

Panspermia Revisited

The discovery of evidence for life on Earth more than 3850 million years ago¹ naturally encourages a revival of speculation about the possibility that life did not originate on Earth, but was carried to the planet in the form of microorganisms such as bacteria, either by natural processes or deliberate seeding of the Galaxy by intelligent beings. This idea, known as panspermia, has a long history^{2,3}, but it is curious that in recent decades astronomers have tended to dismiss the possibility of panspermia on the grounds that microorganisms could not survive the damage caused by ultraviolet radiation and cosmic rays on their journey out of a planetary system like the Solar System⁴, while some biologists⁵ have argued that it is impossible for life to have emerged from simple molecules in the limited time available (now seen to be substantially less than 1000 million years) since the Earth formed. This has led Crick, in particular, to argue that the seeds of life were indeed carried to Earth (and presumably other planets) protected inside automated spaceprobes, a process he calls directed panspermia⁶.

Recently, however, Wesson and his colleagues⁷⁻¹⁰ have pointed out a way in which biological material could escape from a planet like the Earth orbiting a star like the Sun by natural processes, and survive with its DNA more or less intact. The problem is that although microorganisms could escape from the Earth today, their biological molecules would quickly be destroyed by radiation in the near-Earth environment. Bacteria shielded inside fine grains of material such as carbon could survive in the interplanetary environment near Earth, but would then be too heavy for the radiation pressure of the Sun today to eject them from the Solar System. The solution is to argue that suitably shielded microorganisms can be ejected from a planetary system like ours when the star is in its red-giant phase. This makes it possible for natural mechanisms to seed the Galaxy with viable life forms — and even if the biological material is damaged on its journey, as these authors point out, even the arrival of fragments of DNA and RNA on Earth some 4000 million years ago would have given a kick start to the processes by which life originated here.

The remaining puzzle about this process is how the grains of life-bearing dust get down to Earth. In their eagerness to suggest how microorganisms could have escaped from a planetary system, few of the proponents of natural panspermia seem to have worried unduly about how the life-bearing grains get back down to a planetary surface. But the work of Wesson and his colleagues naturally leads one to surmise that the immediate fate of the microorganisms ejected from a planetary system during the red giant phase will be to mingle with the other material ejected from the star, forming part of the material of interstellar space and becoming part of an interstellar molecular cloud. When a new planetary system forms from such a cloud, it is likely that the accretion processes in the circumstellar disc produce very large numbers of cometary bodies, which preserve intact the material of the cloud. Although the processes of accretion of a planet like the Earth generate heat which would destroy any microorganisms present (and which may well have driven off all the primordial volatiles), it is likely that as the planet cools it will be bombarded by comets containing large amounts of primordial material (and water) down to the surface (for a review, see ref. 11). If this material includes dormant bacteria, or even fragments of DNA, life will be able to get a grip on the planet as soon as its surface cools, as seems to have happened on Earth.

The possibility that comets may have brought the seeds of life to Earth in this way has been discussed by, for example, McKay¹²; but those earlier suggestions required that the organic material was ejected from Earth-like planets inside rocky debris as a result of meteoritic impacts. It is difficult to see how material in this form could have become a general feature of the interstellar medium, or, indeed, how it would get in to comets. What I propose here, in the light of the work of Wesson and his colleagues, is that organic material is not only a natural and widely dispersed component of the interstellar medium, but will inevitably be incorporated into the material from which new planets form.

The immediate difficulty faced by this hypothesis is explaining why life did not get a grip on Venus or Mars as well — but that is a difficulty shared by all variations on the panspermia theme. Unlike those other variations on the theme, though, this one is testable. It would be feasible to obtain material from a long-period comet, which has never previously entered the inner Solar System, and analyse this material for traces of DNA. If the hypothesis is correct, there should be biological material very similar to that of life on Earth in these comets.

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REVIEWS

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In terms of its scientific content, this is one of the best edited books I have seen in many years. I do not know if it originates from a conference (there is no indication that it does) but it does avoid the pitfalls of similar volumes by restricting the contributions to a series of substantial and carefully refereed review articles, numbering 23 chapters in nearly 700 pages.

The stated aim of the editors is that they are addressing workers across a range of fields such as space physics, astrophysics, and astrochemistry to encourage