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Commentary: Numerical analysis of Steele et al.: Cause of cambrian explosion - terrestrial or cosmic?

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1. Introduction

Steele et al. (2018) have recently revisited the Panspermia hypothesis of Hoyle, Wickramasinghe and colleagues, that life was seeded on Earth from extraterrestrial sources and that this process continues until the present day. Several lines of evidence are presented and some of these have been criticised by Baverstock (2018) and Moelling (2018).

None of the examples mentioned by Steele et al. (2018) is decisive enough to allow no other explanation, but there are two observations that they cite which lend themselves to a numerical analysis. This analysis, which I outline here, suggests that Panspermia as proposed by Steele et al. (2018) is extremely implausible.

2. Influenza

Hoyle and Wickramasinghe (1979) discount person-to-person transmission as the major means by which influenza is acquired by individuals, and Steele et al. (2018) clearly agree with this proposal. They propose that the influenza virions must have come from some planet outside our solar system. Somehow, the virions get ejected from that planet into interstellar space then, eventually, reach the inner solar system where they are swept up by the Earth as it orbits the Sun.

At 4.25 light years away, the nearest star to Earth is Proxima Centauri. There is strong evidence that it possesses a planet in an orbital zone compatible with life. Nobody knows whether any extrasolar planets have ever supported life but let us suppose that this Planet X is the origin of these virions. Unless Earth is being specifically targeted by malevolent inhabitants of that planet, the virions arising from it must be spread more or less evenly through a cloud with a volume of at least 2.72×10^{41} cubic kilometres if any of the virions in this cloud are to reach Earth.

As it orbits the sun, the Earth travels through a swept volume of 1.12×10^{17} cubic kilometers each year. Therefore, if just one virion is to collide with Earth in a year, 2.27×10^{24} virions must have been released from Planet X. The mass of a single influenza virion is about 5.24×10^{-16} g. Therefore, the mass of virions in the cloud is close to 1,190 tonnes.

Of course this single virion that collides with Earth each year is unlikely to land in the respiratory tract of any susceptible person. Let us make the very generous assumption that it is sufficient to land within 10 m of a person to initiate an infection, and that everyone occupies an exclusive and non-overlapping ten-metre radius circle. In addition, let us assume that everyone on Earth is susceptible to infection and that every virion has not been damaged during the journey from Planet X. I calculate that 491 virions are needed to collide with Earth for one to land close enough to a person to have a 90% chance of causing an influenza infection. The mass of virions in the cloud must be over 0.58 megatonnes.

Even in a mild annual influenza season, there are at least 4 million cases. If all of these are direct infections from outer space with no person-to-person transmission, the virion cloud must weigh 2.34 trillion tonnes. This is about 8,000 times the mass of all humans on Earth.

There is no reason to suppose that entire 2.34 trillion tonnes was ejected in a single event. Perhaps there have been multiple events over the 4.85 billion years since Proxima Centauri formed. An average of 482 tonnes/year would be enough. Still a mind-boggling number.

It would be a remarkable coincidence if the planet ejecting all this influenza just happened to be the one that is closest to Earth. There are 64 reported extrasolar planets within 42 light years of Earth; that is, ten-times the distance to the Proxima Centauri exoplanet. A planet ten-times further away must produce 1,000-times as many virions (2,388 trillion tonnes) to be equally effective, an even more extraordinary number.

These numbers defy credibility, so maybe there is not just one Planet X. Perhaps there are lots of them, each spewing out influenza virions. If the closest 100 exoplanets are all ejecting similar numbers of virions, the amount needed from each is 1.10 trillion tonnes; that is, 46.8% of that which would be needed from the Proxima Centauri exoplanet alone. Adding more and more planets after this first 100 does little to reduce the required output from the original Planet X because each extra planet is further away than the previous ones. Let us assume that every star in the galaxy has a planet that has been ejecting influenza virus for billions of years so that the galaxy is filled with a faint mist of virions. Each planet must have emitted over 200 billion tonnes to account for the incidence of influenza; this is not plausible.

Even if we allow for multiple planets ejecting influenza virions continuously over billions of years, there is still a problem. Imagine

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that the Earth is a source; every year, hundreds of tonnes of virions need to be ejected at a speed in excess of 150,000 km per hour to escape into interstellar space. What events are occurring on the surface that are sufficiently extensive and violent to achieve this, but at the same time are gentle enough to leave the virions and the Earth undamaged? Steele et al. (2018) need to come up with a plausible mechanism for this if we are to accept that each case of influenza is caused by a virus arriving from space.

3. Bacteria in space

Steele et al. (2018) support their Panspermia hypothesis using the results of Grebennikova et al. (2018). In that study, swabs were taken from the exterior of the International Space Station (ISS) then DNA was extracted and amplified by PCR. DNA sequences were identified that match with various terrestrial bacteria as well as some plant and fungal species. Steele et al. (2018) concluded that a “terrestrial origin seems most unlikely”.

I performed a new calculation on these results using the same principles as were used in the influenza calculations shown previously. I assumed (generously) that all components of the ISS where samples were taken had been accumulating interstellar dust for 20 years, and that none had fallen off or been removed in the meantime. I took a guess that the region swabbed for each sample had a 1 m radius, probably a substantial overestimate. I allowed for the fact that the ISS travels further than the Earth in any given time period because it is orbiting the Earth while the Earth orbits the Sun.

If the PCR was capable of detecting a single bacterial cell (highly unlikely given the methodology used), then the mass of bacteria that would need to be ejected from a planet 4.25 light years away is 3.69 thousand trillion (3.69×10^{15}) tonnes.

From Table 2 of Grebennikova et al. (2018) it appears that DNA from at least 10 separate bacterial cells were detected, plus some fungal and plant DNA. Considering the bacteria only, if this is all coming from the same extrasolar planet, it must have ejected nearly 37 thousand trillion tonnes of material.

Consider the alternative hypothesis that these bacteria originated on Earth. Using the same methodology, the amount that would have to be ejected may be calculated. This calculation shows that 150 mg is required. Thus, the choice is between 150 mg escaping from a planet that is known to harbour bacterial species containing DNA that match with the ISS samples, or a minimum of 37 thousand trillion tonnes from one or more exoplanets where there is no evidence at all for life, let alone organisms with DNA sequences that match with those of terrestrial bacteria.

4. Conclusions

It seems certain that there are multiple planets in the Universe where conditions are capable of supporting life. Whether life actually exists anywhere but on Earth is completely unknown, because we can only guess whether the emergence of life is improbable or inevitable when conditions are suitable. Equally, we have no idea how life arose on Earth. It may have occurred here spontaneously but accidental seeding from elsewhere in the Universe cannot be ruled out; neither can deliberate introduction by a space-faring civilisation or divine intervention. These various suggestions are not hypotheses in the conventional scientific sense because none of them is falsifiable. The calculations that I show here do not falsify the ideas of Steele et al. (2018) but they do suggest that a major rethink is needed.

There seems to be no experiment or observation that would clearly settle the question. All we have is belief and opinion that logic may not sway for those who have made up their mind.

Declaration of interests

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