker*. W W Norton. New York, 1986.

Dennett D C. *Darwin's Dangerous Idea.* Simon & Schuster. New York, 1995.

(Note: Books by W W Norton are available with Penguin Books in India.)

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