Search for Aliens and Alien Life

Professor Chandra Wickramasinghe

Director, Cardiff Centre for Astrobiology

Alien life is everywhere in the cosmos, even on the Earth, if we know how to spot it.

There is a sense in which humans have always sought to discover alien life in natural phenomena that they failed to understand. Belief in the supernatural falls in this category, with a pantheon of gods and goddesses and an evanescent world of spirits to explain the forces of nature to which our primitive ancestors had no option but to submit. When such blind forces of nature eventually came to be understood, and in some instances even tamed, the quest for aliens took other forms.

A readiness to believe in UFO's pervades popular culture of the 21st century, despite the tenuous nature of much of the evidence adduced in support. The desire to believe in alien life is also encapsulated in the ever-increasing popularity of science fiction fantasising about aliens and alien life on other worlds. The famous radio broadcast in 1938 of a dramatisation of H.G. Well's "*War of the Worlds*" caused panic in the streets of New York, exemplifying again mankind's readiness to receive news that there is life out there – even intelligent life – on our neighbouring planet Mars. Notwithstanding such an instinct, official governmental bodies and the institutions of science in the 21st century behave differently. An attitude of self-righteous conservatism prevails. Acceptance of even the strongest evidence of primitive life on Mars or elsewhere in the Universe seems hard to achieve in a climate where extraterrestrial life is regarded as an "extraordinary claim for which extraordinary evidence" is demanded.

The ingress of alien microbial life onto our planet, whether dead or alive should not by any rational argument be perceived as a cause for concern. This is particularly so if, as appears likely, a similar process of microbial injection has continued throughout geological time. Unlike the prospect of discovering alien intelligence which might be justifiably viewed with apprehension, the humblest of microbial life-forms occurring extraterrestrially would not constitute a threat. Neither would the discovery of alien microbes impinge on any issues of national sovereignty or defence, nor challenge our cherished position as the dominant life-form in our corner of the Universe.

Aliens on Mars

The planet Mars had been the focus of attention in regard to habitability long before the advent of powerful telescopes or space probes. With the coarser grade of early photographic data the situation remained delightfully ambivalent in the early decades of the 20th century, with serious discussions being conducted as to the possibility of intelligent life.

With a radius of about half that of the Earth and a mass of approximately one-ninth, Mars has a surface gravity which is a little less than half of terrestrial gravity. This permits a thin atmosphere at the present time, though with not enough opacity to shield against damaging ultraviolet light at the surface. The Martian day is almost the same as the Earth day, and because the tilt of its axis of rotation is the same as of the Earth, the seasons are also similar to terrestrial seasons. On the other hand Mars is further than the Earth from the Sun so that the Martian year is nearly twice as long as the Earth year.

Speculations about intelligent Martian life arose as a result of observations of enigmatic features on the planet's surface when viewed with the low magnification telescopes available at the time. Some of these features were due to effects of Martian dust clouds that have only recently come to be fully understood; and the famous Martian canals which were assiduously mapped by many astronomers including Percival Lovell (1855-1916) were observational artifacts or optical illusions.

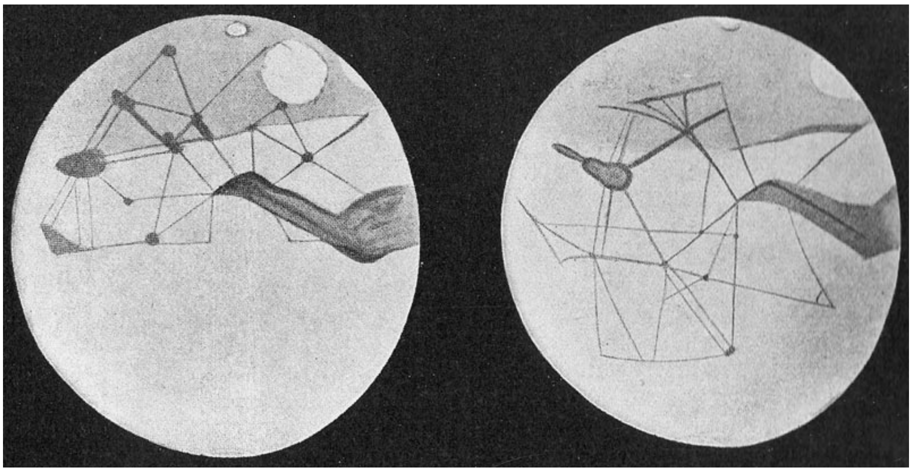


Fig. 1 – Lovell images of Mars canals

Fig. 2 - Photo of Levin – pioneer of Mars life detection

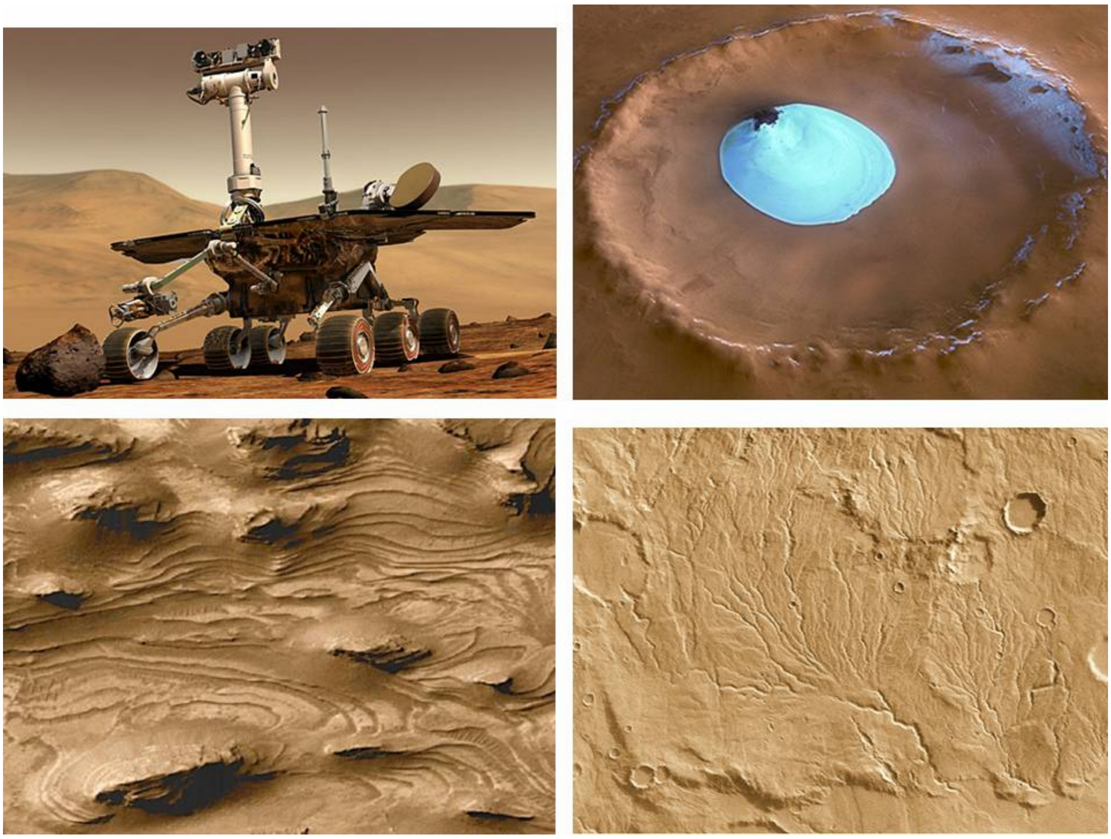


Fig. 3 Photos of taken by the Mars landers of surface features showing ice in the North Pole, sedimentary formations and dried-up river beds.

Although evidence for intelligent Martian life remained tenuous, it was difficult at the time to disprove the theory with the quality of images available at the beginning of the 20th century. An argument that could not be refuted was that if the Earth were viewed using the same telescopes and technologies from a Martian vantage point, our planet Earth would have been just as elusive over the presence or absence of intelligent life. There was no way to resolve this question unequivocally until the first Mariner probes of the 1960's sent back close-up images of the Martian surface. The answer was of course disappointingly negative, so that H.G. Wells' musings sadly came to nothing. Not only was there no evidence whatsoever of intelligent Martian life, but there were no structures that even vaguely resembled the fabled canals.

Since the earliest Mariner probes that photographed and mapped the surface at a resolution of 1km, a veritable flotilla of Mars orbiters and landers have been sent to the red planet and they continue to explore its surface and atmosphere in ever-increasing detail. The Viking orbiters launched in the 1970's quickly led to a revolution in our ideas about the composition of the red planet, and of the possibility of water on or near its surface. Vast river valleys were discovered as well as evidence of flooding in earlier epochs.

The Viking program ended in 1982 and another 14 years and several lost spacecraft (both US and USSR) were needed before the next successful phase of Mars exploration resumed. With the arrival of the *Mars Pathfinder* lander near the mouth of the Ares Valles valley on July 4 1997 further evidence of running water in the distant past was uncovered. Since then *Mars Odyssey*, *Mars Express*, and the rovers

Spirit and *Opportunity* continue to reveal a varied terrain that may well be suited for some types of primitive extremophilic microorganisms – not dissimilar to the forms of life known to inhabit the harshest environments on the Earth.

In nearly half a century of Mars exploration the only space mission that was explicitly directed towards searching for microbial life was connected with the *Viking* missions of 1976 with one of the life detection experiments under the leadership of Gilbert V. Levin (Levin, G.V. and Straat, Patricia A., 1979). These missions involved two landers carrying dedicated life detection experiments. The *Viking 1* lander touched down on 20 July 1976 on the *Chryse Planitia* near the equator; the *Viking 2* lander touched down on 3 September 1976 on *Utopia Planitia* closer to the Martian North Pole. The landers carried out biological experiments *in situ* on samples of soil, one of which was taken from beneath surface rocks. The presumption was that any microorganisms which may be present had metabolic processes similar to those of Earth microbes. The soil was treated with nutrient labelled with ^{14}C isotope, and its uptake by microbes was monitored by detecting radioactive exuded gases such as CO_2 or CH_4.

As with all innovative scientific experiments, the results turned out at first sight to be more complicated that was expected. The profusion of gas released (metabolites) that frothed out when the labelled nutrient was poured on the soil was a strong positive for life detection, but against this was the finding that the Martian soil did not show detectable amounts of even simple organic compounds. Since one could not have biology without evidence of the detritus of biology, the officialdom of NASA (Levin excluded) went public very quickly to say that the Viking results were not consistent with life. What was conspicuously missed in this assessment was the possibility that the turnover rate of life under the Mars surface conditions was so slow that the lack of organics is easily explained. Indeed the *Viking* experiment prototype taken to the dry valleys of the Antarctic several years before the launch of *Viking* yielded nearly identical results in the presence of Antarctic microbiota.

Principal Investigator Gilbert V. Levin always dissented from the official view of NASA that the Viking experiments *proved* no life on Mars. The gas released in the Viking Gas Release experiment was claimed by NASA to be more rationally explained by some inorganic chemistry involving a superoxidant, but to this day the search for the required material on the surface or in the laboratory has not been successful, and extant biology remains the most reasonable explanation of the results from Vikings 1 and 2.

After a careful reassessment of all the Viking Lander data Gil Levin continues to maintain that Viking discovered unambiguous evidence of microbial life on Mars way back in 1976. Taken together with more recent studies by *Mars Express* instruments of the levels of methane in the Martian atmosphere Gil Levin's claim of extant microbial life seems all the more secure, thus establishing him as the undisputed pioneer of Mars astrobiology.

Martian Meteorite ALH84001

Two decades after the Viking affair another result that is fully consistent with Martian life came from studies of the Mars meteorite ALH84001 (McKay et al, 1996). This 1.9 kg meteorite was discovered in Allan Hills Antarctica in 1984 and is thought to have been blasted off the Martian surface by an asteroid or comet impact some 15 million years ago. A team of investigators led by David S. McKay discovered sub-micron sized carbonate globules around which complex organic molecules including PAH's are deposited. Moreover, strings of ovoid-shaped structures and other forms were found which are strongly suggestive of fossilised nanobacteria. This interpretation was supported by an enhancement of the lighter carbon isotope, consistent with biology. An initial worry expressed in some circles related to the sizes of the presumed microbial fossils (nanobacteria) which were some 5-10 times smaller than would be appropriate for normal terrestrial bacteria – too small, critics said, to contain the genetic machinery needed for autonomous metabolism. This objection was largely overcome with the discovery of autonomously functioning nanobacterium (*Mycoplasma genitalium*) containing some 485 genes and about 585,000 base pairs.

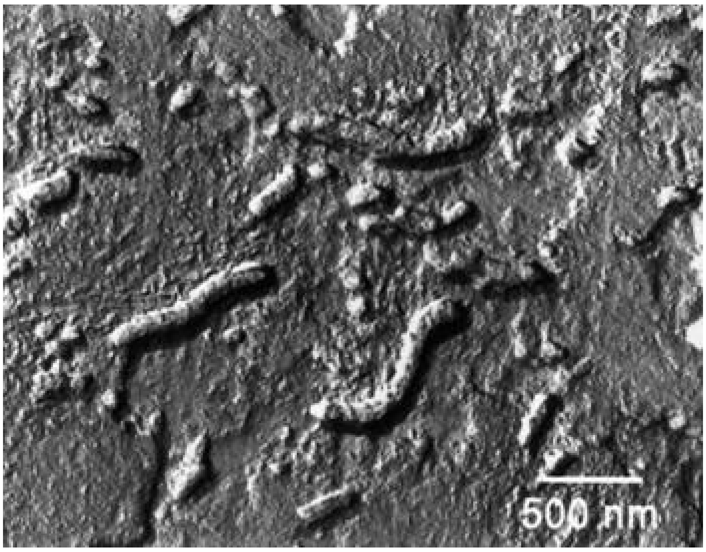


Fig.4 Carbon-based nanobacerial-sized structures in the Mars meteorite ALH84001.

Critics who voiced the opinion that the organics (PAH's) associated with ALH 84001 may be non-biologically generated point to the presence of similar molecules in carbonaceous chondrites as well as in interstellar dust clouds. However, the assertion that complex organic molecules in meteorites or in the interstellar medium have an abiotic or non-biological origin is itself highly dubious. A wealth of evidence supports a biological origin for both interstellar organics and the organic molecules in carbonaceous chondrites (Wickramasinghe, 2010a, b).

When it comes to a choice between biological and abiological explanations of both Gil Levin's Viking data, and David Mc Kay's data relating to ALH84001, Occam's razor is invoked to argue in favour of non-biology. Extraterrestrial biology is perceived as an extraordinary claim for which extraordinary evidence is needed in its defence. However this position is manifestly flawed if biology on Earth was itself derived from an extraterrestrial source, and this is indeed strongly indicated by a wealth of empirical data (Wickramasinghe, Wickramasinghe and Napier, 2010). Thus both Earth and Mars were infected from the same external source, and Occam's razor would effectively rule out the non-biological rather than the biological option.

Interstellar Dust and Life

A very similar resistance was encountered in respect of ideas relating to identifications of biochemicals in interstellar dust clouds. Already in the mid-1970's there was clear astronomical evidence for the widespread occurrence in the galaxy of organic molecules such as formaldehyde. At about this time infrared observations of interstellar dust were beginning to show spectral features in the mid and near-infrared which could not be easily reconciled with a combination of inorganic silicates and water-ice as was hitherto believed. But this evidence was vigorously disputed by our critics for a long time. Fred Hoyle and the present writer spent nearly 5 years of their professional lives modelling this data with biopolymers – polysaccharides, polyaromatic hydrocarbons in particular, and our pioneering work has at last been vindicated by a flood of data coming in from space telescopes and space probes. The complex organic nature of the dust in interstellar space as well as in comets and meteorites is now beyond dispute.

Photo of author and Fred Hoyle taken in 1979

The manner in which some of these molecules might relate to life and biology is still a matter of controversy. The question relates to whether these molecules represent steps towards life – prebiotic evolution – or whether they are the products of biological degradation – the detritus of life. The overwhelming bulk of the organic material found on Earth is the result of the decay of biology. Why is it not the same for the organics in space?

It has been argued for several decades that the probability that organic molecules transform into life in the form of even the simplest bacterium is vanishingly small. Odds against this transformation are estimated at 10^x:1 against with x in the range of several hundreds to thousands. This is surely of such an order that it would be foolish to bet that life appeared more than once or perhaps a few times in the entire history of the universe. The option of maintaining that this unique exceedingly rare and special event happened against all the odds on our planet – a minuscule speck of dust in the cosmos – is pre-Copernican and inadmissible. The model which I favour is one in which the origin of life was a rare event – perhaps even a unique event – but its spread once it has originated is inevitable

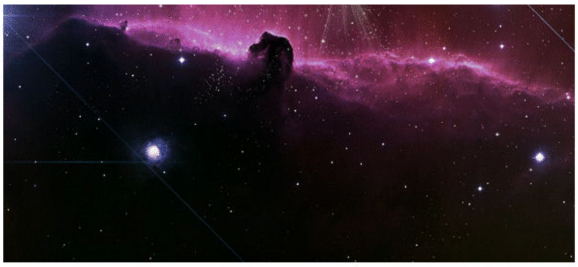
Despite the posturing of several contemporary "astrobiologists" that microbes cannot survive interstellar journeys, the weight of evidence does indeed favour survival to at least to the extent that makes viable interstellar transfers of life inevitable (Wickramasinghe, J., Wickramasinghe, C. and Napier, W.M., 2010). We do not require more than one in 10^{24} iterant microorganisms to survive, until it becomes incorporated in a planet/comet forming event in which a new cycle of exponential amplification occurs; a few viable microbes then turning into trillions. This exceedingly modest requirement of survival would be impossible to violate particularly for freeze-dried microorganisms embedded in particles of interstellar dust. The vast majority of bacteria in interstellar space *do not and need not* persist in viable state, however. Interstellar clouds would thus be filled with the detritus of life which takes the form of genetic fragments that could serve as viruses and viroids, as well as a wide range of organic molecules.

Interstellar organic molecules and the origin of life on the Earth

Facts relating to the widespread distribution of microbial life and their degradation products continue to come from astronomical studies. Figure 6 shows the Orion Nebula which contains giant clouds choc-a-bloc with organic molecules. Here is an active site of star-births, the youngest stars being younger than a few million years, and including many nascent planetary systems (protoplanetary nebulae). This veritable stellar and planetary nursery is considered by many to be a region where pre-biotic chemistry occurs on a grand cosmic scale. I have argued as an alternative that it may rather represent a graveyard of life – polyaromatic hydrocarbons and other organic molecules present here arising from the destruction and degradation of life.

Fig.6 The Orion Nebula – giant clouds of gas and dust - a stellar nursery

Identifying the composition of interstellar dust in clouds such as Fig. 6 has been a high priority for astronomical research since the early 1930's (see Wickramasinghe, 1967). The dust absorbs and scatters starlight causing extinction of the light from stars, and re-emits the absorbed radiation in the infrared. An important clue relating to dust composition follows from studies of extinction or dimming of starlight. The total amount of the dust has to be as large as it can be if nearly all the available carbon and oxygen is condensed into grains. The paradigm in the 1960's that the dust was largely comprised of water-ice was quickly overturned with the advent of infrared observations showing absorptions due to CH, OH, C-O-C linkages consistent with organic polymers. The best agreement for a range of astronomical spectra embracing a wide wavelength interval turned out to be material that is indistinguishable from freeze-dried bacteria and the best overall agreement over the entire profile of interstellar extinction was a mixture of desiccated bacteria, nanobacteria, including biologically derived aromatic molecules as seen in Fig.7a,b.



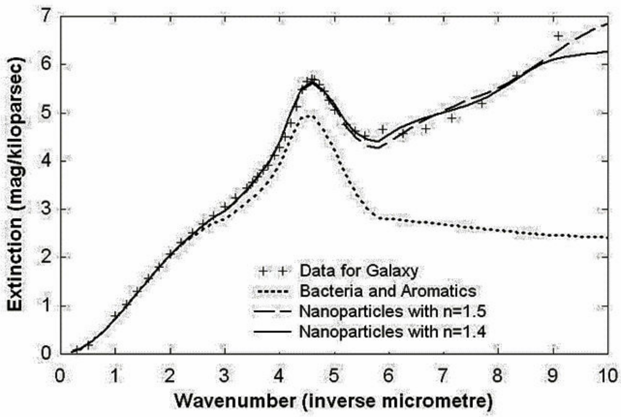


Fig.7a Top – Horsehead Nebula in Orion showing clouds of cosmic dust.
Bottom - Agreement between interstellar extinction (dimming data) (plus signs) and biological models of cosmic dust. The 2175A hump in the extinction is caused by biological aromatic molecules (See J. Wickramasinghe et al (2009) for details)

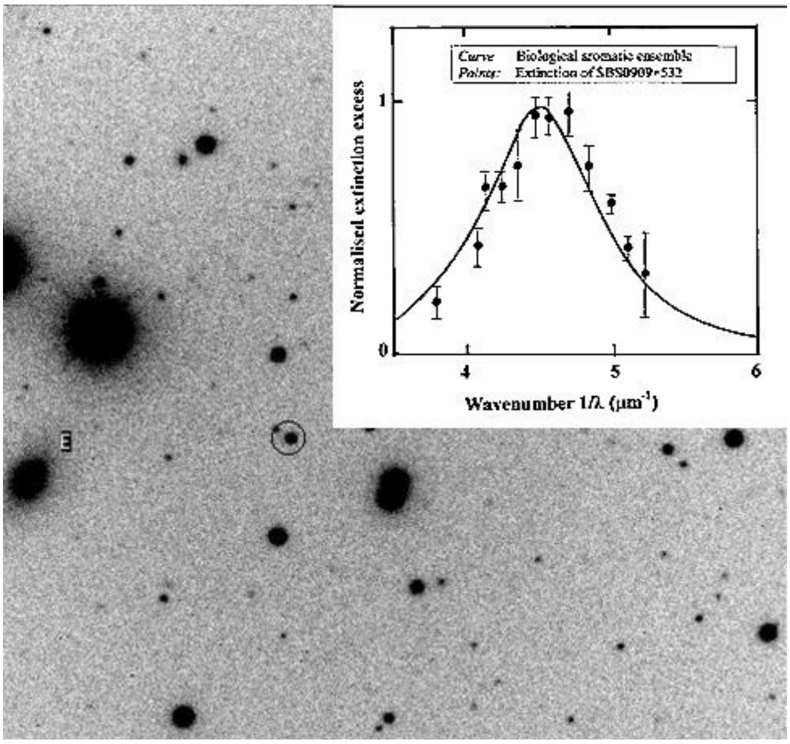


Fig.7b Agreement between the 2175A absorption of biomolecules (life) and the dust dimming profile of the galaxy SBS0909+532 at a distance of nearly 8 billion light years (See Wickramasinghe et al (2004) for details)

Although many astronomers still seek abiotic models to explain the data such as in of Fig 7, biology provides by far the simplest self-consistent model. In particular, a claim that the strong peak of interstellar extinction at 2175A can be explained by aromatics (PAH's) unconnected with life could be seriously flawed (Hoyle and Wickramasinghe, 2000; Rauf and Wickramasinghe, 2009). Aromatic molecules resulting from the decay, degradation or combustion of biomaterial may be similar to soot or anthracite. Figs. 8 and 9 show striking correspondences between astronomical data and such models.

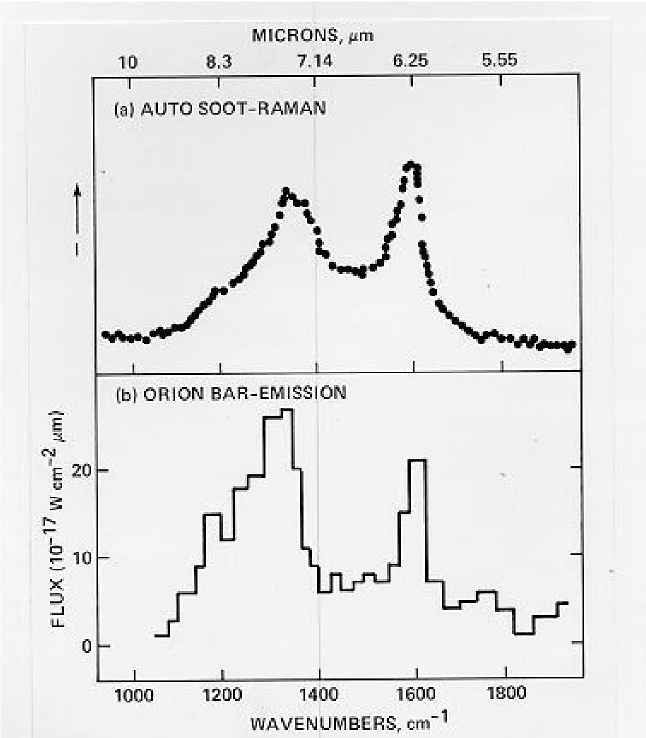


Fig 8. Comparison between Orion Bar dust emission and PAH – autosoot system – autosoot is a biological degradation product.

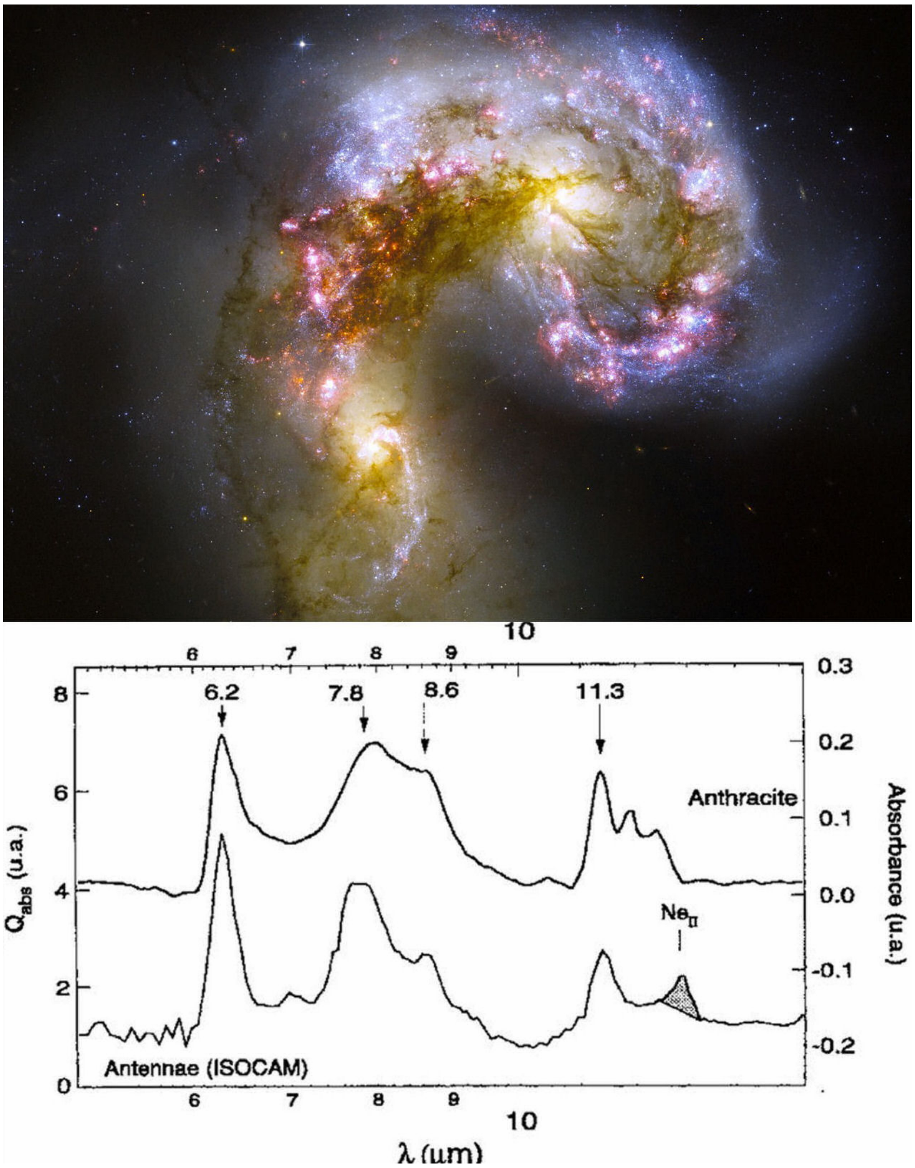


Fig. 9 Emission from dust in Antennae galaxies at a distance of 65 million light years (top) compared to anthracite, a biological degradation product.

Panspermia

The only secure empirical fact relating to the origin of life is encapsulated in a dictum eloquently enunciated by Louis Pasteur *Omne vivum e vivo*—all life from antecedent life (1857). If life is always derived from antecedent life in a causal chain that is clearly manifest in present day life and through the fossil record, the question naturally arises as to when and where this connection may have ceased. The continuation of the life-from-life chain to a time before the first life appears on our planet and before the Earth itself formed implies the operation of "panspermia".

The basic concept of panspermia has an ancient history going back centuries - to the time of classical Greece and even before – referring in general to the widespread dispersal of the "seeds of life" in the cosmos (Hoyle and Wickramasinghe, 1982, 2000; Arrhenius, 1908). Critics of panspermia often say that such theories are of limited value because they do not address the fundamental question of origins.

Nevertheless the question of whether life originated *in situ* on Earth, or was delivered here from the wider universe constitutes a scientifically valid line of inquiry that needs to be pursued.

Whilst the Francis Crick and Leslie Orgel's idea of directed panspermia transfers the problem of origin to another site, possibly invoking intelligent intervention (Crick and Orgel, 1973). Fred Hoyle and I have attempted to expand the domain in which cosmic abiogenesis *may* have occurred, focussing in particular on totality of comets in our galaxy. Like Crick and Orgel (1973) we were influenced by the super-astronomical odds against the transition from organic molecules to even the most primitive living system as we have already mentioned.

Primordial Soup Theory

The familiar Earth-bound theory of the origin of life was evidently inspired by Charles Darwin. Although Darwin never alluded to the origin of life in his 1859 book *On the Origin of Species* (Darwin, 1859, he had thought about the problem and formulated his own tentative position in a letter to Joseph Hooker in 1871 thus:

"….It is often said that all the conditions for the first production of a living organism are now present, 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, &c., present, that a proteine compound was chemically formed ready to undergo still more complex changes, at the present day such matter would be instantly absorbed, which would not have been the case before living creatures were found."

Darwin's prescient remarks provided the basic scientific framework for exploring the problem of abiogenesis throughout the 20th century and beyond. In the late 1920's A.I, Oparin (1953) and J.B.S. Haldane (1929) fleshed out Darwin's thoughts into the familiar "Primordial Soup Theory", proposing that the atmosphere of the primitive Earth comprised of a reducing mixture of hydrogen, methane and ammonia and other compounds from which the monomers of life could be readily generated. Primitive 'lightening' and solar ultraviolet provided the energy to dissociate these molecules, and the radicals so formed recombined through a cascade of chemical reactions to yield biochemical monomers such as amino acids, nucleotide bases and sugars. The classic experiments of Stanley Miller and Harold Urey (1959) demonstrated the feasibility of the chemical processes proposed by Oparin and Haldane, and this led to the belief that life could be generated *de novo* as soon as the biochemical monomers were in place. The formation of the first fully-functioning, self-replicating life system with the potential for Darwinian evolution is riddled with the difficulty of beating super-astronomical odds as we have discussed earlier.

Origin of Life in Comets

Support for the idea that life originated on Earth in a primordial soup is beginning to wear thin in the light of modern geological and astronomical evidence. It is becoming clear that life arose on Earth almost at the very first moment that it could have survived. During the period from about 4.3-3.8 by ago (the Hadean Epoch) the Earth suffered an episode of heavy bombardment by comets and asteroids. Rocks dating back to the tail end of this epoch reveal evidence of an excess of the lighter isotope ^{12}C compared with ^{13}C pointing to the action of microorganisms that preferentially take up the lighter isotope from the environment (Mojzsis et al, 1996;

Manning et al, 2006). The Hadean epoch in the Earth's geological history was undoubtedly marked by an exceptionally high frequency of comet and asteroid impacts. It is generally thought that much of the water in the oceans came from comets. Along with the water, comets also brought life. This is the theory of cometary panspermia proposed in 1979 by Hoyle and the present writer.

In the formation of a planetary system such as the solar system (and the proto-planetary nebulae such as are seen in Fig.10) the first solid objects to form are the comets. These icy objects would contain the molecules of the parent interstellar cloud, and for a few million years after they condensed would have liquid water interiors due to the heating effect of radioactive decays (J. Wickramasinghe et al, 2009). If microbial life was already present in the parent interstellar cloud, the newly formed comets serve to amplify it on a very short timescale.

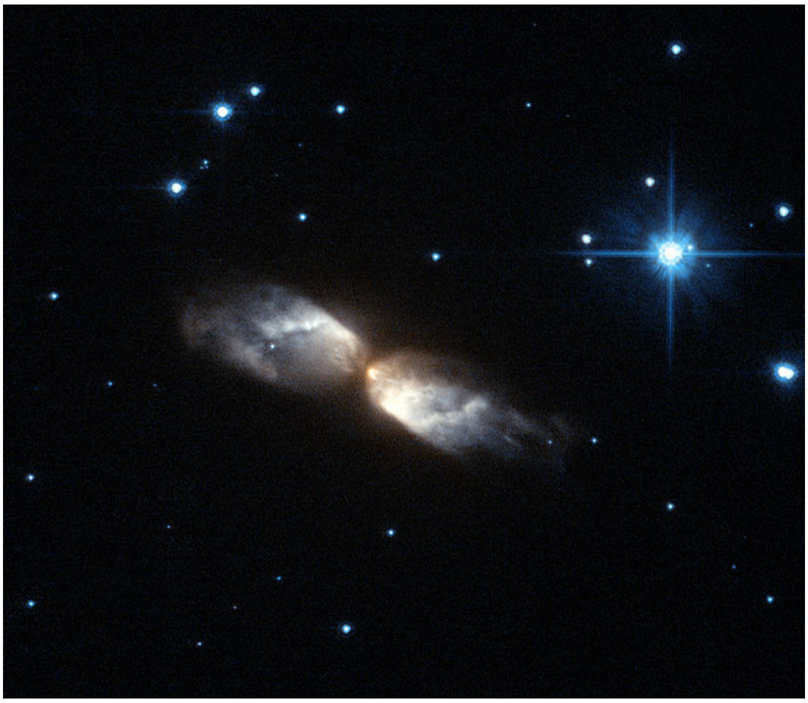


Fig. 10 A protoplanetary nebula – newly forming planetary system seen edge-on

But prior to life being generated anywhere, primordial comets could provide trillions of "warm little ponds" replete with water, organics and nutrients, their huge numbers diminishing vastly the improbability hurdle for life to originate. Recent studies of comet Tempel 1 (Figure 11) have shown evidence of organic molecules, clay particles as well as liquid water, providing an ideal setting for the operation of the "clay theory" of the origin of life (Cairns-Smith 1966; Napier et al, 2007).

It can be argued that a single primordial comet of this kind will be favoured over all the shallow ponds and edges of oceans on Earth by a factor 10^4, taking into account the total clay surface area for catalytic reactions as well as the timescale of persistence in each scenario. With 10^{11} comets, the factor favouring solar system comets over the totality of terrestrial "warm little ponds" weighs in at a figure of 10^{15}, and with 10^9 sun-like stars replete with comets in the entire galaxy we tot up a factor of 10^{24} in favour of a cometary origin life

The next step in the argument is that once life got started in some comet somewhere, its spread in the cosmos becomes inevitable. Comets themselves provide ideal sites for amplification of surviving microbes that are incorporated into a nascent planetary system as we have seen earlier. Dormant microorganisms are released in the dust tails of comets can be propelled by the pressure of starlight to reach interstellar clouds. Transport of life in the form of microorganisms and spores within the frozen interiors of comets carries only a negligible risk of destruction, whilst transport in either naked form, within clumps of dust or within meteorites entails varying degrees of risk of inactivation by cosmic rays and UV light. It cannot be overemphasised, however, that the successful seeding of life requires only the minutest survival fraction between successive amplification sites. Of the bacterial particles included in every nascent cometary cloud only one in 10^{24} needs to remain viable to ensure a positive feedback loop for panspermia. All the indications are that this is indeed a modest requirement that is hard, if not impossible, to violate.

Fig. 11 Comet Tempel 1 showed evidence of relic frozen lakes and clay indicative of early contact with liquid water. Left optical image; Right image taken from cameras on *Deep Impact Mission*

Horizontal gene transfer across the galaxy

Whilst amplification of microorganisms within primordial comets could supply a steady source of primitive life (archeae and bacteria) to interstellar clouds and thence to new planetary systems, the genetic products of evolved life could also be disseminated on a galaxy-wide scale (Napier, 2004, Wallis and Wickramasinghe, 2004; J.Wickramsinghe and Napier, 2008). Our present-day solar system which is surrounded by an extended halo of some 100 billion comets (the Oort Cloud) moves around the centre of the galaxy with a period of 240My. Every 40 million years, on the average, the comet cloud becomes perturbed due to the close passage of a molecular cloud. Gravitational interaction then leads to hundreds of comets from the Oort Cloud being injected into the inner planetary system, some to collide with the Earth. Such collisions can 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 spash-back of surface material back into space. 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 could reach newly forming planetary systems in the passing molecular cloud within a few hundred million years of an ejection event. A new planetary system thus comes to be infected with terrestrial microbes terrestrial genes that can contribute, via horizontal gene transfer, to an ongoing process of local biological evolution. Once life has got started and evolved on an alien planet or planets of the new system the same process can be repeated (via comet collisions) transferring genetic material carrying local evolutionary 'experience' to other molecular clouds and other nascent planetary systems. If every life-bearing planet transfers genes in this way to more than one other planetary system (say 1.1 on the average) with a characteristic time of 40My then the number of seeded planets after 9 billion years (lifetime of the galaxy) is $(1.1)^{9000/40} \sim 2x10^9$. Such a large number of 'infected' planets illustrates that Darwinian evolution, involving horizontal gene transfers, must operate not only on the Earth or within the confines of the solar system but on a truly galactic scale. Life throughout the galaxy on this picture would constitute a single connected biosphere.

Bacteria are Space Travellers

The discovery of bacteria and archaea occupying the harshest environments on Earth continues to provide indirect support for panspermia. Viable transfers of microbial life from one cosmic habitat to another requires endurance of high and low temperatures as well as exposure to low fluxes of ionising radiation delivered over astronomical timescales, typically millions of years. The closest terrestrial analogue to this latter situation exists for microorganisms exposed to the natural radioactivity of the Earth, an average flux of about 1 rad per year. Quite remarkably microbial survival under such conditions is well documented. Dormant microorganisms in the guts of insects trapped in amber have been revived and cultured after 25-40 million years (Cano and Borucki, 1995); and a microbial population recovered from 8 My old ices has shown evidence of surviving DNA (Biddle et al, 2007). All this goes to show that arguments used in the past to 'disprove' panspermia on the grounds of survivability during interstellar transport are likely to be fatally flawed.

Meteorites and Bacterial Fossils

The topic of microbial fossils in a class of meteorite known as carbonaceous chondrites has sparked bitter controversy in scientific circles ever since it was first suggested in the mid-1960's (Claus, Nagy and Europa, 1963). Because carbonaceous chondrites are generally believed to be derived from comets, the discovery of fossilised life forms in comets would provide strong *prima fac*ie evidence in support of the theory of cometary panspermia. However, claims that all the micro structures (organised elements) discovered in meteorites were artifacts or contaminants led to a general rejection of the microfossil identifications. The situation remained uncertain until early in 1980 when H.D. Pflug found a similar profusion of "organised elements" in ultrathin sections prepared from the Murchison meteorite, a carbonaceous chondrite that fell in Australia on 28 September 1969 (Pflug, 1984). The method adopted by Pflug was to dissolve-out the bulk of minerals present in the thin meteorite section and examine the residue in an electron microscope.

Hans Pflug visited Cardiff in 1981and on the 26th of November he delivered a lecture, introduced by Fred Hoyle, that left the audience speechless. The poster for the lecture and some of his key images are shown in Fig. 12a. The response to Pflug's discoveries differed markedly from the earlier attitudes to Claus and Nagy. Pflug was not attacked on grounds of contamination or artifacts, but he was given what could be described as the "silent treatment". There were muffled whisperings in University common rooms, but nothing in the way of a well-formulated technical criticism ever appeared in print.

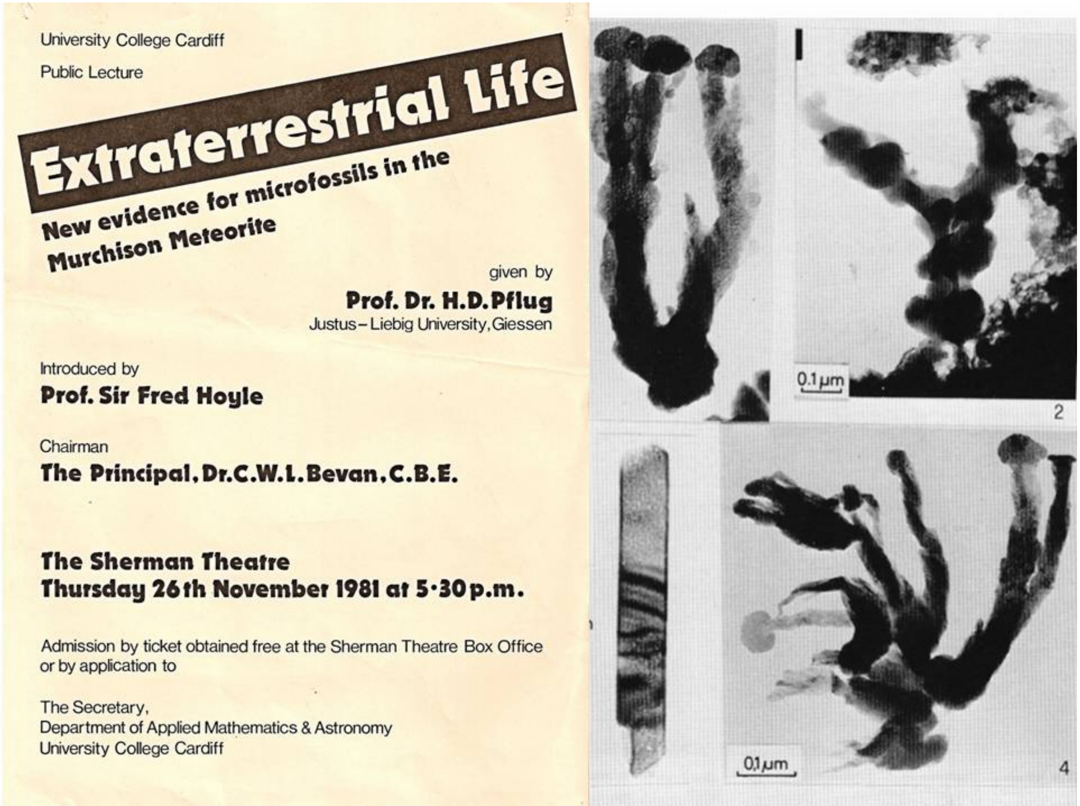


Fig. 12a Pflug's lecture poster and an example of a microfossil of *pedomicrobium* in the Murchison Meteorite.

More recent work by Richard Hoover (2005, 2012) and his team at the NASA Marshal Space Flight Centre leaves little room for any other interpretation of these structures than that they are microbial fossils (Fig 12b).

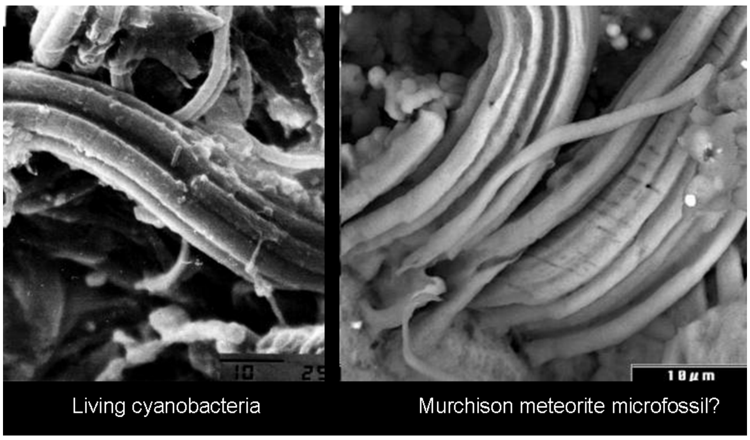


Fig.12b A structure in the Murchison meteorite compared with living cyanobacteria (Hoover, 2005)

The furore that greeted this new publication, with vocal condemnation from Science journals and from NASA chiefs, shows that earlier tactics of rejection by silence have now been replaced by strident ranting and even personal insults. Had we lived in the Middle Ages there is no doubt that Richard B Hoover, and possibly Fred Hoyle, Pflug, and I too, would have come to a bad end – suffering the fate of Giordano Bruno in 1600!

Ongoing Injections of Alien Life

Whilst the arrival of rocks from space containing fossil microbes is interesting enough, even more interesting and important would be arrivals of viablr microorganisms – living bacteria and viruses. From 1986 onwards infrared spectra of comets have shown consistency with the presence of intact desiccated bacteria. With some 50-100 tonnes of cometary debris entering the Earth's atmosphere on a daily basis the collection and testing of this material for signs of life should in principle at least be straightforward. Such a project was recently started in 2001 by the Indian Space Research Organisation, ISRO, in partnership with writer. Samples of stratospheric aerosols collected using balloon-borne cryosamplers were investigated independently in Cardiff, Sheffield and India and have revealed tantalising evidence of microbial life (Harris et al, 2002; Wainwright et al, 2003, 2004). A particularly interesting component of the collected samples was in the form of 10 micrometre clumps that have were identified by standard bacteriological tests as being viable but not culturable microorganisms (Fig. 13).

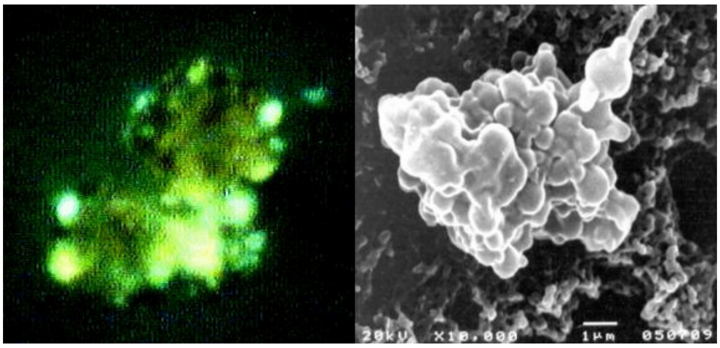


Fig. 13. Cometary particles. The left panel shows a clump fluourescing under the action of a dye and the right panel shows a scanning microscope image showing a clump of cocci and a bacillus.

Because such large aggregates are virtually impossible to loft to 41 km a *prima facie* case for their extraterrestrial cometary origin has been made. In later experiments done by ISRO scientists three new species of bacteria from 41km were actually cultured, with a strong presumption of being of extraterrestrial origin. One of these *Janibacter hoylei* was named in honour of Fred Hoyle – a co-propounder of the theory of cometary panspermia. Hoyle and the present writer have also emphasised the role of bacterial and viral gene additions to our planet in providing the feedstock (genetic innovations) needed for evolution of life. Without this input we argue that the evolution from bacteria to plants, animals and humans would not have been possible.

Red Rain of Kerala: More Evidence of Aliens

On the 25th of July 2001 a sonic boom was heard over a large part of the State of Kerala in South India and minutes later the clouds unleashed rain that looked like blood – the Red Rain of Kerala. At first the red colour was thought due to the suspension of red dust of inorganic composition, but this was soon ruled out by microscope studies. Under the microscope the red particles looked like biological cells, and electron microscope images confirmed that they had all the characteristics of biological cells – thick multilayered cell walls and internal organelles, but so far they have defied identification with any known type of terrestrial bacterium or algal cell.

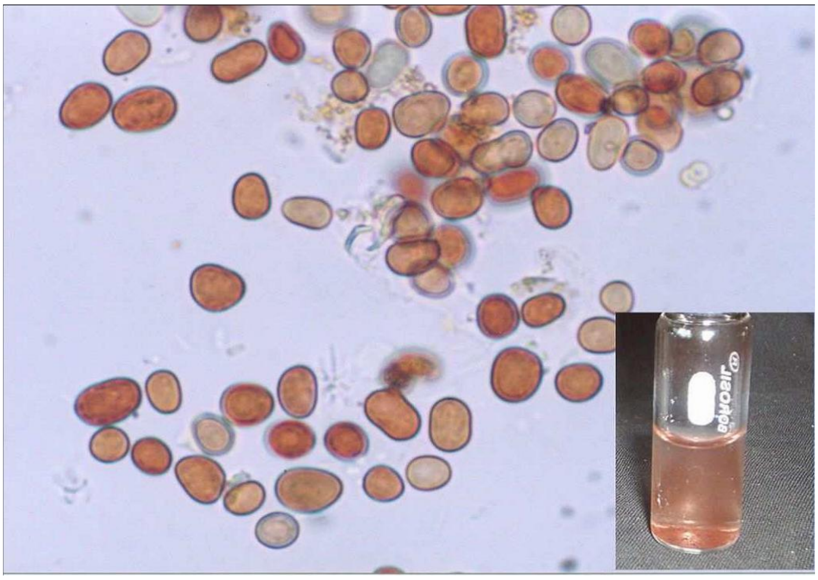


Fig.14 Red cells under optical microscope

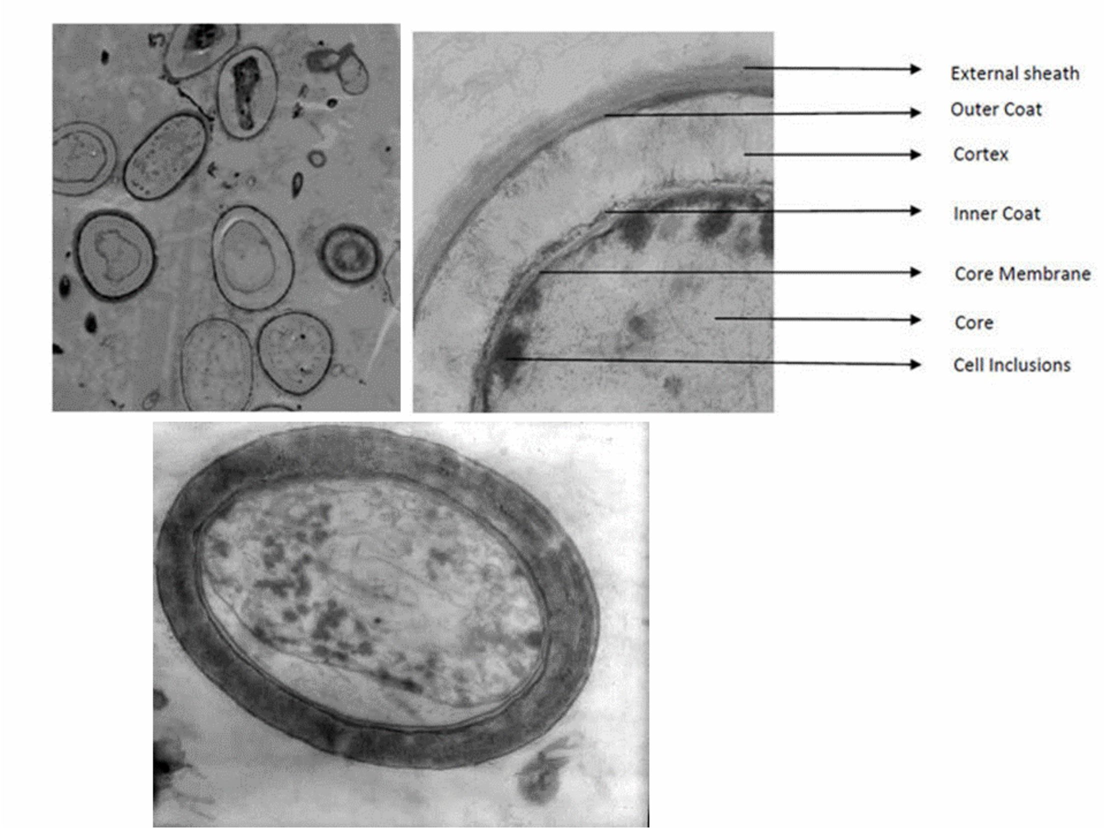


Fig.15 Sections of the red cells studied with transmission electron microscopy. Diameters range from 5 to 15 micrometres.

The controversial theory that the red cells were unleashed from a disintegrating comet fragment continues to be debated. The rain continued for about 20 minutes and the total mass of red cells involved has been estimated at about 50,000 kilograms. These events were repeated intermittently until September 2001. There is also a controversial claim by Prof Godfrey Louis that the cells do not contain DNA and yet can replicate in nutrients in high pressure canisters even when they are heated to 300C. Teams in Cardiff and Sheffield have verified that the cells do reproduce at temperatures of 121C, but we have not been able to verify what happens at higher temperatures (Rajkumar et al, 2011). Some standard tests for DNA have yielded positive results, but our efforts to extract, amplify and sequence it have not yet met with success. The jury is still out but the cells in Figs 13, 14 show all the signs of an alien bug.

Concluding Remarks

The existence of alien bugs, big or small, dead or alive is violently resisted by the 21st century scientific culture that prevails. The intensity of emotion surrounding this issue was driven home to me in witnessing the aftermath of the publication of Richard B. Hoover's life in a meteorite images in the Journal of Cosmology. In the discussion that ensued, it was clear that the general public welcomed the discovery, but an elite scientific establishment shunned it. The reaction was reminiscent of the rejection by the French Academy of Sciences of even the existence of meteorites – stones falling from the skies – in the middle of the 19th century. All such reports were vehemently and authoritatively denied. The world of science is not yet ready to admit that we are not alone – let alone invaded by alien life.

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