Might astronauts bring back a deadly disease from Mars?

A mysterious and rapidly fatal disease breaks out around the crash site of a satellite. Two people are dispatched to recover remains of the satellite and they immediately get sick and die. A team of special government scientists arrives on the scene and determines that the satellite has delivered micrometeoroid material containing an extraterrestrial pathogen–and now the deadly disease is spreading.

That's the opening of the 1969 thriller novel and 1971 film, *The Andromeda Strain*. It's scary and mirrors concerns floating around society today that extraterrestrial microorganisms would pose a severe health risk to human health. It also dovetails with an hypothesis about the origins of certain Earth diseases, including the Ebola virus–an entirely unsubstantiated idea that has nonetheless been hyped in some popular and social media.

Microorganisms may inhabit the planet Mars, and they're also possible on several other worlds of our solar system. If extraterrestrial microbes are identified somewhere off the Earth, it would be a positive development for human civilization, not a reason for public health officials to get concerned. On Earth, most microorganisms are harmless and many are helpful to us; only a tiny fraction of microbial species cause disease. And while it's possible on Mars, or on another alien world, that a human pathogen *might* exist, the extraterrestrial environment does not make it more likely for native microbes to be pathogenic. It actually makes it less likely.

Fear mongering

Case in point of the hyped up, extraterrestrial-related concerns about disease outbreaks is a tabloid story that came out last August, in the midst of the latest Ebola outbreak. Titled "*Ebola… The deadly virus from outer space causing misery on Earth*", the story was also posted around the web under slightly different titles. The quoted source was Ashley Dale, an aerospace engineering graduate student at at the time of the interview at Bristol University in England. This was his argument:

> There is always a chance the Ebola virus could have come from outside this planet at some point during the evolutionary process. We have meteorites from Mars landing on our planet every year, bacteria can survive this journey, we have already seen this in laboratory experiments simulating the extreme environment. Virus particles can also make it through undamaged so there is definitely a possibility something could have arrived back in the evolution of the planet that we are seeing now.

As "crew commander" of the Mars Society's Mars134 Mars mission simulation, Dale certainly could boast a strong background and interest in space science. He was absolutely correct that meteoroids travel regularly from Mars to Earth. In fact, each year, our planet receives approximately a ton of rock material that has been floating around in space as meteoroids after being ejected from Mars by impact events. He also was correct that we are pretty confident that microorganisms can survive both the shockwave associated with launching Mars rock material into space during an impact event and entry of a rock into

Earth's atmosphere. We also think that organisms can survive the transit through interplanetary space for many years. In fact, with colleagues in a project run by The Planetary Society, I'm looking into that very question.

Inspiration from a far-out hypothesis

For inspiration on the biology, Dale may have been influenced by Chandra Wickramasinghe, a disciple of the famous astronomer, the late Sir Fred Hoyle. While Hoyle is renowned for his work on how stars create the various chemical elements, he also championed some unorthodox hypotheses. Opposing the Big Bang model of the origin of the universe, he championed an alternative idea known as the steady state universe. Rather than coming into existence suddenly at a certain point of time, Hoyle's steady state idea implied a universe that always existed. In connection with this, together with Wickramasinghe, Hoyle proposed that all life in the cosmos shared heredity and had existed forever. Called "panspermia" or "cosmic ancestry", the hypothesis implied that all life throughout the Cosmos uses DNA as the hereditary material, with the same four DNA building blocks (nucleotides) and the same genetic code that Earth life forms use.

The biological implication is that that any gene from a microorganism that came here inside a meteoroid from a distant star system, or even a distant galaxy, could be read by the same machinery in our cells that reads our own genes. Therefore, extraterrestrial viruses, bacteria, or other types of extraterrestrial microbes can cause disease on Earth, or deliver extraterrestrial genetic material that works its way into Earth genomes and causes disease.

Cosmic ancestry take on disease outbreaks and rejection of evolutionary theory

Integral to the Hoyle/Wickramasinghe cosmic ancestry hypothesis is an outright rejection of modern evolutionary theory and the concept of *abiogenesis*, the emergence of primitive life from non-biological chemistry. This is not to say that Wickramasinghe and anyone following him are creationists. Rather, in Wickramasinghe's words:

> Contrary to the popular notion that only creationism relies on the supernatural, evolutionism must as well, since the probabilities of random formation of life are so tiny as to require a 'miracle' for spontaneous generation tantamount to a theological argument.

Although Wickramasinghe opposes creationism, his claim that evolutionary theory "relies on the supernatural"–which is completely wrong by the way; the evidence for evolution today is as strong as the evidence for gravity, if not stronger–have been utilized numerous times by creationists. The most notorious example occurred in 1981, when defendants of an Arkansas law requiring public schools in the state to "give balanced treatment to creation-science and to evolution-science" used Wickramasinghe as an expert witness against evolution.

Since being on the fringe of the scientific community is associated with a tendency toward belief in conspiracies, it's noteworthy that Wickramasinghe has also made claims that NASA has been "hiding" evidence for life on Mars. In fact, the "hidden" evidence actually refers to data from NASA's 1976 *Viking*

Mars missions. These data are published and available to the public and have been the subject of numerous scientific articles. It’s just that there’s a debate about how to interpret the data from one of *Viking* ‘s biology experiments.

Based on the cosmic ancestry hypothesis, decades ago, Hoyle and Wickramasinghe claimed that certain disease outbreaks, including the notorious influenza epidemic of 1918-19, resulted from viruses that dropped onto Earth just shortly before the victims got sick. In 1990, in a letter to the prestigious journal *Nature*, they proposed that the arrival of extraterrestrial pathogenic viruses at different periods not only caused epidemics, but was linked to a solar phenomenon known as the sunspot cycle.

The idea has been rejected by virtually all experts in genetics and infectious disease, who consider Wickramasinghe’s ideas to be extremely offbeat. In a beautiful review paper on influenza published in *Microbiological Reviews* in 1992, Robert G. Webster and several other virus specialists rebutted the cosmic ancestry view of influenza in a quick stroke of the pen:

> In reality the occurrence of pandemics is fairly well distributed over all phases of the sunspot cycle. There is absolutely no evidence in support of [the Hoyle/ view], which ignores the most fundamental features of virus biology, and influenza virologists consider it to be without merit. Yet it reappears from time to time in the popular press and the correspondence pages of Nature. Henderson et al. (54,55) statistically analyzed and rejected three versions of cometary models for influenza virus evolution in favor of continuous biological evolution in humans.

Genome analysis

Like many other viruses (including influenza viruses) and other types of microorganisms, and like bigger organisms such as humans, the Ebola virus has been sequenced; five species so far and the project is ongoing. More than one Ebola species causes disease in humans, and based on the genomic analysis that has been going on for years virologists know the evolutionary connections between the different Ebola virus species and larger groupings that include Ebola’s “cousins”.

Ebola viruses are part of a group of RNA viruses called Filoviruses, which in turn belong to a viral “family” called *Filoviridae*, which includes another infamous virus called Marburgvirus. As you may have guessed, being called RNA viruses means that these viruses use RNA as their genetic material, not DNA. While DNA can last a long time in fossils when the environment is favorable, and thus theoretically DNA sequences should be able to survive inside space rocks, RNA is very unstable. Its genetic sequences are very short-lived, and even in the laboratory a lot of care must be taken to preserve them. Given the fact that there is more than one species of disease-causing Ebola virus, that the evolutionary connections with other Earth viruses can be seen in the sequencing, and that the genetic material is RNA, the idea that “There is always a chance the Ebola virus could have come from outside this planet at some point during the evolutionary process” is not very realistic. Ebola evolved on Earth.

Extraterrestrial microbes: Taking reasonable precautions

When *Apollo* astronauts traveled to the moon, NASA decided to quarantine returning crews for the first three missions. For *Apollo* 11, the first time when humans landed on the moon, and thus were exposed to lunar dust and rocks, the quarantine measures were strictest. The astronauts went into quarantine for 21 days, while they and the lunar materials were examined. To make the transition from their capsule to a sealed compartment on the ship that picked them up at the splashdown site, the *Apollo* 11 astronauts wore heavy biological containment suits.

Gradually, however, the precautions were loosened for the next two returning crews, *Apollo 12* and *Apollo 14* (Because of an accident on the way to the moon, *Apollo* 13 astronauts never made a lunar landing, so no precautions for infection were needed), as NASA grew confident that there was no chance of lunar organisms, much less dangerous organisms. Thus, although the *Apollo* 14 crew went into quarantine, they did not wear the heavy containment suits to make the transition from the returning capsule. Instead, they only wore respirator masks on their faces. Then, the *Apollo* 15 astronauts were not even quarantined and that policy held for the crews of *Apollo* 16 and 17.

When humans travel to the next location, be it Mars, an asteroid, or somewhere else, NASA will take precautions similar to those used for *Apollo* lunar missions. There will be quarantines, containment suits, and all of that, but if we become confident that there's no disease, the restrictions will be relaxed, probably in phases. And we'll have an advantage compared with the *Apollo* program. Prior to human Mars explorations, the robot exploration of Mars may have identified life there and probes will have brought back samples from the Martian surface, which also will have been treated with the utmost precautions when arriving on Earth.

How likely are Martian microbes to be pathogenic?

When we talk about isolation of Mars samples and returning astronauts, it's really just a matter of precaution until we're sure what we're dealing with. But from an evolutionary perspective, it's extremely unlikely that microorganisms native to Mars, or another world in our Solar System, will be harmful to human health. There are different ways that a microorganisms can be cause disease. The most feared kind of microbe disease is infectious disease. By infection, we mean that the microorganisms actually thrive inside the human body. This is the most unlikely scenario for an ET microbe. Microbes that infect humans are able to do so, because they co-evolved with us, or in some cases with other animals who serve as hosts.

In the case of Ebola, the virus reached humans because it was already thriving inside bats and other "bush meat" in Africa. If an organism is going to infect your lungs and cause pneumonia, it must already be living in an environment similar to that of your lungs–warm and wet. That happens with the bacterium that causes tuberculosis, but it's not going to happen with anything living on Mars, a cold, dry environment even more so than Antarctica.

Another way that microorganisms can cause disease is by releasing a toxin into the environment and humans then get exposed to the toxin. Two examples on Earth, both from the same genus of bacteria, are botulism and tetanus. Compared with infectious disease, releasing a chemical that happens to be toxic to humans is quite a bit more realistic when considering possible organisms on another planet, such as Mars. When dealing with Martian materials, there will be a lot of containment procedures and other precautions, and the material will be tested for toxicity. It’s a real concern, but with the toxin kind of disease there is no issue of the organism spreading from person to person, causing an outbreak. You do not catch botulism or tetanus from another person. You get botulism by eating food that has been contaminated and tetanus from getting pricked with something that has been contaminated.

But when we consider harm, we must think also about harm to our environment. While there should be no similarity between the warm, wet human body and the cold, dry Martian environment, there certainly can be environments on Earth where Mars life might thrive if carried here by a probe or human mission. Environmental ecology and biospheres on Earth are notoriously complex, so we don’t want to release a native Martian microbe on Earth, particularly in “Mars-like” regions of our planet. That’s something to keep in mind as we move forward, toward a Mars sample return mission, but as noted earlier containment is going to be extremely tight.

As for disease, considering everything, the risk is fairly low, and alongside that risk we also must keep in site of the benefits. What will knowledge of the existence of a biosphere on another planet do to our perspective on biology? It could work wonders in that area, giving us unexpected insights and launching biology into a new era. At the same time, knowing that the planet just next door to us also is a home to life, we could be sure that we inhabit a cosmos in which life is extremely common. We could expect worlds with breathable atmosphere because of life forms using photosynthesis to make food, worlds orbiting nearly stars that we might eventually colonize without the need for pressure domes. And it would increase the likelihood that eventually we’ll come across an extraterrestrial civilization.

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