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# THE TRANSITION FROM EARTH-CENTRED BIOLOGY TO COSMIC LIFE*

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## Abstract

A paradigm shift with potentially profound implications has been taking place over the past 3 decades. The convergence of research in diverse disciplines points to life being a cosmic phenomenon. A near-infinite information content of life appears to have evolved on a cosmological scale – over vast distances, and enormous spans of time. It appears highly unlikely that life could have emerged from chemicals in "some warm little pond" on the Earth; in contrast we maintain that every species of life on the Earth, including *Homo sapiens*, is in essence the result of an assembly of cosmologically derived viral genes. The ingress of such genes that continues to the present day led to their accommodation within the genomes of evolving lineages, sifted according to the "natural processes of selection", a mechanism first enunciated by Patrick Matthews and later used by Darwin. The evidence for this point of view has now grown to the point where we believe, it will soon need to be accepted by the majority of the scientific community. This is particularly critical, since we suggest that new diseases capable of threatening Man's existence could arrive to Earth from space. Moreover, we need to understand that we must live in harmony with the Earth and its ever-changing biosphere if we are to coexist with it.

***Keywords***: panspermia, cosmic origins of life, economics, history of science

## 1. Introduction

Throughout history progress towards understanding the nature of the world has always been hampered by adherence to convention. This has been most severe in matters relating to life. Since the facts of evolution were accepted following the writings of Charles Darwin and Alfred Russell Wallace, the focus has been on a strictly Earth-centred world-view in regard to biology. The origin of life in "some warm little pond" on the Earth is a firmly entrenched scientific dogma that has been virtually impossible to gainsay. The classic experiments of Miller and Urey (1959) showing how small amounts of organic molecules can be produced in the laboratory from inorganic molecules gave a measure of credence to this dogma. Such credence was, however, illusory because the production of a trickle of organic molecules from a complex network of chemical reactions is by no means surprising, and was in any case a very far cry from the origination of life. The difficult step from a mixture of appropriate organic molecules to life is to achieve the specificity of their arrangements into polymers like DNA, RNA or enzymes that are most crucial for life (Hoyle and Wickramasinghe, 1981, 1982). Despite concerted efforts on the part of many teams of scientists worldwide little progress has been made in simulating the process by which life may have originated (Deamer, 2011).

In the early 1970's astronomers began to discover organic molecules in interstellar clouds as well as in the material that flowed out from comets and star systems (Hoyle and Wickramasinghe, 1977, 1978). It is precisely such discoveries that cast the first doubts about the conventional Earth-bound theories on the origin of life. Challenging the conventional position was a long uphill struggle, however, and for more than a decade the data itself was vigorously refuted in some quarters. Fred Hoyle and one of the present authors were among the first to realise that the "game was up" for Earth-centred biology (Hoyle and Wickramasinghe, 1982). At first it was argued that the complex organics from interstellar clouds were mopped up by cometary bodies in the early solar system, and that their radio-actively heated interiors provided trillions of "warm little ponds" within one of which life might be able to originate far more probably than on Earth (Hoyle and Wickramasinghe, 1978). Having so originated in one such comet the argument was that living cells were thereafter exchanged and shared amongst the totality of primordial solar system comets. The next step involved the delivery to the Earth of living cells by comets – a process that would continue to the present day.

With developments in molecular biology confirming the incredible complexity of life at a molecular level it became clear that even the totality of comets in our own solar system is woefully inadequate to make the transition from non-life to life, and that the largest available physical system was needed to bridge a superastronomical probability hurdle. The simplest known bacterium *Mycoplasma genitalium* requires some 500 genes to be assembled from its component amino acids the odds against which can be estimated to be minimally 1 in $10^{6500}$. Such an exceedingly improbable event of origination has thus to be inferred to be a unique cosmological event – an event that took place against incredible odds dictated by the simple fact that "we are here".

In the absence of evidence for spontaneous abiogenesis, a wide range of data from biology continues to support Louis Pasteur's old dictum *Omne vivum ex vivo* (all life from life). The life-from-life connection manifestly persists throughout the fossil record back to the earliest moment when life first appears on the Earth.

We shall assume in the rest of this article that life is a cosmic phenomenon – all pervasive, interconnected and interlinked throughout the observable universe. If this is admitted, the next question is - what are its implications at the present time? Judging from infrared/UV signatures of dust at high redshifts one could argue for the existence of biomaterial in galaxies that formed a few million years after the Big Bang (Wickramasinghe, 2010). This would apply within the framework of standard LCDM Big Bang cosmologies. In one such model (HGD cosmology of Gibson and Schild), still within the paradigm of Big Bang cosmology, life emerges less than a million years after the Big Bang when most of the matter (including life-giving chemical elements) existed within the warm interiors of planetary mass condensations. At later cosmological epochs biology will remain hard-frozen in primordial planets and continue to spread as an ever-expanding reservoir of life (Gibson, Schild and Wickramasinghe, 2012). In quasi-steady state and oscillating cosmological models, which involve an open timescale, the super-astronomical information content life is an ever present property of the Universe (Steinhardt and Turok, 2007; Hoyle, Burbidge and Narlikar, 2000: Penrose, 2010).

## 2. Exoplanets and the Case for Panspermia

The first appearance of life on the Earth is now well documented to have occurred 3.83-4 billion years ago when the planet suffered an episode of comet and asteroid impacts (Mojzsis et al, 1996). This evidence is in the form of an excess of the lighter isotope of carbon, $^{12}C$ relative to $^{13}C$ in the geological sediments pointing to the action of biology which has a preference for $^{12}C$. The ingress of cometary and asteroidal material to the Earth continues to the present day.

The best estimates of the rate of entry of cometary material give values of some hundreds of tonnes per day. Likewise, material from the Earth and other planetary bodies can leave the entire solar system. This happens sporadically, not continuously, as for instance when comets and asteroids impact upon planets like the Earth (Wallis and Wickramasinghe, 2004).

The comet-Earth impact event that took place 65 million years ago must have led to the expulsion of material from the solar system, including a component of Earth debris that would have been inevitably laden with living material (RNA/DNA, spores) (Wallis and Wickramasinghe, 2004). In our solar system episodes of such cometary impacts on the inner planets are expected to take place with an average frequency of once every 40 million years due to close approaches to molecular clouds in the galaxy (Napier, 2004; Wickramasinghe et al, 2010).

Recent studies have led to detections of some 900 exoplants in a nearby small sample volume of our galaxy (Kopparapu, 2013). Extrapolations from this study give an estimate of 140 billion habitable planetary systems in our galaxy alone, most of these being associated with faint red dwarf stars. On such a basis the mean distance between life-friendly planetary systems is only a few light years. This relatively short inter-planet distance is easily bridged by escaping dust, debris, meteorites and comets. Material expelled at speeds greater than the escape speed from a planetary system like our own solar system will, in general, have hyperbolic orbits with respect to a nearby star, so the probability of direct capture will in general be very low. However, sub-micron dust including bacteria and viruses released by transiting cometary bolides, even if they are in hyperbolic orbits, will be easily be stopped by friction (gas drag) in the interplanetary disc of the recipient planetary system, and thus serve to infect habitable planets (Wallis and Wickramasinghe, 2004; Napier, 2004).

## 3. Viruses and Evolution

Successful theories in science have repercussions and applications in many different directions – some often unexpected. The idea of cosmic life is no exception in this regard. Long before the human genome was fully sequenced, Hoyle and one of the present authors (NCW) argued that viral infections leading to pandemics of disease throughout history have a cosmic origin, and moreover that these infections in the long term have a positive role to play in the evolution of terrestrial life (Hoyle and Wickramasinghe, 1979, 1982; Wickramasinghe, 2012). It is through such infective processes, involving aggressive viral actions and integration of viral genes and viruses themselves into the host cells, that new genes for evolution are derived *gratis* from the cosmos (Villarreal, 2004). Without this process we argue that major leaps in biological evolution would grind to a halt. If viruses were exclusively bad or deleterious for higher life it would be remarkable that higher life forms, in the course of their long evolution, have not developed a mechanism for blocking the ingress of viruses. Logically, the very much larger information content of our own DNA would surely have been able to outwit the relatively trivial information content of a viral genome. It was argued (as early as

1982) that the fact that this has not happened must indicate that the process of viral ingress is somehow *necessary* for evolutionary progress (Hoyle and Wickramasinghe, 1982). A recent discovery of HERV-W, an endogenous defective retrovirus in human placental morphogenesis (Mi et al, 2000), is an example of virus in action to protect life, thus stressing the vitally positive role of viruses.

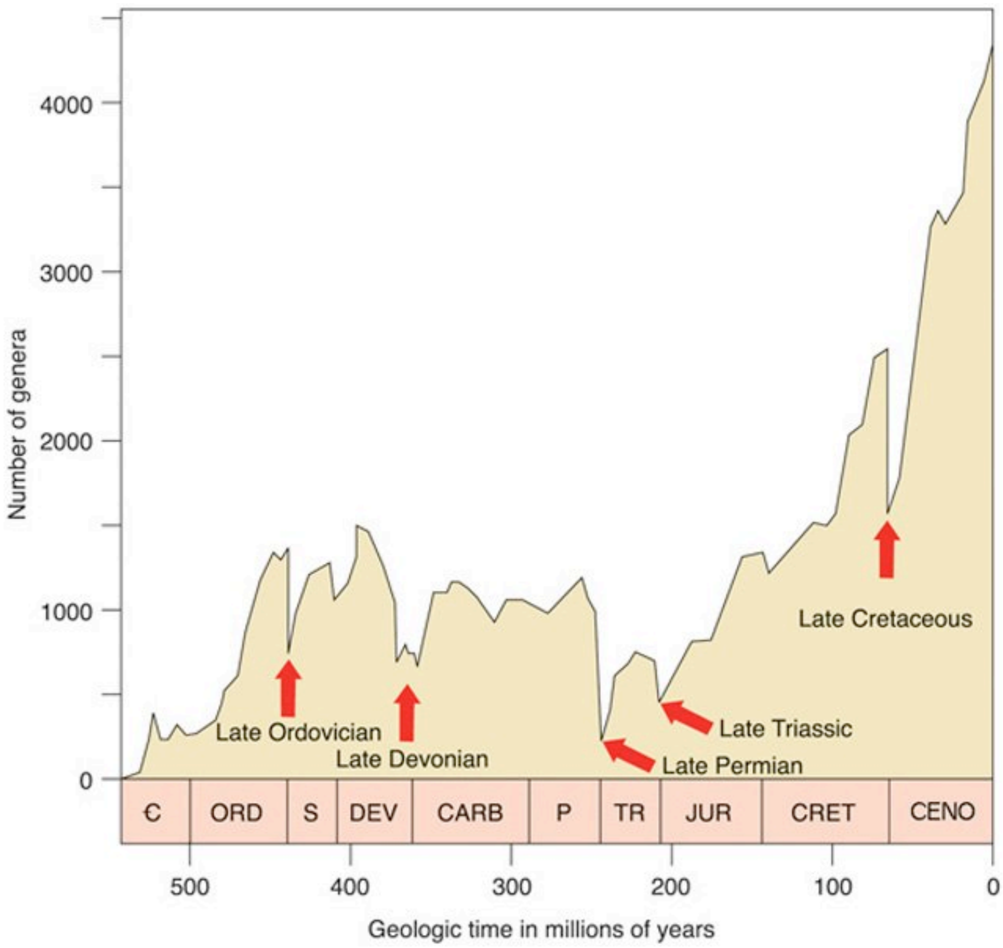


Fig.1. The number of genera in geological sediments of various ages

The plot of the number of genera (families) of life in the fossil record shows a pattern of abrupt dips immediately followed by a sharp rise with an average separation between such episodes being about 50 million years. This is similar to the average separation between episodes of bunched comet impacts that have been calculated by Napier and others (Wickramasinghe, et al, 2010). At the K/T boundary 65 million years ago an extinction event (including the extinction of the dinosaurs) is followed by a sharp rise in the emergence of new genera. The physical effect of such an impact could cause stress-induced extinctions of species, but in addition pathogenic viruses could also attenuate species. Likewise, the sharp rise in the number of families could be due to viral ingress contributing to evolution in the manner we have discussed earlier. In this connection it is interesting to note that a recent study of a fossil meteorite in a limestone quarry in Sweden has shown that the Earth was bombarded by meteorites resulting from a comet/asteroid break up around 470 million years ago – a time that coincides with a sharp explosion of metazoan species (Schmitz et al, 2014)

## 4. Viruses in our DNA

With the complete sequencing of the human genome our cosmic ancestry was essentially laid bare (Venter, et al, 2001). It came as a surprise to find that much of our genetic inheritance may be comprised of DNA actually derived from viruses. At least 40% of the entire human genome may be traced directly to viruses and their closely related products (Villareal, 2004) This estimate is based on the likely hypothesis that 34% of the human genome which constitute LINEs (Long Interspersed Nuclear Elements) (21%), and SINEs (Short Interspersed Nuclear Elements) (13%), which are retroviral derived and controlled, and HERVs (Human Endogenous Retroviruses) and LTRs (Long Terminal Repeats) (9%) (Villareal, 2004; Horie et al, 2010; Tokoro and Wickramasinghe, 2014).

The picture that has emerged is that we humans are essentially a complex mixture of cosmic viruses. Moreover the evolution of life in every significant respect was directed by the ongoing incidence of cosmic viruses.

## 5. Direct proof of ongoing panspermia

A prediction of the theory of cosmic life is that biological material from space (from comets) must be reaching the surface of Earth at the present time. If a fraction of this were comprised of viruses and bacteria that were pathogenic to plants and animals a positive detection might be achieved. The difficulty, however, is to distinguish between bacteria/viruses that are endemic or indigenous to the Earth and those that are coming in at the present time. In the book *Diseases from Space* it was argued that many historical epidemics that seem to appear suddenly in human populations, and often disappear equally suddenly, are best explained on the basis of direct incidence from space (Hoyle and Wickramasinghe, 1979).

In addition to evidence from epidemics, the actual recovery of incoming cometary viruses and bacteria from the stratosphere would constitute a decisive validation of the ideas we have discussed. Such a recovery which would firmly establish our cosmic connection poses a challenge to scientists in the present day. Although attempts at stratospheric microbial recovery go back to the 1960's, these early recoveries were often dismissed (often illogically) as contamination without proper critical evaluation.

In January 2001, in collaboration with a group of Indian scientists at the Indian Space Research Organisation (ISRO) balloon-borne devices (cryosamplers) were lofted to a height of 41 km in order to collect stratospheric air and aerosols aseptically. Positive results that were obtained indicated clearly that the prediction of a continuing ingress of biomaterial from comets was dramatically verified (Harris et al, 2002; Wainwright et al, 2003). A similar experiment was repeated by ISRO in 2009 (Shivaji et al, 2009) with the recovery of 3 new microorganisms including one named in honour of Fred Hoyle as *Janibacter hoylei.*

## 6. The Sheffield Balloon Experiment

The existence of microbiota in meteorites, in particular within cometary micrometeorides that form part of a meteor stream, was recently confirmed by a team led from Sheffield, UK (Wainwright et al, 2014). A balloon-borne device designed to collect impacting cometary micrometeoroids was flown to a height of 27km in the stratosphere in June 2013 during the peak of the Perseid meteor shower. The device included an assembly of electron microscope stubs that were exposed to the stratosphere at the peak of a balloon flight for 17 minutes and thereafter securely and aseptically sealed and parachuted back to ground. The exposed stubs, once they were recovered, were examined under an electron microscope. Clear evidence was found of *infalling* microorganisms, some of which actually cratered the recipient stubs, as shown for instance in Fig 2. Slow-drifting of organic particles lofted from the ground was ruled out on various grounds, not least the fact that the craters on the stubs implied downward descent and impact at high speed.

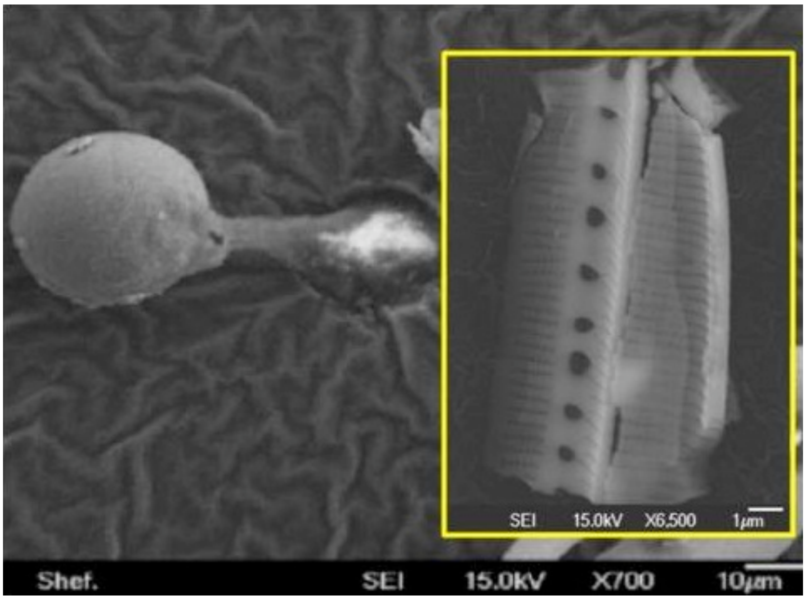


Fig 2. (left). A spherical biological cell possessing a thin titanium shell that was micromanipulated out of a crater pit, with organic ooze visibly emerging in the process. Fig 2 (right) diatom frustule that landed at speed from above.

The image shown on the left of Fig 2. is of a spherical cell possessing a thin titanium shell that was micromanipulated out of a crater pit, with organic ooze visibly emerging in the process. Several other biological structures, including the diatom frustules shown in right hand box in Fig. 2, were also discovered on the stubs. All these were falling downwards on to the stubs at high speed and must therefore have a cometary origin.

## 7. Microfossils in Meteorites

From the early 1960's evidence of extraterrestrial lifeforms in meteorites – albeit in fossilised form – had been available and became subject to vigorous debate (Claus and Nagy, 1961). From the 1980's onwards the data relating to microfossils was so strong as to generate vicious opposition to it in the scientific community. Hans D. Pflug studied carbonaceous meteorites and found striking evidence of microbial fossils – bacteria and viruses deeply embedded within them. Morphologically the identification with well-known terrestrial forms was beyond dispute, and issues of contamination that plagued earlier work were adequately dealt with by use of improved techniques that left very little room for debate (Pflug, 1984). Continuing investigations by Richard Hoover on a number of different carbonaceous meteorites strengthened further the case for the existence of microbial fossils (Hoover, 2011; Wickramasinghe, 2011). It came as no surprise that the new evidence of extraterrestrial life was once again either rejected or ignored by scientific orthodoxy, and so the data for extraterrestrial life in fossils was once again allowed to drift into obscurity.

It is against this backdrop that a witnessed fireball event, followed by a meteorite fall in central Sri Lanka on 29 December 2012, came to be studied. When samples of the meteorite were examined using an electron microscope the existence of fossilised microbial structures, were clearly seen, including diatoms, the characteristic morphologies and microstructures of which were unquestionably diagnostic of their biological provenance (Wickramasinghe, et al, 2012; Wallis et al, 2013). See Figure 3.

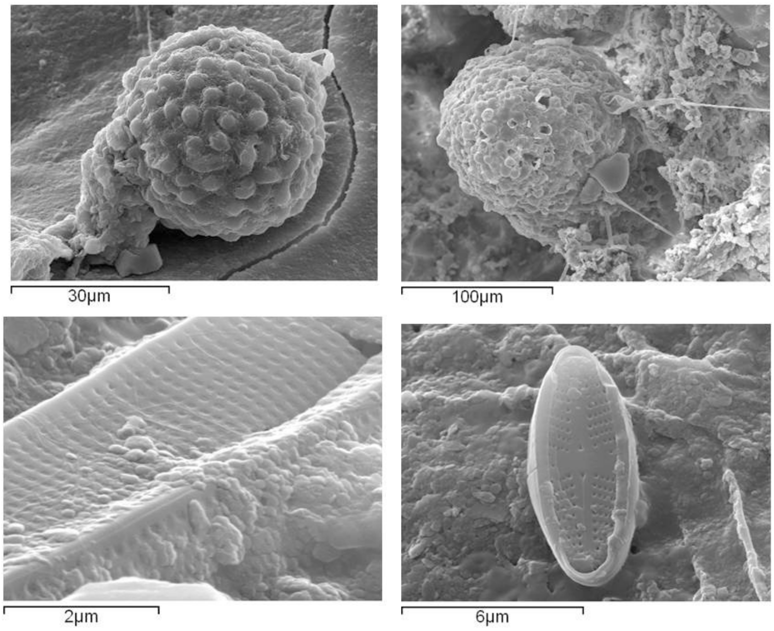


Fig 3. A fossilised acritarch and diatoms in the Polonnaruwa meteorite

The structures in the top row of Fig 3 resembles extinct microbial fossil known as an acritarch, and the images in the bottom correspond to species of diatoms with distinct and unambiguous morphologies. These structures cannot be interpreted on the basis of contamination, or mineralogical artifacts.

Wallis et al (2013) have shown that the ratios of stable oxygen isotopes ($^{16}O$, $^{17}O$, $^{18}O$) cannot be consistent with a terrestrial origin of these structures. Furthermore the analysis of trace elements in the bulk composition of the meteorite has yielded high abundances of the element iridium which is untypical of terrestrial material. This data provides strong confirmation of the extraterrestrial origin of these stones. The argument the diatom structures in Fig, 3 can be modern contaminants can be disposed on the basis of the low N/C ratio of the carbonaceous content of the meteorite can only be understood if the biological structures are fossilised. Moreover, the acritarchs in the top row of Fig 3 cannot be modern by any stretch of the imagination, since they represent organisms that have been extinct on Earth for several billion years.

The stable isotope analysis for the Polonnaruwa meteorite carried out by Wallis et al (2013) was repeated by an independent group in Tokyo who arrived at essentially the same result. Together with other analyses of the rock an opinion favoured by Japanese group, however, is that the oxygen isotope (although consistent with an extraterrestrial origin) may have been the result of an artificially contrived manufacture process involving the combustion of carbonates. This reaction must only stem from the conviction that any rocks containing microfossils *cannot* be accepted as meteorites, simply because it is "inconceivable" and contrary to accepted dogma. The porous, fluffy structure of the stones also does not readily fit with any well-established meteorite class, and so also is their high silica content. However, the undisputed connection with a fireball, anecdotes of hands burnt on touching the stones, evidence of distinct fusion crusts, and the timing of the event at the end of the December Taurids, corroborate a meteorite identification, albeit a meteorite of a hitherto unrecognised classification.

Some critics have expressed the view that the diatom and microbial fossils found in these meteorites are too closely related to well-recognised species of diatoms that exist on the Earth. An origin of such organisms in a comet, according to them, would make no sense from an evolutionary biology point of view as life strives always to be ideally adapted to its particular environment. However, we have for long argued that subsurface lakes in comets provided habitats ideally suited to microorganisms including algae and diatoms (Wickramasinghe et al, 2010)

The reason why fossil microbes and diatoms in the meteorites are similar to their modern terrestrial counterparts is that they all originated from space and continue to do so. Life on Earth is an expression on the Earth of a Darwinian - Matthewian evolutionary scheme that has taken place over a vast cosmological scale. The connected biosphere of the Earth should now be regarded as being connected to a vast cosmological biosphere within which frequent exchanges of genes have established a unity of all life in the cosmos.

Most likely connected with the Meteor events of December 2012 were several incidents of red rain that fell over north central Sri Lanka. The general characteristics of the red rain were similar to events that happened in 2001 in Kerala India. In the Indian case, the red rain was preceded by a loud sonic boom heard in the sky, the presumption being that an icy meteoroid laden with red rain cells exploded in the stratosphere, and the red cells subsequently seeded tropospheric rain clouds. Despite intensive investigations of both the Kerala and Sri Lankan red rain, their content of red cells still remains unidentified (Louis and Kumar, 2006; Miyake, 2013). The most plausible explanation remains that the red cells although superficially similar to terrestrial algae are of a totally unidentified genus and species – possible an alien cometary microorganism.

## 8. Viruses and Pandemics

The attempts to recover microorganisms directly from the stratosphere have thus far been largely confined to bacteria, algae and diatoms. The next priority in our view must be an attempt to recover infalling viruses because of the known ability of viruses to directly enter the nuclei of cells and thus to influence their DNA and the future course of evolution. The total number of DNA viruses resident on the Earth's seawater alone at any given time is currently estimated at $10^{31}$. In their total mass viruses contribute over 90% of the biomass of our planet. These facts, combined with the evolutionary arguments described earlier, require us to turn our attention to the possible continuing ingress of viral material from space. We consider it timely to conduct such a search in earnest to and initiate a series of balloon flights devoted to the recovery of viruses of possible extraterrestrial origin. One of the main aims of the newly constituted Institute for the Study of Panspermia and Astroeconomics (ISPA) will be to accomplish such a goal.

With the data that is currently available across a wide range of disciplines there can be little doubt that life is a cosmic phenomenon. A transition from Earth-centred biology to cosmic-centred biology is long overdue, and a delay in accepting this change of paradigm could have potentially serious consequences for the generally accepted Darwinian-Matthewian hypothesis, particularly in relation to the input of new diseases. We believe there is an urgent need for the possibility of bacterial and viral ingress from space to be taken seriously and explored with the best scientific technologies that are available. There is clear evidence that humans have evolved over tens of thousands of years with pandemics of disease punctuating evolution, and with the relics of offending viruses still resident in our genes (Ryan, 2009; Wickramasinghe, 2012; Tokoro and Wickramasinghe, 2014).

We cannot illustrate an imminent danger better than by quoting from an article by Dr. Louis Wienstein in the New England Journal of Medicine of 6 May 1976 in which he reviews all the available data relating to the influenza pandemic of 1918/1919 that caused some 30 million deaths worldwide:

"The influenza pandemic of 1918 occurred in three waves. The first appeared in the winter and spring of 1917-1918…..This wave was characterised by high attack rates (50% of the world's population was affected) but by very low fatality rates….The lethal second wave, which started at Ford Devens in Ayer, Massachusetts, on September 12, 1918, involved almost the entire world over a very short time…..Its epidemiological behaviour was most unusual. Although person-to-person spread occurred in local areas, the disease appeared on the same day in widely separated parts of the world on the one hand, but, on the other, took days to weeks to spread relatively short distances. It was detected in Boston and Bombay on the same day, but took three weeks before it reached New York City, despite the fact that there was considerable travel between the two cities. It was present for the first time at Joliet in the State of Illinois four weeks after it was detected in Chicago, the distance between those areas being only 38 miles……"

With no air travel in 1918 a simultaneous first strike in Boston and Bombay is strong evidence of a component of the virus (perhaps a fragment of transformative RNA) falling in from space.

Studying the epidemiology of a later influenza pandemic "Red Flu" (caused by the H1N1 subtype) Hoyle and one of the present authors (NCW) argued that the detailed patterns of incidence among school children in England and Wales was inconsistent with person-to-person infection being the dominant disease process (Hoyle and Wickramasinghe, 1979, 1990). Any person-to-person spread of the virus, if it occurred, had to be augmented by the action of a "molecular viral trigger" that descended through the lower atmosphere displaying complex patterns of turbulence that matched the clumpiness of incidence of clinical influenza that was found.

Although the changes with time of the dominant subtype of influenza has been diligently mapped by virologists (See Fig. 4), all attempts to predict the onset of a pandemic following a newly emergent subtype had led to failure.

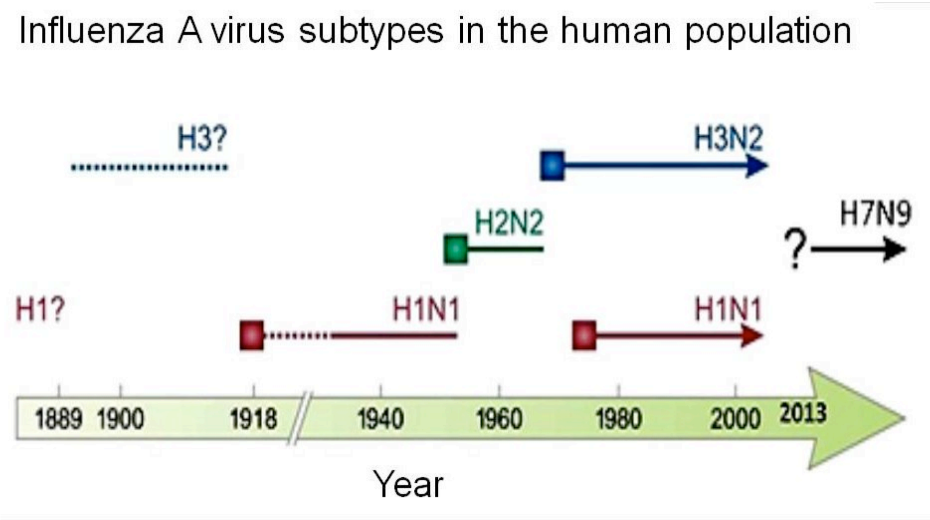


Fig. 4. Influenza A virus sub-types in the human population

From past experience it would be prudent to leave open the possibility of a viral trigger (DNA, RNA or even entire virus) deposited in the stratosphere that leads to the onset of a pandemic process. Whilst such a proposal may seem to fly in the face of scientific orthodoxy, the potentially disastrous consequences of any future pandemic of the 1917-1918 type must justify its consideration at the present time. We have raised similar issues earlier in relation to the SARS epidemic, the origin and termination of which still remains a mystery (Wickramasinghe, Wainwright and Narlikar, 2003).

From the foregoing discussion it is clear that we cannot afford to ignore the evidence that terrestrial life originated in comets, and furthermore that life in the present day continues to be inextricably linked to the cosmos. The economic cost of turning away from such facts could turn out to be globally disastrous. Not only would it impede a proper understanding of both biology and astronomy, but it would have repercussions on the economic well-being of humanity. This would be particularly the case if we continue to stubbornly turn away from the reality of microorganisms being incident from space. From the facts already to hand it is clear measures need to be put in force to monitor the stratosphere for incoming potential pathogens. In the event of a threat being discovered, preventative measures such as the production of appropriate vaccines could be put in place. This would be a practical proposition particles of viral size dispersed in the stratosphere by evaporating cometary bolides will take several years to fall to the troposphere and ground level. The Sheffield balloon programme, as well as a similar programme which is to be initiated at the newly formed Institute for the Study of Panspermia and Astroeconomics (ISPA) in Japan, could pave the way to progress. In this way it might be possible to avert the worst consequences of any future, space-derived, pandemic that could threaten us. Besides the cost in human life an unchecked attack on the scale of the 1917-1918 pandemic would set back world economies to the tune of trillions of dollars. Finally, a full and unequivocal recognition that life came from space and that all terrestrial life is integrated with a stupendous spectrum of cosmic life must change our worldview, our psychology and influence the way we live in harmony with nature.

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