N89-18383 / 175234
48

THE POSSIBLE CONTAMINATION OF JUPITER

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Centuries ago, when the first Anglo pioneers invaded the shores of the Americas, they brought with them more than just the hope and will to survive that we normally associate them with. They carried with them on their ships, their clothes, their cargo, unseen microorganisms, bacteria and disease. North America, and the Native Americans who inhabited it, being isolated from Europe by the Atlantic Ocean, had never before encountered these foreign bacteria. The "pilgrims," on the other hand, had not only coexisted with their domestic diseases, but had battled viciously with them and eventually built up an immunity which protected them from being overridden by bacteria. The Native Americans had no such defense system, and as a result of that, the bacteria thrived in the pure environment of the New World. Now keep in mind that these were not any bacteria of the complex sort; no, these were quite ordinary bacteria, predominantly just the common cold. But because these bacteria were in no way common to the uncontaminated Americas, the disease spread like wildfire and was responsible for more Native American deaths than any head-scalper.

This contamination of North America was not planned. Man knew little of life invisible to the naked eye, and even less of the catastrophic reaction to these new microorganisms that the Native Americans displayed. The New World, as America was referred to in the first years of its "discovery," was a land full of mysteries to be solved. Explorers came from every land in an attempt to untangle and map out the unknown geography that North and South America represented. They came on a quest for knowledge, hoping to find a relative Garden of Eden and steal its forbidden fruits.

Well, now it's 1986, and "The New World" is completely charted, its lands tamed. Satisfied with our knowledge of this now old world, we look beyond our own planet, into space, hoping to find newer worlds. There are at least eight others out there, future sites of expeditions and explorations, waiting for rocket-boosted Mayflowers to arrive. Space, perhaps the final frontier, a vast, uncharted sea. The days of exploring new continents are long over, and, as history repeats itself, the people of Earth enlarge their perspective to include other planets, the solar system, the universe. What a beautiful and pacifying new sea upon which will embark a new breed of explorers!

But like the pilgrims, will space explorations represent a threat of bacterial invasion? Bacteria are one of the most basic of Earth's organisms, hypothesized to be one of the turning points in our own evolution. It is said that the simpler things are, the better they are. Well, this is most certainly the case when we take into account the great capacity for survival which bacteria have. Temperatures much too hot for any human to survive in are no sweat (no pun intended) for most bacteria. Bacteria can survive in inhumanly cold temperatures just as easily, and are even able to exist on the outermost hulls of ships in the vacuum of space.

It is inconceivable to totally condemn the pilgrims for their contamination of the New World; they simply didn't know what they were doing. But now we know about bacteria, and we know that they will survive space travel. Contamination becomes less of a laboratory issue and more of a moral dilemma because we know what we are doing. Is it not the hope of NASA to someday discover other forms of life, perhaps intelligent life, on planets beside our own? And if the answer to this question is yes, then wouldn't any type of bacterial invasion deeply risk reducing our chances?

The only way to avoid contaminating an alien environment with terrestrial organisms is either to completely sterilize any and all equipment/persons that come into contact with the environment, or else simply not to come into contact with it. If we must come into contact, then it is the logical and responsible choice to sterilize as best we can. It takes only one bacterium to start an epidemic. Sterilization has been met with much skepticism and much dislike. Not only does the present method of extreme heat cost a great deal, but it also forces the developers of space exploration to face new problems. Bacteria can survive high temperatures which can ruin the most intricate and complex parts of a space vessel, such as its circuit boards. So when designing landers and probes, scientists must be extra careful that their final product will survive the heat of sterilization. The early Ranger series, intended for exploring the moon, met with this difficulty and could not be made to function properly after sterilization.

The Viking mission, however, is a testimony to our ability to sterilize spacecraft without creating malfunctions. It's true that Viking took a great deal of money, time, and more money, but the final product passed the test. Though it was proven that Viking was not totally sterile, it was a cornerstone in space sterilization.

Recently, there has been much concern regarding the fact that the Galileo probe, though its fate is now uncertain, will be the first probe ever which will not be sterilized. Designed to enter into the atmosphere of Jupiter, the probe will simply take readings and measurements as it falls to its eventual death. It was thought that the Galileo probe need not be sterilized, for Jupiter was considered to be an environment where the chances of contamination are "nil." Most assumed that no terrestrial life could live on the planet, but is that an accurate assumption?

BACKGROUND INFO ON THE MODEL

Jupiter, to the best of our knowledge, is completely composed of gases. Like Earth, its temperature increases as one gets closer to the center, its core an inferno. There are various vertical layers in Jupiter's atmosphere, and particles can travel from one layer to another by two primary means. The first way is simply by gravity; the particles are pulled to a lower layer by Jupiter's own gravitational force. Countering the effects of gravity on Jupiter are conditions such as winds, turbulence, and heat, all of which cause particles to rise to a higher level. This process of rising and falling is known as "mixing."

The main argument against bacteria surviving on Jupiter is that it is believed that there will be little, if anything, for the microorganisms to eat. Without substantial nutrients, bacteria cannot multiply and will eventually be pulled down by gravity to a layer whose temperature is too high and will cause combustion. If bacteria can get enough food to multiply and reproduce, then, even though some bacteria will perish in lower-layer infernos, others will survive and reproduce more, continuing the legacy of bacteria. If there is enough food, the bacteria will reach a point of equilibrium in their reproduction; this point is achieved when the number of bacteria being produced is equal to the number which are being destroyed, thus yielding a constant number of bacteria.

Well, is there food for bacteria on Jupiter? Yes, there are substances known as "tholins" which have been proven to be a good carbon source for bacteria. Tholins are organic compounds which are produced by mixing gases, such as methane and ammonia, and then exposing this mixture to some form of energy. The energy transforms the simple ammonia-methane mixture into complex chains of molecules (amino acids) which bacteria can then live on. Jupiter has gases in its atmosphere which will mix, and, when exposed to energy such as lightning or sunlight, produce tholin, which the bacteria can then use as food. But will there be enough food to allow enough bacteria growth to overcome the loss of many bacteria in the gravitational pull? In other words, will the bacteria be able to reproduce faster than the rate at which they will be killed?

Due to the varying temperatures of the Jovian atmosphere, bacteria growth is limited to a certain atmospheric region. This area is known as the habitable zone. Characteristically, it is bounded by temperatures ranging from 0 to 100 degrees Celsius, since those are the parameters within which water is in its liquid form, a necessity if bacteria are to grow. Bacteria can only grow while in the habitable zone, and therefore growth is limited by how much tholin enters this zone. The process of "mixing" plays a key role in the bacteria's survival. Will the bacteria, at the mercy of the mixing process, stay within the zone long enough to encounter tholin (another traveler dependent on the mixing process), eat it, and produce more bacteria? How much time do the bacteria have to find food, eat, and then double before they are swept away? If the mixing process does not allow the bacteria enough time to complete this cycle, bacteria will not be able to exist on Jupiter. However, if there is an adequate amount of time in which the bacteria can fulfill their survival obligations, then bacteria will more than likely thrive.

THE MODEL ITSELF

A computer model simulates Jupiter's conditions. It regards two things when testing to see if bacteria will survive: 1. altitude (are the bacteria in the habitable zone, how much has drifted out of the zone), 2. time (have certain bacteria been in the zone long enough or too long, at what time should they naturally be mixed out of the zone). Not only are these two dimensions applied to the bacteria, but to the tholins as well. (How much tholin is in the biozone, did it all get consumed by the bacteria, is there an excess, how much tholin has left the zone, how much has entered.)

The simulation program suggested that bacteria would indeed exist and multiply within Jupiter's atmosphere, and that the point of equilibrium would be reached approximately one year after the initial contamination occurred. Once bacteria enter Jupiter, there is no getting rid of them. Total colonization by the bacteria would be achieved.

Two notable errors in the program's simulation are:

1. The time step between each mixing occurrence was too large. It allowed too much time for the bacteria to eat and reproduce.

2. It was assumed that the tholin which entered the habitable zone would be consumed if needed by the bacteria. No consideration was given to the fact that the tholin must come in contact with the bacteria for them to eat it.

Regardless of these flaws in the initial simulation, bacteria would still, most likely, thrive in the Jovian atmosphere. The point of equilibrium may not be reached in the time given by the initial simulation, but the point would be reached. Also, the quantity of bacteria, which was phenomenally large, would be reduced, of course.

CONCLUSIONS AND AFTERTHOUGHTS

The Galileo probe, though at present its future is uncertain, would, if not sterilized, represent a good chance of contaminating Jupiter. Most scientists opposed to sterilizing the probe argue that to order the probe sterilized at this point would be the death of the project, since sterilization would entail a reconstruction of the probe, and there are just not enough funds to accomplish this. These scientists, however, are ignoring a relatively simple and inexpensive alternative to the traditional heat sterilization method. The main threat of contamination comes from Galileo's exterior surfaces: the shell of the probe and its parachute. The probe's innermost components would not represent a threat since the probe is sealed. In light of the fact that only the exterior of Galileo would have to be sterilized, heat would not have to be used as a method of sterilization. Instead, various gas mixtures could be sprayed entirely over the probe and its parachute, gases which would kill any and all bacteria. Though this method could fit in the Galileo budget, it is being overlooked. Why? Certainly the avoidance of contamination is worth the small amount of time and money that this alternative sterilization would cost. Isn't it?

Bacteria appear to have played a key role in our evolution. Jupiter, a planet which appears to be in a far more primitive state than ours, may be involved in its own evolution. Surely any terrestrial bacteria would jeopardize this evolution by either eating or destroying any domestic microorganisms, or by producing mutant bacteria and new breeds, interfering with the original destiny of Jovian evolution. And how would we know, many years after the contamination, if any life we then discover on Jupiter is its own, or simply our own unrecognizable mutant leftovers? We have a responsibility to make moral decisions when dealing with space exploration. Is that not one of the main aspects to space exploration in the first place, to learn about other worlds and hopefully other beings? The information that the Galileo probe would furnish is not enough to take such a risk. Contamination is too possible.