

Was
Darwin
Wrong?



Fred Hoyle's The Intelligent Universe

A summary & review

by Gert Korthof

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Fred Hoyle was an important scientist who worked at the frontiers of astronomy and theoretical physics. In 1983 he published a well-illustrated popular book for nonscientists in which he attacked the whole idea that life originated and evolved on Earth and replaced it by 'intelligent cosmic control'.

Summary of the Chapters

Comments

Foreword

Hoyle places Darwin in a cultural context. The foreword contains religious and ethical issues such as the 'real purpose in life' and 'moral sense'. Orthodox scientists are occupied by a fight against religion in stead of finding the truth. A 'nihilistic outlook dominated science' after publication of Origin of Species. Hoyle's motivation for writing this book is a protest against 'nihilistic philosophy'.

To my surprise Hoyle's attitude to Darwin and Darwinists closely resembles the attitude of Creationists (Johnson, Behe, Dembski). They are reviewed on this site. We shall discover that Hoyle and creationists have many ideas in common.

1: Chance and the Universe

"Could life have evolved at random?" asks Hoyle in the subtitle of the chapter and further on he says "The probability of life appearing spontaneously **on Earth**" [1].

Hoyle describes the famous analogy: a horde of monkeys could type Shakespeare if enough time is given [2].

The chance that even one protein appeared spontaneously is equal to the chance that a blindfolded person could solve the Rubik cube:



using 1 move per second. It takes 300 times the age of the Earth.[3]

This chapter contains the often quoted claim that the chance that the 2000 universal house-keeping enzymes originate from random processes is $1 : 10^{40000}$ (these enzymes are crucial for life) [4].

Are there many possible biochemistries? If so, then the problem is easier. Hoyle's answer is 'NO' because those 2000 reactions are determined by the properties of Carbon atom, and so our biochemistry is literally universal and alternatives are non-existent [5].

Hoyle attacks the primordial soup idea. Enzymes are never produced in soup conditions in the lab. Next follows the famous Boeing-747 story. He imagines how molecules could make useful combinations in a primordial soup, and concludes that this scenario would only work if an intelligence made the choices and combinations [6]. If proteins spontaneously originate, they should easily have been reproduced in the lab! And if the experiment would have succeeded it would have been well-known and famous throughout the world!

"In short there is not a shred of objective evidence to support the hypothesis that life began in an organic soup here on Earth." Continuing unconditionally: "life did not appear by chance", however also suggesting that our theories of the origin of life are too geocentric [7].

[1] The addition 'on Earth' makes a great difference of course! We will return to this.

[2] Hoyle does not mention that this example is from Julian Huxley (evolutionist). The Shakespeare example was also refuted by [David Foster](#) (1993) chapter 10.

[3] Hoyle does not compare it with the age of the universe. So we don't know if Hoyle accepts a naturalistic origin of life. The following points invalidate the cube analogy: a) one second as the unit of the trial is too long, considering chemical reaction times are in the order of femtoseconds = 10^{-15} seconds (the scientist Ahmed Zewail received the Nobel Prize 1999 for research in this area). b) taking a human cell is not right, because according to Maynard Smith we have 60 - 80,000 genes and first life could have as low as 500 - 2000 genes. Hoyle wrongly uses 'genetic code' as the information in DNA (p13). c) Hoyle bases his calculation on 20 different amino acids. Wrong. It is now thought that the original genetic code started with 7 amino acids (see Yockey(1992), p183).

[4] Hoyle ignores that each enzyme can be coded for by many different codes because the genetic code is redundant. For example, a protein of 20 amino acids can be coded for by 340 million different codes and if stopcodon is included by 1,02 billion ways (Caporale, 2003, p.30). Furthermore, not every amino acid has an unique function, some are interchangeable without loss of function of the protein. [updated 5 Mar 2006]

[5] This looks like the fine tuning argument: Carbon is fine-tuned to create life. This argument is anti Stuart Kauffman and pro fine-tuners like Michael Denton. Hoyle's presentation of the argument is very short, and not elaborated.

[6] This conclusion is almost defining Intelligent Design Theorists today.

[7] Hoyle still is not clear if chance excludes

2: The Gospel According To Darwin

This chapter is about the Darwinian theory of evolution. How Darwinism became the dominant theory in biology or even became a superstition. How did this happen? Biology started with the invention of the microscope by Van Leeuwenhoek (1673). "News of Van Leeuwenhoek's achievement quickly reached London, and soon the Fellows of the newly formed Royal Society were at work." [8]. The microscopist Robert Hooke was the first to propose links between species. The replacement of the doctrine of special creation by evolution was caused by socio-economic factors especially in France. The popularity of Darwinism in the UK is explained by industrialisation [9]. Hoyle rejects Lamarckian inheritance for the right reasons ('one-way system'). Rejects Young Earth Creationism. Edward Blyth had a significant role in the origin of the theory of evolution, but accepted 'special creation'. Wallace too had a significant role, he had sharper ideas on evolution and natural selection than Darwin himself did. Darwin was neither the inventor of 'evolution' (the idea existed for two centuries), nor the inventor of the idea of natural selection [10]. However Darwin's *Origin* was a 'substantial work'. As a teenager Hoyle became convinced that the idea of natural selection was circular (tautology) [11]. Further Hoyle rejects the widely accepted fact that **mutation frequency** is high enough to produce enough mutations for natural selection to work on. The copying of DNA seems to be too accurate. Furthermore advantageous mutations are rare. The most are harmful. Hoyle compares the operation of natural selection with Maxwell's devil and concludes that in nature there is no similar 'intelligence' ('outside intervention') to do the selection [12]. Lethal mutations are automatically eliminated and large harmful mutations are easily eliminated by natural selection. The negligible effect of small mutations is described with the nice metaphor: a 'signal' which is swallowed by 'noise'. The result is that natural selection is powerless to prevent the accumulation of many small mutations, which add up to a lower fitness of the members of the species. For the same reason natural selection is powerless to pick up the very small **beneficial** mutations. It's easier to select large beneficial mutations [13].

also the spontaneous origin of life in the universe!

Does the chapter title look like "Darwinist Religion"? This is a chapter in Phillip Johnson's *Darwin on Trial*.

[8] Hoyle forgot to mention that the news came by letters of van Leeuwenhoek (Dutch) himself, in which Van Leeuwenhoek described all his observations he made himself with his microscopes, and which were published in the proceedings of the Royal Society. So Van Leeuwenhoek did not only invent the microscope but observed for the first time ever sperm, and all kinds of little animals no human eye had ever seen before.

[9] This is an external (opposed to internal) explanation of scientific change. It's remarkable for the scientist Hoyle to ignore scientific facts themselves as the most important triggers for scientific change!

[10] See for identical point of view in [Dempster](#) and most other Darwin-critics.

[11] It's mysterious why Hoyle finds it useful to mention the tautology, while he knows that natural selection can be defined in exact mathematical terms, as he himself did in the [Mathematics of Evolution](#).

[12] A beautiful analogy on its own, it shows at the same time that Hoyle is focussed on 'intelligence' and 'outside intervention', so characteristic of Intelligent Design Theorists! The illustration on page 37 depicts something like what biologists call sympatric speciation. Hoyle does not know about allopatric speciation. Hoyle's analogy is wrong. Temperature differences originate between rocks and earth, despite the same solar energy input. No intelligence is needed for that.

[13] These are important ideas elaborated mathematically in his *Mathematics of Evolution*. However 10 small beneficial mutations could equal 1 big beneficial mutation and 10 small harmful mutations

A page titled **Darwin's Unsolved Problems** contains warning colours, cleaner fish, the complex life of a parasite, bee food dance, a spider's web. Hoyle says these examples are problems because intermediate forms are useless or even dangerous [14].

Fossils, fossils, and fossils...

Darwin propagandists told the public and other non-biologist scientists that the fossil record supports Darwin's theory of evolution. Yet the situation was quite otherwise. The famous horse series could be explained by nutrition [15]. There is no evidence of step-by-step changes in insects and there are more than enough insects in the fossil record. The famous *Archaeopteryx*, half reptile and half bird, is not enough evidence for a link between reptiles and birds [16]. "The Darwinian theory is wrong because random variations tend to worsen performance". An explanation that accounts for the facts just as well is the sudden arrival of genes from space [17].

could add up to 1 big harmful mutation and consequently can be selected for or against groupwise. Especially when they are positioned on the same chromosome they can easily be eliminated or selected as a group. The picture on page 34 shows people with only two toes on each foot as an example of a mutation in humans. While I was reading this book, a publication in Cell appeared which reported the discovery of the gene responsible for the condition, the P63-gene. It is dominant, not lethal and is inherited in 50% of the children of a patient.

[14] These examples are told in a few words and not examined in any depth, a serious omission for a scientist. Why show them and not give them more space than 1 page? I wonder where he got the examples. Hoyle does not say those unsolved problems refute Darwinism. However I think it's unreasonable to demand from a scientist to have an immediate answer to every question that can be asked. Science exists by virtue of unanswered questions. Outsiders easily get the impression that science has answers to all questions and evolutionists fail because they don't have an answer to every question. In a popular book it is surely not necessary to make such misleading suggestions. Please note that the unsolved problems are instances of Irreducible Complexity, a term which was introduced by Michael Behe 13 years after the publication of Hoyle's book.

[15] No references or details are given for this claim. There aren't any references to scientific books or journals at all in *The Intelligent Universe*.

[16] Please note Hoyle does not talk about forgery at all! Hoyle and Wickramasinghe published in 1987 '*Archaeopteryx, the Primordial Bird: A Case of Fossil Forgery*'.

[17] Evolution on Earth can only profit from genes from space if they have exactly the same genetic code. I showed in this review that this is extremely unlikely.

3: Life did not originate on Earth ¹⁸

This chapter is about the study of comets and meteorites. A meteorite caused the extinction of Dinosaurs. Could such objects bring life to Earth? However very small particles down to the size of a virus do not get burned by entering the Earth's atmosphere and can land undamaged on the Earth after months or years and they are coming in huge quantities. Meteorites do contain carbon and inorganic materials in a form that suggests nonterrestrial biological origin. Inside meteorites, protected from contamination, fossilised *Pedomicrobium*-like bacteria have been found. Meteorites cannot contain living cells. The four commonest elements of comets are hydrogen, carbon, nitrogen and oxygen, and these are blown into space. Cometary material contains not only precursors of life, but is fossilised life.

4: The interstellar connection

This chapter is about dust between the stars. In the 1960s Hoyle and Wickramasinghe suggested the dust consists of carbon, but this could not explain all observations. In 1979 they discovered that **dried bacteria** perfectly explain all the observations. Bacteria need to survive a temperature of 390°F = 200°C for a few seconds caused by entering the Earth's atmosphere. Almost like a too short sterilisation procedure. However sea-floor volcanos harbour bacteria that survive 582°F (= 306°C). Bacteria are small enough not to get burned in the Earth's atmosphere. "There is no possibility, for example, of the eggs of birds passing safely through the atmosphere from space, **so that birds must have arisen by evolution here on the Earth**" (p91) [20].

However eggs and sperms of insects might survive! Hoyle gives a very useful lesson about prediction in science. An astronomer produced a mathematical formula that accurately predicted the number of sunspots over the whole of a century. But the formula failed completely when new data came in. Hoyle concludes that it is easy to find a formula that fits the data, but difficult to invent one that predicts future events. Hoyle's life from space theory predicts resistance to high doses of radiation. Such a bacterium has been found: *Micrococcus radiophilus*.

[18] The title of the chapter does not describe the contents of the chapter. It should be something like: "evidence for life outside the Earth". How could comets and meteorites prove that life did not originate on Earth? They could **add** lifeforms. Evidence from meteorites is not sufficient to prove that life did **not** originate on the Earth. Hoyle's argument is not very careful here.

[20] The flying bird's egg is besides extremely funny also revealing about Hoyle's reasoning: **birds did evolve**. So what about Hoyle's Archaeopteryx forgery claim? What about intermediates between birds and reptiles? Hoyle's logic is here the same as the standard evolutionist logic!

[21] Space is hostile to life as Hoyle notes: X-rays and UV-rays are destructive for life. Space is not an optimal environment for life. While I was preparing this review an important article appeared in *Science* (1) about **Deinococcus radiodurans** which is the most radiation resistant organism on Earth. The bacterium does not have some mysterious property. Since radiation induces DNA damage, the damage needs to be repaired. All organisms have repair mechanisms, but this bacterium has very efficient DNA-repair machinery, such as many 'redundant' copies of the repair-genes plus additional mechanisms that help the repair process. The bacterium is found in radiated canned food, medical equipment sterilised by radiation and a lot of 'normal' environments. It seems that the trick is accumulation of all kind of the genes that do the job. Later I found out that "Its resistance to ionizing radiation is coupled with

Another was found living in a nuclear reactor! [21]. Bacteria found in the stratosphere up to 25 miles above the Earth cannot come from the Earth (except from exceptional volcano outbursts) and therefore must come from space. The most remarkable data are from air samples from 45 miles (75 km) which contained living bacteria *which where subsequently cultured!*[22].

Hoyle's interpretation of NASA's Viking-mission to Mars is that life is present on Mars.

a more general resistance to other types of physical stress, including ultraviolet radiation, hydrogen peroxide, heat, desiccation and a variety of toxins" (5). So this is not necessarily an adaptation for space environments but may be an adaptation to radioactive environments on earth. Besides that how could the bacterium be genetically close related to *Thermus thermophilus*, a heat loving bacterium? One needs more data than the above, but it's clear that the remarkable properties of this bacterium do not necessarily come from space. It seems plausible that mutation and selection can explain in principle this extreme adaptation.

Even if Hoyle showed that it must come from space, then still there is the question of the mechanism: how did that extreme adaptation originate in space? By conventional Darwinian mutation and selection processes in space? See also the amazing story about tardigrades (2).

[22] It's unbelievable that no genetic analysis was performed of the cultured cells! Information about the genetic code of these bacteria would be of exceptional scientific importance. It would be relatively easy to establish if the genetic code was different from our terrestrial code. These cells could have been the first ever living extraterrestrials on Earth.

5: Evolution by cosmic control

Cosmic genes

Darwinism is an Earthbound theory. The **information content** of life on Earth comes from space. Since the universe is bigger and older than the Earth, the chances are better for the origin of life in space [23]. Mutations are not the driving force of evolution on Earth as Darwinians think. Genes from space are good and don't need any improvement. Anyway mutations are nearly always harmful. DNA is stable. Darwinian evolution is extremely slow. To produce a specific chain of 10 amino acids would take a million generations, assuming a population of one hundred million individuals and the standard mutation frequency. A protein of 100 amino acids long could not be produced [24]. Hoyle concludes

[23] Hoyle does not calculate the odds of life originating in space at all. See also Chapter 10.

[24] This sounds impressive. However every spoonful of garden soil contains some 10^{10} bacteria. There are a lot of spoonfuls of soil on our planet. According to Hoyle's own account (p113) a bacterium can produce millions of offspring within a few days. So Hoyle's protein with 10 amino acids would not be a problem and larger proteins would also be possible. The question is however: are proteins with 100 amino acids easily assembled in the rest of the universe? Hoyle forgot to say **YES** or **NO**.

that the situation for the neo-Darwinian theory is evidently hopeless [25].

"Large multicellular animals cannot withstand unearthy conditions [-418° F or -250°C] as micro-organisms can, a sure indication of their very different origins." p117 [26]

Pseudogenes are genes picked up at random from space waiting for the right conditions to become active. This explains why for example humans have 95% redundant DNA. This explains why genes that produce blood are found as pseudogenes in plants [27].

It seems Hoyle thinks that viruses transport cosmic genes from space to plants and animals to the Earth. His evidence comes from the micro-geographic distribution of influenza epidemics.

6: Why aren't the others here?

The cosmic theory predicts extraterrestrial intelligent creatures. They have not visited us, because planet Earth is extremely difficult to detect from a great distance. Furthermore too many stars need to be inspected before an inhabitable planet is found. And it takes too long. So extraterrestrial intelligence is not refuted. Humans are *intentionally* isolated from other intelligent life in the galaxy [28].

Panspermia ("seeds everywhere") is the correct theory of the origin and evolution of life on Earth. The co-discoverer of DNA structure, Francis Crick believes in Panspermia, but rejects micro-organisms freely travelling in space. Hoyle replies that a layer of Carbon of 0.0001 cm thick is sufficient to shield organisms against ultraviolet light. Furthermore there are usually some individuals which turn out to have far greater resistance than the average of their species [29].

[25] What Hoyle means of course is: neo-Darwinism *restricted to the Earth* ! If Earth-DNA is stable AND it originated from space, then space-DNA is also stable and has a low mutation frequency. So Hoyle is misguided in attacking neo-Darwinism. The only thing he needs to attack is that neo-Darwinism is an Earthbound process. Furthermore he doesn't seem to reject Common Descent completely. So this give him the complete freedom to let it rain genes from space and let common descent do the rest.

[26] But this inference is not valid if Hoyle believes that the information content of all life came from space. So why did multicellular organisms not inherit those cold resistance genes from monocellular organisms?

[27] Because Hoyle has limited biological knowledge, he cannot think of neo-Darwinist explanations. Conclusion: The cosmic 'control', if present, does not look very efficient or directed. How could a rain of random cosmic genes *control* something? Exactly where do the genes come from? what distances? how do they find their way from the Earth's atmosphere to the target organism? Maybe 'control' hints at something in chapters 8-10.

[28] These isolated, unexpected remarks show Hoyle's belief in a superior controlling intelligence in the universe, a characteristic of IDT's and creationists (f.e. Remine).

[29] This throws doubt on his earlier argument that radio-resistance proves extraterrestrial origin. If radio-resistance is a naturally occurring variation than natural selection could produce such species as *Micrococcus radiophilus* in nuclear reactors. This is impressively supported by the article in *Science* (1).

7: After the Big Bang

The Big Bang theory has become the dominant theory in astronomy. Hoyle is a critic of the Big Bang theory. He proposed the rival Steady State theory: a universe without explicit beginning. A steady state universe is also expanding but matter is continuously created. Ironically Hoyle's research turned out to support the Big Bang theory. However there are still serious and maybe unresolvable problems with the Big Bang theory. The textbooks and the majority of astronomers ignore these problems. Each theory had one point right and one point wrong. The sole prediction of the Big Bang is not yet shown to be correct. In the meantime mainstream astronomers are busy repairing contradictions in the theory. "When a pattern of facts becomes set against a theory, it rarely recovers" (p186).

"Something went wrong for the Steady State theory in the mid-1960s." [30].

8: The information-rich Universe

Introduces particle physics and quantum mechanics. On an atomic scale cause and effect dissolve into indeterminacy. Free will and consciousness is explained with quantum properties. Radiation travelling from future to past is compatible with Maxwell's equations. Biological systems are able in some way to utilise the opposite time-sense in which radiation propagates from the future to past. Information necessary for the development of life comes from the future. The information is coming from a source of information, an intelligence, placed in the remote future.

As the inventor of the Steady State theory Hoyle is a critic and part of the minority in astronomy. On his excursion into biology he joins the critics of evolution and Darwinism and gives Darwin-criticism new impulses. An example of a limited sort of Darwin-criticism within biology is Gould's and Eldredge's Punctuated Equilibrium hypothesis.

[30] Hoyle gives an unprecedented honest account of the refutation of 'his' Steady State theory! This is an impressive example of scientific integrity: Hoyle explains why his own Steady State theory fails.

If Hoyle has this solution to the origin and evolution of life on Earth, does he need panspermia (from the past)? I suppose this chapter is an exercise in undogmatic thinking.

9: What is Intelligence up to?

Our planet seems ideally suited for our needs. [31] Oxygen and carbon are produced in stars in the right proportions to permit life. Is this tuning accidental or deliberate? There are too many of these odd coincidences. Both the anthropic principle and theology are dead-end arguments. The anthropic principle is a modern attempt to evade all implications of purpose in the Universe, no matter how remarkable our environment turns out to be. "The same nihilistic belief that no aspect of the Universe can be thought of as a consequence of purpose underlies both Darwinism and the anthropic principle" [32]. The tuning of the universe for life was done by an intelligence.

10: The Intelligent Universe

"Genes from outside the Earth are needed to drive the evolutionary process" (242). "Even after widening the stage for the origin of life from our tiny Earth to the Universe at large, we must still return to the same problem that opened this book - **the vast unlikelihood that life, even on a cosmic scale, arose from non-living matter**" [33]. It is apparent that the origin of life is overwhelmingly a matter of arrangement by intelligent control. Unintelligent natural selection is only too likely to produce an unintelligent result [34]. "If on occasions my opposition to the Darwinian theory has seemed fierce, it is because of my feeling that a society oriented by that theory is very likely set upon a self-destruct course". "Darwinism with its philosophy that opportunism is all" ... "leading with mounting inevitability to two World Wars".[35]. "I am not a Christian" [36].

[31] However *other* planets are not suited for our needs! It's no wonder that the Earth is suited for our needs. Hoyle himself thinks cosmic genes are *selected* by the environment of the Earth. So the "fine-tuning" is partly done by Hoyle's version of natural selection.

[32] I find this hostility to the Anthropic Principle (with its perceived purposelessness) always puzzling. The Anthropic Principle is based on the amazing number of fundamental properties of atoms and stars (our sun) that are essential for the existence of life, thereby connecting us and all life on Earth to the rest of the universe. Which is a new and valuable contribution to our worldview. A number of creationist writers have incorporated this negative attitude to the Anthropic Principle in their thinking.

[33] This means that his Panspermia hypothesis is not a solution to the problem of the origin of life. This claim is the best evidence that Hoyle is an IDT and rejects naturalism. See also: [23].

[34] Dawkins computer programs, and evolutionary algorithms proof otherwise. This is a serious omission of Hoyle.

[35] Here Hoyle's emotional and moral motives for the battle against Darwinism surface. No evidence is given for these extraordinary claims. If Darwinism is morally bad, then Nature is morally bad, because Darwinism describes Nature as it is. The misuse of the theory should be attacked, not the theory. '**Value**' does not follow from '**fact**' and '**ought**' does not follow from '**is**'.

[36] That's a difference between Hoyle and creationists.

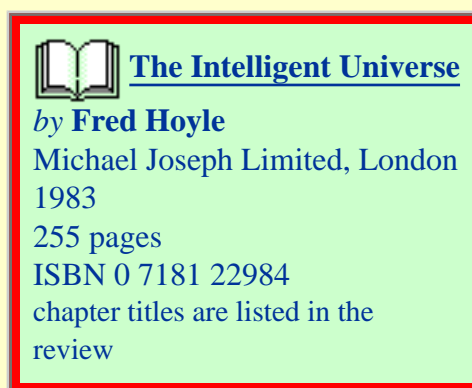
Conclusion

Has Hoyle proven the case of extraterrestrial origin of life on Earth? Let's compare it with proof in a murder case. If two persons A and B have been seen at the scene of the crime, and if A is incapable of committing the murder, this does not prove that B is the murderer. So it is with (A) neo-Darwinism and (B) life from space. Even if life in space or on another planet exists or fossil life inside meteorites is found, and even if there are tons of space debris penetrating the Earth's atmosphere, and even if neo-Darwinism is incapable of explaining the origin of life and subsequent evolution, this is not sufficient to establish that bacteria from space did it.

Even if the **origin** of life on the Earth could be explained by unicellular organisms from space, still all multicellular organisms on Earth need to be explained. This single invasion scenario just moves the problem from Earth into space.

Multiple invasions (for example genes in viral vectors) as an explanation for **multicellular** life, can only be of any use if all those life forms have the same genetic code, that is the same assignment of 20 amino acids to 64 codons. And this requirement implies common descent of all those extraterrestrial genes. Because only common descent guarantees the same genetic code.

Independently evolved extraterrestrial life is expected to have major deviations from the terrestrial genetic code. Panspermia does not require the existence of only **one** genetic code in the entire universe, but at least that every gene successfully incorporated in life on Earth must have the same genetic code.



In the last chapter Hoyle concludes without any calculation that even on a cosmic scale it is unlikely that life arose from non-living matter. Subsequently Hoyle replaces Panspermia with the vague and speculative '**intelligent control**' theory. Intelligent control is not an afterthought. Its importance for Hoyle is reflected in the title of the book. If Panspermia were the most important *The Living Universe* would be more appropriate. '*The Intelligent Universe*' appears to be a mix of good and bad Darwin-criticism, an alternative evolutionary theory and Intelligent Design Theory, driven by a mix of scientific, moral and religious (3) motives. Hoyle's theories range from closely connected to data to highly abstract and speculative. In this book Hoyle appears to be a forerunner of Creationism and IDT (4). This book was published two years before Denton(1985): '*Evolution. A Theory in crisis*', which inspired many creationists. I did give a detailed summary of *The Intelligent Universe* because the book is not available anymore, and is an important source for now famous anti-Darwinism arguments such as the Boeing-747 analogy.

Notes:

Fred Hoyle died on 20 August 2001 at the age of 86.

1. [Genome Sequence of the Radioresistant Bacterium *Deinococcus radiodurans* R1, Science Nov 19 1999: 1571-1577.](#)
2. Jon Copley: "Indestructible", New Scientist 23 Oct 1999, p45-46.
Tardigrades can withstand pressures six times greater than those at the bottom of the ocean and endure temperatures ranging from more than 100°C down to absolute zero; can shrug off lethal radiation, survive in a vacuum and go without water for more than a century.
3. According to Robert Shapiro (1986) *Origins. A Skeptic Guide to the Creation of Life on Earth*, p245, Hoyle and Wickramasinghe moved from a scientific to an "essentially religious position in the 1980s". Shapiro gives a useful overview of the work of H & W in Chapter nine.
4. see Dean Overman (1997): "By his own admission, Hoyle's atheism was dramatically disturbed when he calculated the odds against these precisely matched resonances existing by chance", p129. However Hoyle did not start as an atheist, on the contrary. Hoyle had a christian education. See for an opposite 'admission' the Preface of his *The Mathematics of Evolution*.
5. Nick Lane(2002) *Oxygen. The Molecule that made the World*, pp 125-127.

Further Reading

- [COSMIC ANCESTRY: The modern version of panspermia](#) by Brig Klyce. Contains all scientific support for the panspermia theory and is kept up-to-date by the owner.
- [The Mathematics of Evolution](#) by Fred Hoyle (on this site).
- [Fred Hoyle's Boeing-story in the Evolution/Creation literature](#) on this site.
- Francis Crick (1981) *Life Itself. Its Origin and Nature* (hardback, Simon and Schuster, 192 pages). In this book Nobel Prize winner Francis Crick proposes the theory of 'Directed Panspermia'. One of the rare books focussed on panspermia.
- Lynn Helena Caporale (2003) *Darwin in the genome. Molecular Strategies in Biological Evolution*

I am grateful to my wife Susan for making this book available from the Royal Library (Koninklijke Bibliotheek), The Hague.

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