Chapter 1

Origins: Prelude to the Journey

"*There was nothing in the idea of evolution; rock pigeons were what rock pigeons always had been*"

Wilberforce, 1860

During the debate on evolution which took place at a meeting for the British Association for the Advancement of Science in Oxford, June 1860, Bishop Wilberforce turns to Thomas Huxley: "Sir, is it on your grandfather's or your grandmother's side that you claim descent from a monkey?" Famously Huxley replied that he would sooner have an ape for an ancestor than accept the dogma of the church. This much mythologised altercation took place a year after the publication of Darwin's *Origin of Species*. Up until this time, the Judeo-Christian account of creation had dominated Western thought and Darwin's impacting new theory posed a significant threat to the Anglican Church, establishing the autonomy of Science. Darwin's theory of evolution grew in strength throughout the early 20th century with expressions of it being evident in literature, philosophy and social policy. Some sectors of the Church were to assimilate the secular aspects of his theory into their doctrines, but others remained staunchly opposed and an undercurrent of dissention remains even in the present day.

All thinking people were required to have an opinion on the subject of creation and even as late as the 1920's and 1930's students seeking admission to Cambridge University had to satisfy the examiners in a paper called "Paley's Evidences". My first sight of such

papers came from my father's documents — he was a Senior Scholar in Mathematics at Trinity College Cambridge from 1930 to 1933. William Paley (1743–1805) was a theologian and philosopher whose influence prevailed over the intellectual world for over two centuries. In his treatise *Natural Theology*, Paley introduced the renowned image of the "watch (that) must have a maker" to expound a teleological argument for the existence of God. The tenor of his work was almost scientific and quite distinct from the doctrines of a miraculous creation. He looked at the intricate workings of the natural world and conjectured that such perfection must imply the work of a Creator: "The marks of design are too strong to be got over. Design must have a designer. The designer must have been a person. That person is GOD".

Darwin was familiar with the writings of Paley, "the logic of ... Natural Theology gave me as much delight as did Euclid", and his own works echo Paley's style and methodology. Both men sought to explain evolution in terms of mechanistic, natural processes, albeit to different ends. Where Paley would always revert to metaphysics to explain the first cause, Darwin remained elusive. Indeed in this respect the title of his *Origin of Species* is somewhat misleading, as he traces the evolutionary processes that led to the fact of Man, but seems to slide away from looking into the causes of the first stirrings of life. However, in a landmark letter to Hooker in 1871, he writes:

> "*It is often said that all the conditions for the first production of organisms are now prevalent which could ever have been present. But if* (*and oh! What a big if!*) *we could conceive in some warm little pond, with all sorts of ammonia and phosphoric salts, light, heat, electricity, etc. present, that a protein compound was chemically formed ready to undergo still more complex changes. At the present such matter would be instantly devoured or absorbed, which would not have been the case before living creatures were formed.*"

It is interesting that Darwin, who never relished the prospect of being viewed as anti-establishment, chose the intimate medium of a letter

to put forward his views on the origins of life. And the idea expressed here marks the beginnings of the primordial soup theory of life's origins that came to govern scientific thinking throughout much of the 20th century.

By 1939, the year of my birth, the primordial soup theory had gained so much credence that it was the only scientific way of looking at the problem of the origin of life. Indeed science proudly considered it to be a problem solved. The scientists Oparin and Haldane had set the ground rules for discussions of this theory that life on Earth originated on Earth. Recognising that the production of organic molecules in the present-day atmosphere of the Earth was unlikely, Oparin and Haldane argued for a hydrogen-rich primordial atmosphere in which the organic molecules required for the origins of life would be formed. The process first required the break-up of inorganic gas molecules such as water, methane and ammonia into reactive fragments or radicals through the action of solar ultraviolet light and electric discharges. Next, the radicals recombine through a cascade of chemical reactions, and in this process a trickle of organic molecules is formed. Such molecules, which are the chemical building blocks of life, then rain down into the primitive oceans forming a dilute primordial soup. It is from such a soup, through a multitude of chemical reactions over millions of years, that life is supposed to have begun.

This model of life's origins had rapidly acquired popularity and kudos in the post-Darwinian era. Haldane, a distinguished geneticist, physiologist and philosopher was reputed also to possess great charisma which he employed successfully to popularise his theory which eventually came to be written into biology textbooks as irrefutable fact. The reasons for its success were multifarious — it reassured man to consider himself to be autonomous with terrestrial origins, and in an age where religious beliefs were dwindling, Science was stepping in to offer man a "logical" explanation of his origins. The only problem with the primordial soup theory was that it had no foundation in fact. In the 1920's and 1930's, there was no empirical basis whatsoever for its justification, and a judgement had to be made solely on aesthetic or philosophical grounds. For the Soviet scientist Oparin, an overall consistency of this theory with Marxist

materialistic ideologies appears to have been an important consideration. Haldane too had espoused Marxism in the 1930's and was for several years editor of the *Daily Worker*. In Haldane's chequered career he later became disillusioned with communism, as indeed with British imperialist policy, and in 1957 emigrated to India where he spent the rest of his days.

Retrospectively, I suspect that Haldane's communist leanings may have contributed to the alacrity with which Fred Hoyle embarked on our challenge of the Oparin–Haldane model in the 1970's. Fred Hoyle, though he came from working class parentage — his father was a wool merchant — was always a staunch supporter of British Conservative politics. His distrust of communism and Marxist philosophy may have added to his suspicion of theories — even scientific theories — that had sprung from such a system of thought. But his political leanings quickly became incidental in our opposition to the received theory of the origins of life — our bold refutation emerged as a natural outcome of our fervent interests in astronomy.

Whilst scientists in the modern age like to believe that their activities are always free of prejudice, such a position cannot be further from the truth. At the deepest level, science, particularly when it comes to fundamental questions such as the origins of life, is inextricably linked to cultural traditions. That includes political as well as religious prejudice. Although subconsciously ignored or sublimated they remain as invisible constraints.

Some aspects of my personal life are relevant to the thesis of this book only in so far as they connect to the remarkable story of my journey with a man who was amongst the most original and imaginative of scientists in the 20th century. My collaboration with Fred Hoyle from 1960 onwards led me, over four decades, to question one of the most cherished paradigms of science. We did not meet until the 21st year of my life. But the period of my life up to this time that was spent in my native land of Sri Lanka was a preparation for the unique adventure that was to follow.

My early years spent in Sri Lanka followed a more or less predictable course *vis-à-vis* my circumstances. Sri Lanka (Ceylon as it was then called) was an outpost of the British Empire, in many

ways overshadowed in importance by the neighbouring subcontinent of India. It is a fertile island of supreme versatility accommodating mountains, rain forests and beaches within its relatively small confines. The interest it held for its successive colonisers was, however, mostly commercial, in its precious stones, spices, coffee and later tea. The Dutch, the Portugese and the British prized this colony mostly for these commodities as well as for the strategic location of its natural harbours on sea routes to the Far East. Sri Lanka has a history stretching back over two millennia with sprawling sites of ancient ruins testifying to epochs of past splendour. However, four centuries of colonial domination had to a great extent left Ceylon demoralised in a state of national lethargy, and even its struggle for independence from Britain, which was achieved in 1948, was a pale shadow of the emotions expressed in the independence struggles of India.

In my earliest recollections Ceylon was an impoverished feudal society with a sharply visible division between rich and poor. The rich privileged class had access to good schools, whilst the poorer underclass was only minimally literate with limited access to education. The country was also sharply divided between the amenities available in a few major cities (e.g. Colombo, Kandy and Jaffna) and a multitude of villages of which the country was comprised. My own home was in the capital Colombo, and my school Royal College Colombo, established in 1838, was modelled on the traditions of the English Public School system. My teachers, specially in mathematics and physics, conveyed to me their own passion for these subjects, and were a source of inspiration in my formative years. I was lucky too in that my father was a talented mathematician who obtained the highest honours in this subject both in Ceylon and in the Mathematical Tripos in Cambridge, where he became a B star wrangler in 1933. Not only did I have this added source of stimulus at home but I was also surrounded by my father's collection of mathematical and astronomical books which included classics such as Eddington's *Mathematical Theory of Relativity* and Brown's *Lunar Theory*, not to mention an extensive popular list.

A benefit of living in Ceylon in the 1950's was that the environment was still pristine and unpolluted. There were no bright street

lights in the suburb where we lived and hardly any pollution from cars and buses, so that the pageant of the night sky was magnificently brilliant. We lived close to a beach by which a rail road ran connecting Colombo with smaller cities in the south. I would often walk along this beach in the evening, sometimes along the railroad sleepers, and watch the sun set over the Indian Ocean. I vividly recall my childhood experience of spectacular sunsets such as I have never since seen. Within minutes the sunset disappears into a wide black canvas overhead studded with millions of stars. Looking up at the myriads of stars that populate the Milky Way, contemplations about man's place in the universe were inevitable.

It is rare to see such a spectacle nowadays in our modern cities with their deplorable output of light pollution. Our inability to enjoy our natural heritage of the night sky leaves us far poorer, and also less able to make a connection between ourselves and the wider cosmos — a connection that was deeply felt by our ancestors.

Sri Lanka is steeped in Buddhist traditions and its influence is inescapable. The island is strewn with ancient temples and 2000 years of Buddhism literally permeates the land. Buddhist descriptions of cosmology that date way back to the early Christian era are distinctly post-Copernican. In a Buddhist text *Visuddimagga* (written in Sri Lanka in the 1st century AD) it is stated that:

> "*. . . as far the these suns and moons revolve shining and shedding their light in space, so far extends the thousand-fold universe. In it are thousands of suns, thousands of moons . . . thousands of Jambudipas, thousands of Aparagoyanas . . .*"

the latter being translated as meaning extraterrestrial abodes of life. The billions of galaxies of modern astronomy could be identified in statements found in other contemporary Buddhist texts which referred to the entire Universe as "this world of a million, million world systems". Such passages made a significant impact on me in my young years, and I noticed a striking similarity between these ideas and the ones expressed by James Jeans in his *Mysterious Universe*.

My resolve to study astronomy was strengthened by an astronomical event that was fortuitously connected with my homeland.

A total eclipse of the Sun, visible from Sri Lanka, was to take place on June 5, 1955. I was 16 at the time and my serious interest in science was just beginning to develop. Sri Lanka, which had hitherto been a scientific backwater, was suddenly transformed into a hive of professional scientific activity. This particular eclipse was to have the longest period of totality since AD 699 and several important scientific experiments were being planned. Scientists from Britain, USA, France, Germany and Japan all converged here and the local newspapers where full of news about these momentous scientific events. One experiment that was planned was a test of Einstein's Theory of General Relativity which predicts a bending of light by a small predictable amount (1.75 arc sec) as the light of a star passes close to a massive object like the sun. The project was designed to validate an experiment of a similar kind carried out by a team led by Eddington during the solar eclipse of 1919.

As a keen amateur photographer, I had set up my own experiment with a simple camera fixed at the end of a home-built telescope to capture the event. We were of course warned about the dangers of looking directly at the Sun, so at the appointed hour, we had our darkened glasses and basins of water in place to watch the progress of the eclipse. I watched with bated breath as the Moon slid ominously over the Sun's disc, casting an instant gloom over the landscape as in an impending thunderstorm. Then total darkness descended suddenly, lasting for an interminable seven minutes. There was a noticeable chill in the air and a denatured atmosphere. Lotuses began to fold their petals inwards, animals cowered and crows cawed wildly. The fabled spectacle of the solar corona with its outstretching flaming tongues was visible intermittently through transient clearings in a thin veil of drifting cloud. Then it was all over, the noon day sun mystically reappeared. I felt more than ever before the indomitable power of the cosmos.

As often happens with observations in astronomy, most of the observing teams in 1955 were disappointed because clouds intervened, but a few stations were able to make successful observations that led to new science. To a teenage admirer of science these events provided a thrilling experience. Science was happening at my own

doorstep, and the events of 1955 played no small part in my determination to pursue astronomy as a career.

Nowadays most students enter astronomy through undergraduate courses in physics, or physics and astronomy. When I asked around for advice on how one became an astronomer the answer I was given by informed persons, not least my father, was through mathematics. So I entered the University of Ceylon in 1957 as an entrance scholar in Mathematics and had set my sights on my father's old University, Cambridge, should things work out for me as I had hoped.

The transition from school to University was an easy one as I attended University from home. The University of Ceylon, Colombo was only 20 minutes away by bicycle or ten minutes by car. I took my three years of University studies in my stride, following most of the courses in applied mathematics, because I felt this was the most important tool for exploring the Universe. I was lucky to have some excellent teachers who inspired me. A person who influenced me greatly in those early years was the professor of mathematics C.J. Eliezer who was himself a distinguished Cambridge product, a former Fellow of Christ's College and a pupil of the illustrious physicist Paul Dirac, whose major success was to reconcile special relativity and quantum mechanics. Through Eliezer's lectures I obtained exciting insights into the theory of electromagnetism, a subject in which I was later to specialise. I did not realise at the time that Eliezer and Fred Hoyle were Cambridge contemporaries and that they both had associations with Dirac. Because of the connection between these three people — Dirac, Eliezer and Hoyle — it turned out by a really curious coincidence that Hoyle was to be the external examiner in mathematics for the University of Ceylon in the same year that I sat my final degree examination. It amused me later on to think that Fred would have read my examination scripts long before he ever set eyes on me.

In the summer of 1960, I graduated with First Class Honours in Mathematics and was awarded a Commonwealth Scholarship by the British Government to pursue postgraduate studies at Cambridge University. I applied for a place to do a PhD in Theoretical Astronomy at Trinity College, my father's old College, and I was

delighted to be accepted, and more so to be told that I would be supervised by Professor Fred Hoyle of St John's College who was Plumian Professor of Astronomy and Experimental Philosophy at the University of Cambridge. Whilst at the University of Ceylon I had already read two classic books by Hoyle: *Nature of the Universe* and *The Frontiers of Astronomy*, both of which had made an indelible impression on me. So when I received a handwritten letter from Fred Hoyle at my home in Colombo, recommending a list of books to read prior to coming to Cambridge in October 1960, I was naturally overjoyed.