UNRAVELLING OUR COSMIC ORIGINS

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A scientific and cultural revolution that is well under way is one that relates to our continuing attempts to understand our connection. A central figure in the story is a Sri Lankan-born British Astronomer Chandra Wickramasinghe, who has been a regular guest at this hotel. Together with the late Sir Fred Hoyle and a team of collaborators, colleagues and students over a period of 4 decades Chandra has transformed the way we think about ourselves and about life in the cosmos. An Earth-centred theory that life originated in a primordial soup on the Earth dominated science for nearly a century. This theory that was regarded as a natural extension of Darwin's theory of Evolution for over a century has finally given way to the theory of cosmic life the theory that was pioneered by Chandra Wickramasinghe. At long last we are beginning to recognise that we are truly creatures of the cosmos. Homo sapiens sapiens (Man) is a lifeform that has found a temporary home on planet Earth – this planet - Gaia, Terra firma, a planet we now know is very similar to billions of other planets the Milky Way.

SUMMARY OF KEY DISCOVERIES AND EVENTS

The basic idea of life being a cosmic phenomenon has a long history. Its earliest recorded roots go back to a time in ancient India and to the Vedas nearly 4000 years ago. The idea of life being cosmic rested uneasily in Western culture, both before and after the advent of Judeo-Christian ideas. The first clear articulation of the concept of panspermia due the Greek pre-Socratic philosopher Anaxoragas was vigorously refuted by Aristotle two centuries later, replacing it with the idea of spontaneous generation – life emerging "readily" from non-life whenever and wherever the right conditions prevailed.

Firm scientific/logical rejections of "spontaneous generation" began in the 19th century BCE with the laboratory work of Louis Pasteur that will be described later. The chronology of the rejection of spontaneous generation and its replacement with panspermia is summarised below:

- 5th century BCE: Anaxoragas introduced the concept of Panspermia and life as a cosmic phenomenon into Western culture
- 3rd century BCE: Aristotle rejects Panspermia and advances the rival concept of Spontaneous Generation
- 3rd century BCE to 19th century CE: Spontaneous Generation remains the dominant world view, having received the blessings of Christendomn over a broad front.

- 19th century CE: Louis Pasteur and Lord Kelvin, Svante Arrhenius among others attempt to revive panspermia, but the dominance of Spontaneous Generation as the approved concept remains.

- 1962-2022: Chandra Wickramasinghe, Fred Hoyle and their collaborators continue to amass evidence to support Panspermia from disciplines as diverse as astronomy, geology, epidemiology, gene sequencing studies.

- 1962: Chandra Wickramasinghe and Fred Hoyle show that interstellar dust in our galaxy is made mostly of the element carbon, first proposing the idea of soot-like dust grains.

- 1974: Chandra Wickramasinghe introduces the idea of organic polymers in cosmic dust

- 982: Chandra Wickramasinghe and colleagues show that the infrared absorption properties of inter-stellar dust are indistinguishable from desiccated bacteria.

- 1982: Fred Hoyle and Chandra Wickramasinghe propose the theory of cometary panspermia – comets as the repositories of bacterial and viral genes throughtout the Universe.

- 1986: Observations of Halley's comet on its return to perihelion shows evidence of surprisingly dark surface (blacker than coal) and dust tails with spectral properties of bacteria.

- 2001: Completion of Human Genome Project shows viruses make up a large fraction of our DNA, consistent with viruses from space controlling genetic evolution.

- 2002: First recoveries of stratospheric bacteria from 41km shows tonnes of bacterial material falling on the entire planet every day.

- 2013: Rosetta Mission to Comet 67P/C-G shows consistency of surface properties of the comet with bacterial dust.

WE CAME FROM SPACE

Our hominid ancestors roamed the surface of the Earth for a very long time, the first hominids inhabiting eastern Africa some 5-7 million years ago. The first modern humans walked out of Africa as hunter-gatherers just 70,000 years ago at a time when the total population was perhaps no more than about a million. When our ancestors then turned from being hunter-gatherers to take up an agrarian way of life and the first cities developed, they may have had more leisure to contemplate the deepest issues of our existence. The unpolluted night skies that greeted them at this time would have been spectacular and the scene was thus set for our long struggle to understand our cosmic origins.

What scientists accept today without any dissent is that we are all star-stuff. Every atom of carbon, oxygen, nitrogen and metal of which we are made was synthesised by nuclear reactions taking place in stars. This definite knowledge was obtained in the 1950's largely from the work of the British astronomer Fred Hoyle, who was working at the time with nuclear physicist Willy Fowler and astronomers Margaret and Geoffrey Burbidge.

Ten years later Fred Hoyle began his monumental work with Sri Lankan-born British astronomer Chandra Wickramasinghe and showed in 1961 that the gigantic clouds of dust that are seen as dark patches against the background of stars in the Milky Way are made mostly of the element carbon – which they first conjectured might resemble soot particles. A further decade on in the 1970's new astronomical data and new calculations by Chandra and Fred Hoyle led to the stark conclusion that the dust in space has an organic composition with properties uncannily similar to dried-out bacteria in the laboratory. When in 1986 Comet Halley was found to have a dust tail with exactly the same emission properties as heated bacteria, the theory of Cometary Panspermia was launched. This led immediately to an urgent need to revisit the problem of the origin of life on Earth and in the Universe. Deeply entrenched dogmas concerning this question had to be reassessed in the light of new discoveries in science.

Every textbook in biology began and still begins with the confident assertion that life originated on Earth in a primordial soup of organics at its surface perhaps some 4.2 billion years ago. This time in Earth's history is now established as the first moment after it had formed from the coalescing of smaller asteroids, when water could have existed at the surface – water that was almost certainly delivered by the impacts of comets. It is in rocks that formed on the Earth at precisely this time (Jack Hills formation, now exposed in Australia) that the first hint of bacterial life has been recently discovered. How these first bacteria originated still remains an unsolved mystery, a mystery because even the simplest bacterium is an incredibly complex system. Assessing the mind-blowing complexity of stringing together a basic set of functional biomolecules, the enzymes, we can quickly arrive at probabilities like 1 in 10^500 – odds that have been compared most graphically to a tornado blowing through a junk yard assembling a fully functioning jet aircraft! Notwithstanding such insuperable difficulties the accepted scientific dogma is that a primordial soup on the Earth, even against incredible odds must somehow have generated the first life, life that thereafter evolved and diversified into the magnificent panorama of life we find around us today.

This theory of life's origins known as "spontaneous generation" can be traced back to the Greek philosopher Aristotle in the 3rd century BCE. Aristotle argued that given the right conditions and the right mixtures of non-living ingredients, life arises spontaneously. He cites the phenomenon of "fireflies emerging from a mixture of warm earth and morning dew" as supportive evidence for his thesis, and there are many more which all collapse under closer scrutiny. The Aristotlean doctrine was taken up with much enthusiasm by later Christian theologians who adapted it to suit their own narrative – "God said let there be light and there was light".

For whatever reason the spontaneous generation of life came to be securely established in Europe right through to modern time. Despite the most valiant attempts to generate life from non-life in the most advanced scientific laboratories in the world no progress has been made, and this is to be expected on the basis of the probability argument to which we have already referred.

After the DNA of humans and other lifeforms came to be sequences after 2001, the role of viruses (retroviruses) in evolution came to be unravelled. One of the many surprises that followed was the discovery that what was once considered "junk DNA" actually had a viral origin. Perhaps as much as 30% of our DNA consists of retroviral sequences (endogenous retroviruses, ERVs) - RNA viruses that have reverse transcribed their RNA into DNA. These are the relics of ancient viruses of cosmic origin that may have actually contributed to our evolution over hundreds of millions of years – and they clearly disprove the belief that cosmic viruses cannot be the cause of pandemic disease.

The origins of ideas relating to life as a cosmic phenomenon, and indirectly to cometary panspermia, could arguably stretch back over thousands of years:

For instance, Gautama Buddha (born 564BCE) said:

"As far as these suns and moons revolve, shedding their light in space, so far extends the thousand-fold world system. In it there are a thousand suns, a thousand moons, a thousand inhabited Earths and a thousand heavenly bodies …." Anguttara Nikaya Sutta

The pre-Socratic Greek philosopher Anaxoragas (born 500BCE) stated:

"….Seeds of life are carried across the cosmos and take root wherever they fall on fertile soil……"

Metrodorus of Chios (331-277BCE). wrote thus –

"It is unnatural in a large field to have only one shaft of wheat and in the infinite universe only one living world……"

Strong experimental evidence in support of panspermia, and a disproof of spontaneous generation began to emerge from the latter part of the 19th century. A key figure in this process was the French scientist Louis Pasteur (1822-1895) who carried out a series of experiments on fermentation in the 1860's and concluded:

Omne vivum e vivo—all life is from life.

This marked a significant set-back for spontaneous generation, although a dogmatic adherence to it persisted and still continues to have stranglehold on science. German physicist Hermann von Helmholtz (1821-1894), who was immediately impressed by the experiments of Pasteur, wrote thus:

"It appears to me to be fully correct scientific procedure, if all our attempts fail to cause the production of organisms from non-living matter, to raise the question whether life has ever arisen, whether it is not as old as matter itself, and whether seeds have not been carried from one planet to another and developed everywhere where they have fallen on fertile soil…"

Similarly, Lord Kelvin (William Thomson) (1824-1907) declared:

"Dead matter cannot become living without coming under the influence of matter previously alive. This seems to me as sure a teaching of science as the law of gravitation……".

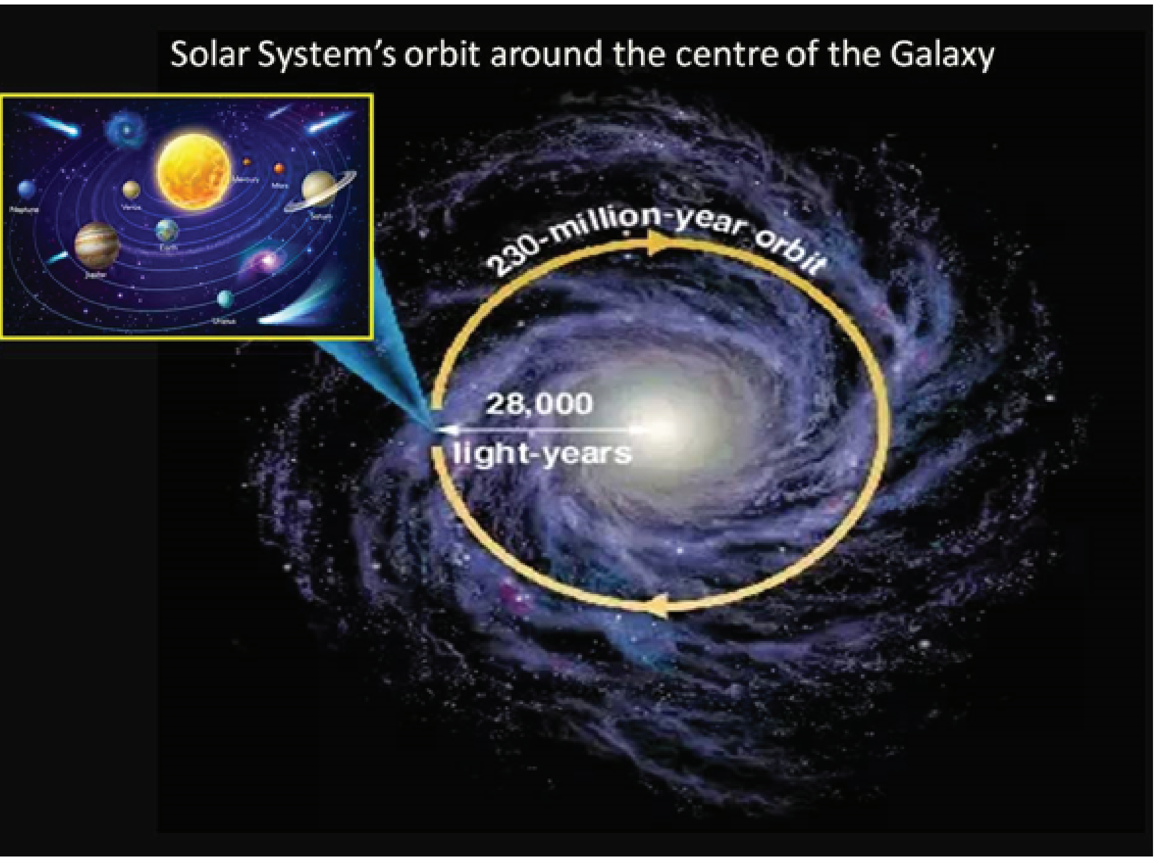
In a long series of books and papers Chandra Wickramasinghe and Fred Hoyle followed the example of Helmholtz and Lord Kelvin and systematically challenged all the conventional ideas on which Earth-bound biological theories are based. New information from many different fields of science was drawn together to show that the life in all its magnificence and diversity and can be logically understood only as a cosmic phenomenon. That includes you, me, and every single life form on the Earth down to the simplest of single-celled organisms. The emerging viewpoint at once transcends and subsumes religion.

This new perspective on life posits that viral genes are continually added to genomes of evolving life-forms leaves the role of neo-Darwinian evolution occupying a less important role as a kind of fine-tuning, rather than as the main driving force. Major evolutionary traits in the development of complex life are all externally derived, and evolution essentially driven from outside. If this is so the overall impression will be of a pre-programming in the higher levels of development in biology. The mechanism is that the relevant viral genes that were transported to Earth had evolved over vast timescales and in innumerable locations and suddenly came to be expressed locally on the Earth. The evolution of the eye may be seen as one example of this type, and even some highly complex, and less definable manifestations of gene expression in our own immediate line of descent in hominid evolution bear the signs of "pre-programming" or pre-evolution as pointed out by the celebrated Japanese biologist S. Ohno who wrote thus:

"Did the genome of our cave-dwelling predecessor contain a set or set of genes which enabled modern man to compose music of infinite complexity and write novels with profound meaning? One is compelled to give an affirmative answer......It looks as though the early Homo was already provided with the intellectual potential which was in great excess of what was needed to cope with the environment of his time....."

The theory of cometary panspermia asserts that the relevant genes for all such processes, including the musical and intellectual development in humans discussed by Ohno, evolved in a cosmic context and involved dispersal and exchange of viral genes across billions of light years. We can argue that Darwinian evolution occurred not on a single planet like Earth but over innumerable habitats in the grandest possible cosmic setting. We saw in Paper I that evidence from the examination of meteoroids and other astronomical data supports this point of view. The huge numbers of habitable planets that have recently been detected and the estimated mean distance of such planets being only a few light-years, imply that panspermia must be regarded as inevitable.

Whilst comets could supply a source of primitive life (bacteria, viruses and genes) to interstellar clouds and thence to new planetary systems and embryonic exoplanets, the genetic products of evolved life (local evolution) could also be disseminated on a galaxy-wide scale. At the present time our planetary system, which is surrounded by an extended halo of some 100 billion comets (the Oort Cloud) replete with microbial content as we have seen, moves around the centre of the galaxy with a period of 230My. Every 40 million years, on the average, the cloud of comets in our solar system becomes gravitationally perturbed due to the close passage of a giant molecular cloud. Such gravitational interactions lead to hundreds of comets from the Oort Cloud being thrown into the inner regions of our planetary system, some to collide with the Earth. Such collisions do not only cause extinctions of species (as one impact surely did 65 million years ago, killing the dinosaurs), but they could also result in the expulsion of surface material back into deep space.



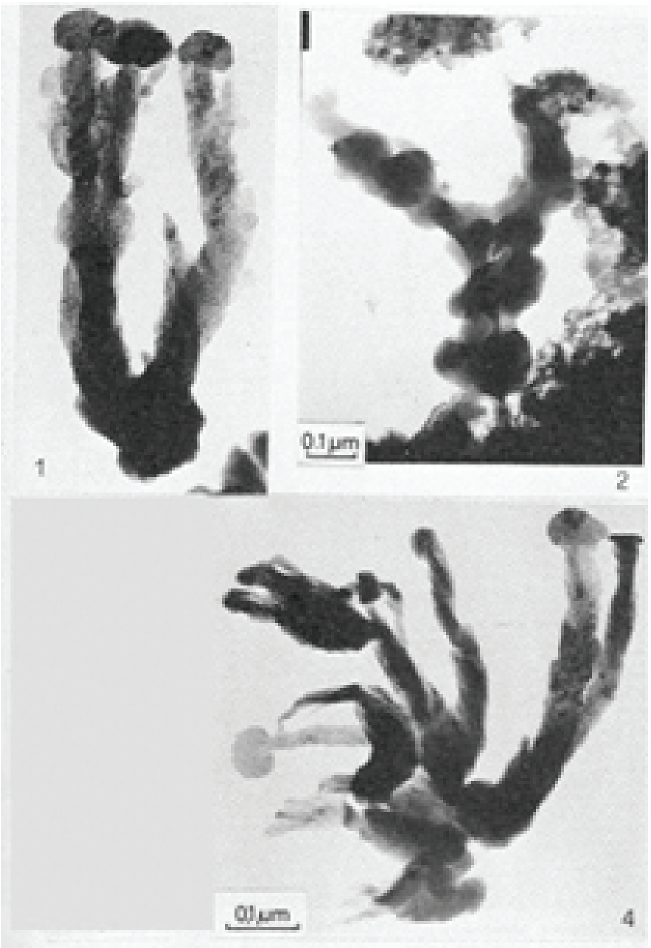
A mechanism can thus be identified for the genes of evolved Earth-life to be transferred to alien habitable exoplanets. A fraction of the Earth-debris so expelled survives shock-heating and could be laden with viable microbial ecologies as well as genes of evolved life. Such life-bearing material from the Earth could reach newly-forming planetary systems in the passing molecular cloud within a million years of the ejection event. A habitable exoplanet could then become infected with terrestrial microorganisms and terrestrial genes that can contribute to the process of local biological evolution.

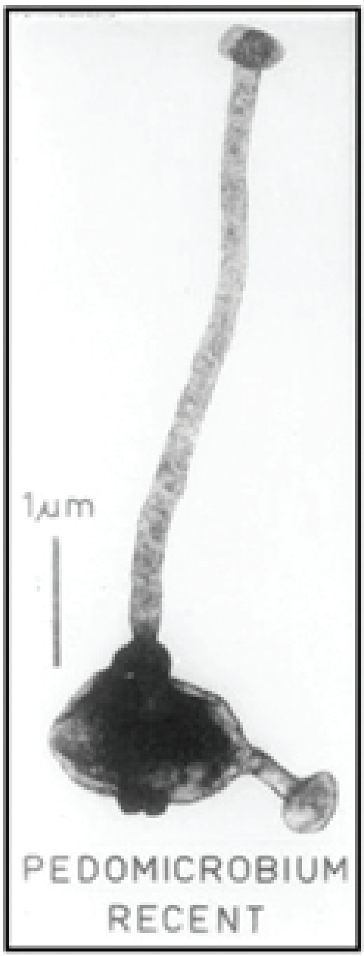
Once life has got started and evolved on an alien planet or planets of a new system, the same process can be repeated (via comet collisions) transferring a new compliment of genetic material carrying local evolutionary 'experience' to other molecular clouds and other nascent planetary systems.

Meteorites and evidence of cometary bacteria in the Earth's stratosphere

When a life-bearing comet makes its repeated orbits around the sun its volatile surface material with an entrained component of bacteria and viruses are progressively peeled away. Carbonaceous chondrites that occasionally fall to Earth represent fragments of comets denuded of volatiles but retaining a residue of silicates and more robust organic structures, possibly fossilised microbial forms.

Organic structures identifiable with bacteria, eukaryotic cells, and viruses have been reported in carbonaceous meteorites over several decades, including studies by Hans D. Pflug in the 1980, and Richard Hoover in more recent times. Fig. 6 shows carbonaceous structures discovered by Hans Pflug in the Murchison meteorite and identified with fossilised microbiota. Similar structures identifiable with fossilised bacteria have been discovered in more recent studies, including studies of a meteorite that fell in Sri Lanka in 2013.





Microfossils in the Murchison meteorite (left) discovered by H.D.Pflug (1984)compared with a microbial structure in a recent geological deposit.

One crucial test of the theory of cometary panspermia is to probe the stratosphere for in-falling alien genetic systems – bacteria and viruses. The first dedicated effort to test the idea of bacterial in-fall from comets was made in 2001 by a group of UK scientists in collaboration with scientists at ISRO (Indian Space Research Organisation). Positive detections of in-falling microbiota were made, and the number of bacterial cells collected in a measured volume of the stratosphere at 41km led to an estimate of an in-fall rate over the whole Earth of 0.3-3 tonnes of microbes per day. This converts to some 20-200 million bacteria per square metre arriving from space every single day.

Bacteria have also been recovered more recently from the exterior of the international space station which orbits at a height of 400 km above the Earth's surface. More expensive and sophisticated investigations need to be carried out even on the samples collected so far, if we are to prove beyond a shadow of doubt that these microbes are unequivocally alien. The sad truth is that funding for such vitally important experiments is well-nigh impossible to secure due to a deeply ingrained prejudice in favour of an Earth-centred theory of biology.

Viruses, Evolution and Pandemics

On the Earth a continued arrival of new bacteria and viruses must have taken place from the time when microbial life was first introduced by comet impacts. New viruses eventually succeed in becoming incorporated into the genomes of evolving lifeforms, this process continuing over billions of years of geological history. Such interaction of new viruses with evolved host species is not always harmonious, however. Throughout recorded history we have clear evidence of a succession of pandemics of disease that have swept over the planet from time to time – the most recent pandemic of COVID-19 being a case in point.

Document prepared by

Chandra Wickramasinghe, Kamala Wickramasinghe and Gensuke Tokoro