FEATURES

Comets, Panspermia, Culture, and Prejudice

We often think that science in 2021 is free from any form of irrational prejudice and is based only on irrefutable fact. In this article, we show that this is far from being true in relation to the biggest questions of science, particularly those that relate to the origins of life. We argue that it is important to recognise the role of such cultural constraints operating at the present time, which have the effect of delaying a long-overdue paradigm shift from Earth-centred biology to theories of cosmic life.

by **Professor Chandra Wickramasinghe**

1. Introduction

From the time of the earliest philosophies of classical Greece, the struggle has been to disentangle religion and the "gods" from any involvement in explanations of the external world. Democritus (460–370 BCE) and Epicurus (341–270 BCE) held firmly to rationalist explanations, including the concept of an infinite and eternal universe. They had both supposed that all matter is comprised of invisible particles known as atoms and that all phenomena in the natural world – including life – are the result of such atoms moving, swerving, and interacting with each other in empty space through an infinite world.

Although most of Epicurus' writings did not survive into the modern age, a long succession of his disciples recorded and transmitted his views, particularly Metrodorus (331–277 BCE) and Lucretius (99–55 BCE). The surviving writings of these authors bear testimony to a profoundly post-modern Epicurian view of life in the cosmos. In around 400 BC, Metrodorus of Chios 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…" –Metrodorus**

And Lucretius:

> **"Nothing in the universe is unique and alone, and therefore in other regions there must be other Earths inhabited by different tribes of men and breeds of beasts…" –Lucretius**

Such an evidently post-modern set of ideas relating to life implied furthermore an infinite Universe that was essentially independent of control by any god or pantheon of gods.

The same freedom from theistic control was implied in pre-Socratic ideas relating to the origins of life first attributed to the philosopher Anaxagoras of Clazomenae (500–428 BCE). Anaxoragas posited that "seeds" (*sperma*) are distributed everywhere (*pan*) throughout the cosmos – *pan* linked with *sperma* signifies seeds of life everywhere and thus, defining the etymology of the modern word *panspermia*.

We should note, however, there are much earlier references to the same idea in the wider world outside of Europe. Ancient Egyptian papyri and engravings have references and depictions of panspermia that date before the second millennium BC; even older Vedic traditions of ancient India encapsulate ideas concerning the cosmic nature, antiquity, and eternity of life. The non-European non-Christian provenance of the concept of panspermia, in the author's view, played no minor role in the development of prejudice against it.

2. Resistance to Panspermia

The first rejection of panspermia came scarcely a century after it was first proposed by Anaxoragas and Epicurus. This was mainly due to the powerful influence of Aristotle (385–323 BCE). Aristotle proposed in its place the concept of the "spontaneous generation" of life, suggesting that life arose spontaneously from non-living matter whenever and wherever the right conditions prevailed. This was famously exemplified by his "observation" of "fireflies emerging from a mixture of warm earth and morning dew."

Although religion or theistic intervention was not explicitly stated by Aristotle, the doctrine of spontaneous generation of life on the Earth lent itself readily to such an interpretation. Aristotle's influence as a philosopher and an observer of the world is evident in the vast number of surviving texts and commentaries that are still being studied by philosophers and scholars.

Beyond the idea of spontaneous generation, Aristotle's writings span an incredibly wide range of disciplines including logic, metaphysics, biology, psychology, ethics, political theory, aesthetics, and rhetoric. Following the adoption of Christianity in the Roman Empire by Constantine in the 3rd century CE it was therefore not surprising that Aristotelean philosophy had to be somehow accommodated. This was accompanied by a firm rejection of the ideas of Anaxoragas, Democritus, and Epicurus that were essentially atheistic.

The Aristotelean worldview later came to be fine-tuned by Christian philosophers, notably Thomas Aquinas (1224–1274 CE) who advocated a strictly geocentric model of the world, one that necessarily included the concept of life being Earth-centred. Allegiance to such a model soon came to be tied up with faith rather than fact so that overturning it became ever more difficult as the centuries progressed. The concept of a physical universe firmly centred on the Earth persisted for several centuries and was of course eventually dismantled by the Copernican revolution of the 16th century. The idea of Earth-centred life and biology, however, persisted right through into modern times.

3. Abiogenesis vs Panspermia

At the dawn of the 21st century the fundamental logical choices in relation to the origin of life lay between two competing concepts: (a) *abiogenesis* – life generated *in situ* on Earth (following Aristotelian thinking) and with such life emerging and evolving independently of the wider cosmos, and (b) *panspermia* – life being a cosmic phenomenon, arriving on a planet such as Earth and evolving by means of the transfer and interchange of microbiota (bacteria and viruses) in a vast cosmic context. As we have already mentioned, the latter point of view has deep roots going back to the pre-Socratic philosophers, and even much earlier to ancient Vedic philosophies of India.

Louis Pasteur (1822–1895) was the first to confront the subject of panspermia with a series of famous experiments – e.g. the souring of milk and the fermentation of wine. He showed to everyone's satisfaction that these processes do not take place in the absence of microorganisms, and therefore microorganisms, in general, must always be derived from pre-existing microorganisms.[1] Pasteur thus effectively *disproved* the reigning dogma of "spontaneous generation," the Aristotelean idea that life could arise spontaneously from inorganic matter. He also famously enunciated the dictum—*Omne vivum e vivo*—all life is from life, and this view was taken up enthusiastically by several distinguished contemporary physicists. For instance, the German physicist Hermann von Helmholtz[2] wrote:

> **"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…"**

And in Britain, Lord Kelvin (William Thomson)[3] 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…" Likewise in Sweden, the Nobel Prize-winning Chemist Svante Arrhenius was similarly swayed and enthusiastically proselytised the "doctrine of panspermia" in his book *Worlds in the Making.*[4]

In retrospect, it is difficult to believe that all such pronouncements were consistently ignored in the decades that followed. At every turn, the Earth-centred Aristotelian point of view of spontaneous generation re-emerged to dominate, by decree, even the strongest evidence pointing to the validity of an alternative panspermic viewpoint.

Weak and uncertain evidence of the lack of space-hardiness of bacteria was presented in the 1920s to argue against the feasibility of panspermia. Over the past few decades, however, the space hardiness of bacteria has been established almost beyond refute, so all the initial objections that were raised are shown to be false. Contrary to what is often *wrongly* stated, in popular as well as more scientific writings, panspermia is furthest removed from mere speculation; rather it is firmly rooted in data and irrefutable facts.

So, spontaneous generation or panspermia? This is fundamentally a cultural choice at the outset, but once the choice is made, it should be rigorously subjected to empirical tests and verification/falsification in a Popperian sense.

4. Growing Evidence for Cometary Panspermia

In most ancient cultures throughout the world, comets were regarded with reverence and awe as bringers of pestilence and death on the one hand, and of life on the other. In the present era of so-called "enlightenment," we tend to dismiss such views as ignorant superstition. When my colleagues and I revisited comets from the 1980s onwards and came to argue that aspects of such ancient superstition might well be fortuitously true, we were often criticised. An unwritten rule of modern science was that no vestige of a discarded ancient belief could be revisited, let alone revived.

Fig.1 Medieval depiction of a comet causing disasters from Stanislaus Lubieniecki's Theatrum Cometicum (Amsterdam, 1668)

From the 1970s onwards, the present author, in collaboration with the late Sir Fred Hoyle and later with other collaborators, began to assemble a vast body of data and evidence to support panspermia from astronomy, geology, as well as biology. New data and facts continue to provide ample verification of prior predictions with ever-more compelling evidence pointing to the *inevitability* of panspermia as opposed to spontaneous generation as the mode of origin and propagation of life throughout the Universe.

We have argued from the 1980s through to the present day that comets are incubators and distributors of life in the form of bacteria and viruses throughout the Universe.[5] The fact that comets have been both revered and feared in many ancient cultures as the bringers of life, pestilence, and death has stood as a cultural impediment to considering the modern evidence for cometary panspermia. Whilst comets are conceded at long last as the repositories of complex organic molecules that may have contributed to the spontaneous generation of life, their role as carriers of life, despite contrary evidence, is still fiercely resisted in many academic circles.

I will not dwell on details of evidence here but only summarise the salient facts that have been amply discussed in a long series of recent books and technical papers.[6,7,8,9,10,11] The following timeline of developments is worthy of note:

- **1962:** The prediction and discovery that carbon was the main component of cosmic dust.
- **1974:** The identification of organic polymers making up the bulk of interstellar dust, suggesting they are the break-up products of bacteria and viruses.
- **1977:** The epidemiology of an outbreak of H1N1 influenza that was consistent with viral ingress from space.[9]
- **1982:** A prediction of the detailed mid-infrared absorption spectrum of cosmic dust based on prior laboratory experiments that were verified by observations of the galactic infrared source GC-IRS7.[5,6]
- **1986:** A prediction of the detailed mid-infrared emission spectrum of the dust tail of comet P/Halley based on prior laboratory experiments for freeze-dried bacteria.[5]
- **1996:** Eruption of Comet Hale-Bopp at a large heliocentric distance of 6 AU (six times the Earth's mean distance from the sun) when solar heating would not have been enough to vaporise the comet's surface. This was a clear indication of microbial activity in radioactively heated "pools" beneath the comet's surface.[5]
- **2001:** A prediction of bacteria entering the stratosphere was first *verified* by a stratospheric balloon experiment carried out in collaboration with the Indian Space Research Organisation.[10]
- **2015:** Rosetta Studies of Comet 67P/Churyumov–Gerasimenko showing consistency with the presence of bacteria.[13]

- **2016:** Earliest evidence of life on the Earth was discovered in rocks dated 4.2–4.3 billion years ago, during the Hadean epoch.[11] This was a time of intense comet impacts – the comets most likely delivering the first life onto the Earth.
- **2018:** Microorganisms found on the *outside* of the International Space Station at a distance of 400 km above the Earth.[12] There is no easy way to maintain that such microorganisms could have been lofted from the surface of the Earth to such a height, so this constitutes strongly supportive evidence for panspermia.

In addition to such explicit verifications of prior predictions, there was also the discovery after 2001 of unmistakable "viral footprints" in our own DNA and the DNA of plants and animals, confirming the prediction, from panspermia, of cosmic viruses driving biological evolution on the Earth.[14,15] Other astronomical and biological data decisively supporting panspermia is summarised in two recent reviews by Steele et al.[16,17]

The partial list given above can be enlarged to include more detailed facets of correspondences between the predictions of the panspermia model and a diverse set of observations. I would argue that no wrong theory can be characterised by such an impressive record of detailed–and verified–predictions. Ironically, the stronger the supportive evidence for panspermia in recent times, the more intense the ferocity and irrationality of opposition to it. It is becoming amply clear that cultural constraints are beginning to play a decisive role in stalling a long-overdue paradigm shift in science.

An aspect of panspermia that has been subject to much ridicule is the idea that viral and bacterial pathogens responsible for epidemics of disease could have an ultimate space origin.

In the context of an unknown or poorly defined origin of the current COVID-19 pandemic, and with the growing evidence in support of panspermia, a *panspermic* primary origin of this virus cannot be ruled out, although an artificially engineered virus introduced into the tropospheric weather system cannot be absolutely ruled out based on the data alone.[18] However, I consider the latter cold-war-based explanation exceedingly unlikely. All aspects of the epidemiology of this new virus supports the idea of a primary atmospheric fall-out modulated by atmospheric turbulence over several scales and followed by person-to-person spread. The disentanglement of the two processes presents a continuing challenge to the world.

Figure 2 shows a pictorial summary of the sources of new evidence accumulated between 1980 and 2021 that point to the validity of the theory of cometary panspermia and life as a cosmic phenomenon.

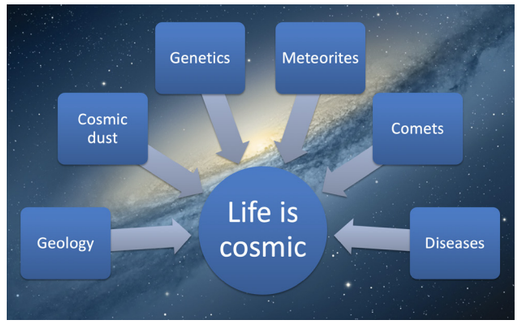

Fig.2 Sources of evidence converging on the theory that life is a cosmic phenomenon.

In the past five decades, abiogenesis has been confronted with a formidable array of new facts from astronomy, geology, space science, and molecular biology, all of which may have challenged its validity. Simultaneously an ever-increasing number of predictions of panspermia has come to be verified to an astounding degree of precision. Wrong theories do not perform in this way, so it soon became clear that panspermia's star was on the ascendant!

The sociology of science now took over: the triumphs of panspermia over rival Earth-centred models of life began to irritate an ever-increasing body of scientists. This was aggravated by the fact that all attempts to demonstrate the validity of Earth-bound abiogenesis in the most advanced laboratories in the world have consistently led to dismal failure.

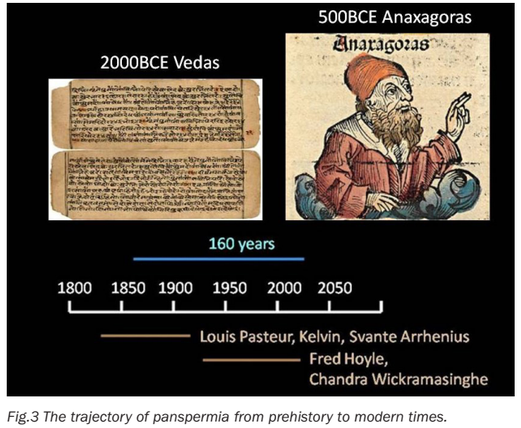

Fig.3 The trajectory of panspermia from prehistory to modern times.

The timeline of panspermia from its early roots in the Vedas through to Anaxoragas in the 5th century BCE and into modern times is sketched in Fig.3. The last phase following on from Arrhenius led up to the verification of predictions described earlier. As we have noted, this unfolding scientific drama summarised above is well-documented in a large corpus of scientific papers and recent books to which reference has already been made.

The tenacity of adhering to cultural symbolism has been common throughout history and has pervaded diverse cultures. And when there is not a great deal that rests on such symbolism, it is not a matter of much consequence. In the 5th century BCE, the worship of Athena, for instance, served to maintain the integrity and unity of the city-states of classical Greece, and although this was of course thoroughly irrational, it clearly did not detract from glories and intellectual achievements that followed!

Unfortunately, a great deal does, however, rest on the acceptance or otherwise of theories relating to life in the Universe. It is likely that our very survival may depend on facing facts and conceding the long-overdue paradigm shift from the idea of the spontaneous generation of life on Earth to life as a cosmic phenomenon and cometary panspermia, as proposed by the present writer and Fred Hoyle nearly four decades ago. APBN

Fig.4 Fred Hoyle and Chandra Wickramasinghe, in Sri Lanka, 1982.

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About the Author

Chandra Wickramasinghe is a world-renowned astronomer and a pioneer of astrobiology. He was formerly a Fellow of Jesus College, Cambridge, a founder member of the Institute of Theoretical Astronomy in Cambridge, and a former Professor of Cardiff University. He is presently an Honorary Professor at the University of Buckingham, UK as well as universities in Sri Lanka. He has published over 35 books, several published by World Scientific.