A brief history of exo-Earths and the search for life elsewhere

November 25 2014, by Brad Carter, Belinda Nicholson And Jonti Horner

Artist's impression of a sunset on the planet Gliese 667Cc. While that planet is likely not an ideal target, we will discover planets far more like our own. Credit: ESO/L. Calçada, CC BY

Ever since humans first looked up at the night sky, we have wondered whether we are alone in the universe. Dreams of life beyond Earth pervade literature, TV shows and drive Hollywood blockbusters – but the truth of life beyond the Earth continues to evade us.

In the coming decades, however, we face the very real prospect of discovering Earth-like planets orbiting distant stars and being able to search for life upon them.

But before we look at what we think are the various ingredients needed to contribute to the recipe of a perfect world, we need look at the history of the search for life elsewhere in the universe.

Infinite worlds around infinite suns

The story has as many beginnings as there have been people who have gazed at the night sky in wonder, and one of particular note is the story of the Dominican Friar, Giordano Bruno.

Bruno is regarded as anything from the forefather of astrobiology to an over-cited historical oddity. The story of his life and eventual death, burnt at the stake on the orders of the Roman Inquisition, is fascinating.

Bruno's link to astrobiology comes from his ideas of an infinite universe containing infinite suns with infinite planets therein. At the time, this view was considered heretical – in stark contrast with the views of a church convinced that the Earth was the centre of the universe, but in retrospect, it seems almost prophetic.

Is there life on Mars?

In the 19th and early 20th century, interest in life beyond Earth was at a high point with scientists and the general public, fascinated by the idea that Mars might host vegetation and intelligent life.

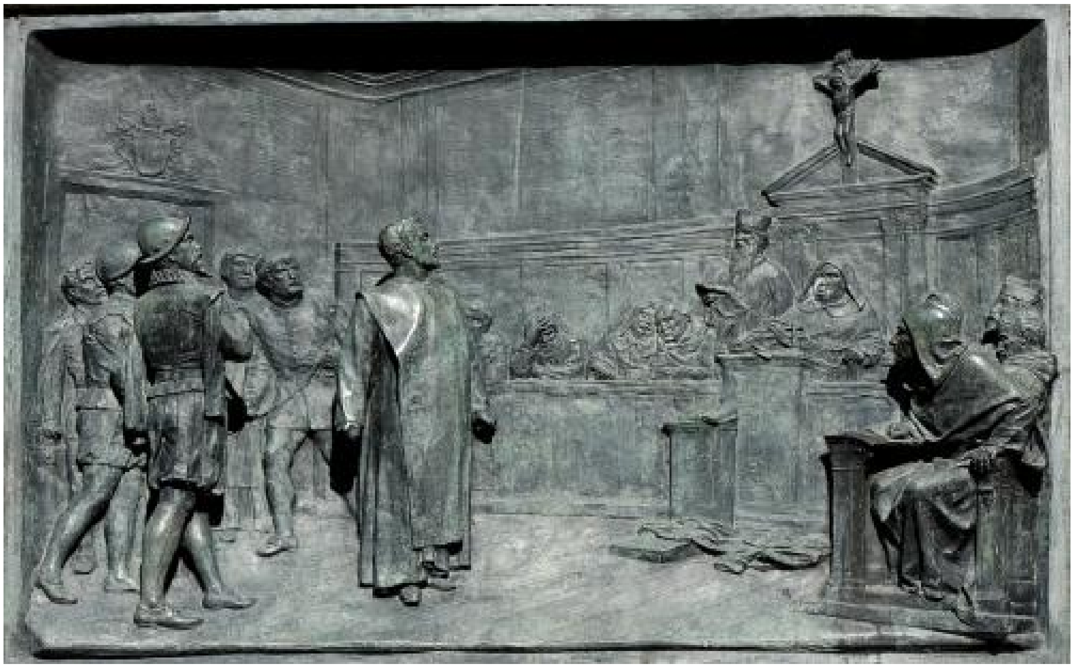
The presence of polar ice caps on Mars, kin to those on the Earth, was discovered relatively quickly in the years following Galileo's use of an early telescope to observe the night sky. By the mid-19th century it was well known that those ice caps expanded and contracted with the seasons, and that in many superficial ways, Mars was a very similar planet to the Earth.

The Martian day is almost the same as that on Earth – just half an hour longer. Similarly, the planet is tilted by almost the same amount as the Earth – meaning that temperate regions on Mars would experience similar seasons to those on Earth – albeit on a longer timescale, due to Mars' longer year (about 687 days).

So if Mars was so similar to our Earth, wasn't it reasonable to consider that it might also host life? Things looked promising – surface features on Mars appeared to shift with the seasons. Could this be vegetation growing in the summer and dying back in the winter?

The famous Italian astronomer, Giovanni Schiaparelli, even reported observing "canali" – channels spanning the Martian surface like a fine lace mesh. The English-speaking world translated this as "canals", sparking the thought that these features were designed to carry water by an intelligent race.

New technology allowed spectroscopic analysis of Mars' atmosphere to be carried out in detail and the results were sobering. Rather than a wet, warm, habitable world, scientists found no trace of water or oxygen in the planet's atmosphere. It soon became clear that Mars was an arid, cold world, far from that imagined just a few years beforehand.



Bronze relief depicting Giovanni Bruno's trial by the Roman Inquisition, by Ettore Ferrari (1845-1929). Credit: Wikimedia

The "vegetation" turned out to be dust blown around in giant planet-spanning dust storms. The "canali" were just an optical illusion – a combination of poor telescope optics and confirmation bias – people seeing what they thought was there.

There still remains a chance that life could be found on Mars, or elsewhere in the solar system. We now envision bacteria – buried in the moist Martian tundra or thriving in the oceans that lurk beneath the surfaces of moons in the outer solar system.

But while the discovery of bacteria on our celestial doorstop would be an incredible one, the more exciting prospect for many is the possibility of detecting complex, thriving biospheres on planets orbiting other stars.

The search for exo-Earths

It is now almost two decades since the discovery of the first planet orbiting another sun-like star. That planet, 51 Pegasi b, was about as alien and hostile to life as it is possible to imagine. A behemoth – comparable in size and mass to Jupiter – it spins around its host star at a distance approximately 1/20th that between the Earth and the sun.

The temperature of 51 Pegasi b's cloud tops is likely in excess of 1,000C, so hot that clouds of metal and silicate probably float among the hydrogen that most likely makes up the bulk of its atmosphere. A fascinating planet, yes, and one that revolutionised our understanding of planet formation and evolution. But Earth-like, it is not.

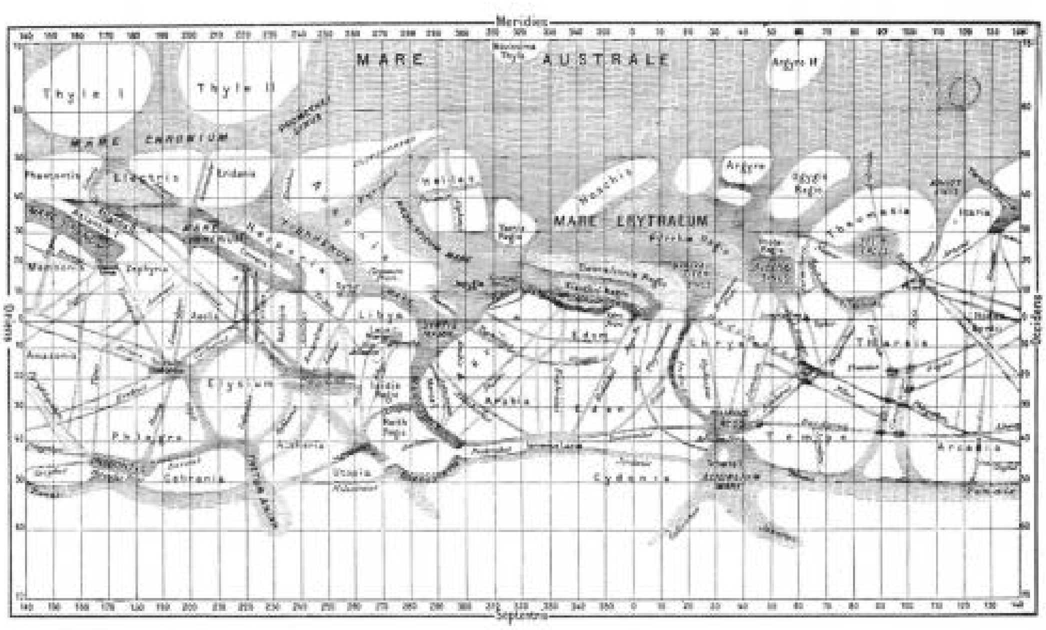
In the time since that discovery, rapid improvements in technology (with fantastic innovations such as the Kepler mission) have led to the number of known exoplanets exploding. At the time of writing, there are more than 1,500 confirmed exoplanets orbiting other stars.

In addition, the scientists analysing the vast trove of data taken by the primary mission of the Kepler spacecraft have a further 4,178 candidate planets, awaiting confirmation.

As each year passes, we come closer to finding the first planets that truly resemble Earth – detecting ever smaller planets, orbiting at more temperate positions in their host system. It seems almost certain that the first truly terrestrial planets will be discovered in the next decade, and the search for life upon them will begin in earnest.

A pressing question

But where should we look? The observations required to detect clear and incontrovertible evidence of life on one of these exoEarths will be hugely time-consuming and costly. Indeed, a recent paper suggests that even the incredible James Webb Space Telescope, scheduled for launch in 2018, will be unable to perform the requisite observations.



Giovanni Schiaparelli’s map of Mars, based on observations taken between 1877 and 1886. Many of the features depicted are real, and can be seen in modern images but the straight ‘canali’ do not exist. Credit: NASA/Wikimedia

Because of this great difficulty in performing the required observations, the selection of the most promising target will be key. Our solar system illustrates this need remarkably nicely.

In the inner reaches lurk three Earth-like planets – Venus, Earth and Mars. From a distance, all three could be considered to fulfil our requirements, rocky worlds of around the same size. How would we chose which to target?

Despite their superficial similarities the three planets are vastly different. Venus is far too hot, the victim of a runaway greenhouse effect with a surface that would melt lead. Mars is too cold, too arid and with too thin an atmosphere. Only one, Earth, is just right and is covered with abundant life.

Based on this comparison, when new exoplanets are detected, the discussion of the most Earth-like usually boils down to one thing – the likely surface temperature of the planet. The reason is simple: water.

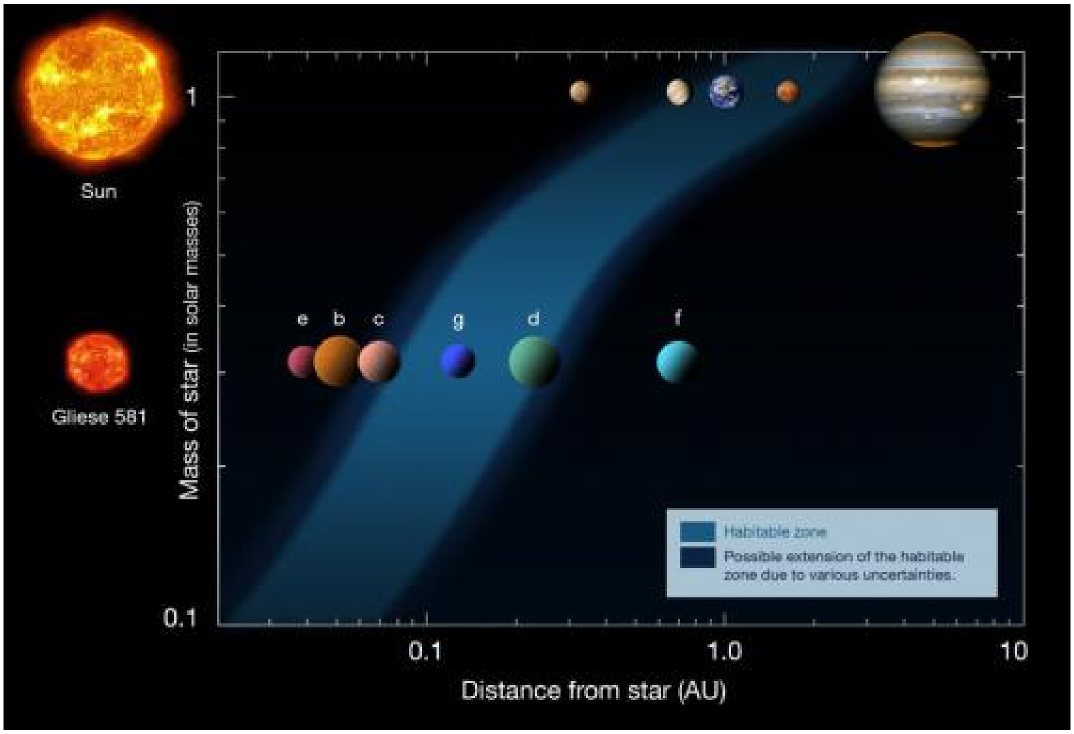
The Goldilocks zone

One of the problems we face when discussing life beyond the Earth is small number statistics. The Earth is the only planet where we are certain that life exists.

On Earth, life is found everywhere – or at least everywhere that has some access to water. All living things we know of need water in its liquid phase to grow and reproduce. So when scientists search for life beyond Earth, that search naturally centres on finding evidence of liquid water.

For this reason, astronomers arrived at the concept of the "habitable zone", or "Goldilocks zone", around a star. Move a planet too close to the star and it will be so hot that liquid water will not be able to exist on its surface (as in Venus). Move it too far away and any water will freeze out (just like Mars, or the moons of the outer planets). Between these extremes lays a broad region in which an Earth-like planet will be neither too warm nor too cold – the "habitable zone".

By the time that we are ready to search for evidence of life on newly discovered exoEarths, the recent explosion in the number of exoplanets known suggests that there will be a wealth of potential targets to consider. And for that reason, it is likely that simply a determination of which lie in the habitable zone will not be sufficient to whittle down their numbers.



Artist’s impression of the habitable zone for the solar system (top) and the planetary system around the nearby star Gliese 581. The planet GJ581 g is still considered very controversial but, if confirmed, would sit bang in the middle of the ‘Goldilocks zone’. Credit: ESO

It is likely that there will be tens, if not hundreds, of potential targets available for the search. So it will be vital to find other criteria with which to cull those planets that are least promising from the lists.

For that reason we need to provide a tentative "recipe for a habitable planet". We need to consider some of the many factors that come together to make one planet a more promising location for life like ours to develop and thrive. And that is what we will present, through the course of this series of articles.

Source: The Conversation

Citation: A brief history of exo-Earths and the search for life elsewhere (2014, November 25) retrieved 24 April 2024 from https://phys.org/news/2014-11-history-exo-earths-life.html