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Space Travel and Life Beyond the Earth

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Even in antiquity, at the age of mythological fantasies, there was understanding among the sages that the Earth is a globe and that beyond it there could be other inhabited bodies similar to our Earth. In these speculations, the Moon as a possible candidate for extra-terrestrial life came first. Thus, in his epic describing the creation of the world, Hesiod, the ancient Greek poet of the 8th century B.C., was guided by far-reaching analogy in saying that there, on the Moon—or Selene—are mountains, cities and temples. Although this saying was naive and contrary to modern knowledge—as we know, there is no life on the Moon—this bold suggestion shows deep vision and deserves our respect; it went against popular beliefs and myths of the time, by daringly maintaining that the Earth and the Moon are both celestial bodies, with similar properties. At present we know, indeed, that the difference is only one of size—a quantitative, not a qualitative one. Of course, there is no air or water on the Moon, while on Earth these life-sustaining substances abound; yet this seemingly qualitative difference is a direct consequence of a quantitative one: with its smaller mass and weaker gravitation, the Moon is unable to keep an atmosphere and cannot prevent it from dissipating into space.

When presented in the form of verses, such "unorthodox" views were accepted or tolerated by the audiences of antiquity. Otherwise, however, the wise men were not allowed to express freely their views against current prejudice or dogma: it was dangerous.

After a long period of hidden scientific progress during which astronomical truths were repeatedly uttered but suppressed or forgotten, the Copernican revolution of thought brought ultimately an understanding of the nature of the planets as bodies similar to our Earth. One went to the other extreme—as Hesiod did in antiquity—in accepting the habitability of all these bodies, with terrestrial conditions and forms of life, and with similar human-like inhabitants. Especially popular was the Moon in this respect, such as in the fantastic stories of Cyrano de Bergerac in the 18th century, and later on.

However, the subsequent progress in astronomy, physics, chemistry and the biological sciences soon caused disappointment in such "optimistic" speculations. It became obvious that the Moon is a lifeless body without an atmosphere where every exposed living being would die instantaneously. All those fantastic stories—about humans visiting the Moon, moving there freely around, unprotected and encountering "selenities" or the imaginary inhabitants of the Moon—have turned out to be even worse than mere fiction: the happenings so described are simply impossible. In comparison, Dean Swift's Gulliver's Travels are full of realism.

Despite this, because of our technical know-how, the Moon has now acquired new attractions which a desert spelling death could not otherwise offer. Travel to the Moon has now become a reality. American astronauts have been walking there, protected against the airless vacuum by space suits, as are the divers on Earth who carry their breathing apparatus with them under water. Russian robots, radio controlled automatic vehicles or "lunokhods" have been doing the same, in anticipation of carriers with human crews. At present such visits to the Moon are only in an experimental stage, serving the purposes of scientific exploration as well as of "technical reconnaissance". Yet in the future—we cannot foretell when—we expect that human habitations will be installed on the Moon, airtight cities under glass cover where plants are grown in the always available sunshine. During the lunar "day" of a fornight's [sic; "fortnight's"] duration the excessive heat must of course be checked by air conditioning, while during the extreme cold of the lunar night of same length some kind of storage heating will be needed. Water could be obtained chemically, with the aid of solar energy, from the hydrogen and oxygen content of lunar rocks and dust (as in the time of Moses from rocks of the Sinai desert). This could appear as a millionaire's paradise—but in the future, with the supreme technological achievements, all mankind could be millionaires by present standards! The changing aspects of weather, wind, rain or snow, could be a matter for artificial control, if for no practical purpose but to dispel the boredom of uniformity.

In the remote future the Moon could become in such a manner a place for emigration, after on our over-populated Earth every bit of land—and sea—being occupied, including all our deserts (which still are more attractive than the Moon!), polar tundras, and even the sea which can be covered with gigantic rafts carrying soil, gardens and fields. The area of the Moon equals some 40 million square kilometres, amounting to about 40 per cent of our continental area. When completely exploited by way of artificial methods, the Moon could feed and shelter a population of 10,000 million—21/2 times that of the present population of the Earth, being then about as densely populated as present China or the Netherlands.

Because of the lower gravity, as compared to their earthly motherland, these lunar inhabitants would feel 6 times lighter than here. Even the fattest man could swing himself up a tree with the speed of a monkey, or jump unharmed from the second floor of a house and run faster than a top marathon runner.

On the other hand, these lunar glass cities will be subject to the permanent danger of meteorites. Over the years a stony fragment from space could pierce the glass roof of a city, so that air would escape through the hole into the surrounding vacuum. The danger is similar so that for stratospheric aircraft with pressurized cabins when they move in thin atmospheric strata unfit for human breathing and when a hole or a crack in the fuselage could arise. To guard against such catastrophes, adjacent lunar cities must be separated from each other by airtight walls and doors, so that the effect of the meteorite could be confined to a small area. Also, one could imagine some balloons freely floating under the roof, with flat airtight valves on top which automatically would be carried by the air stream toward the hole (most holes will be small!), to close it until repairs can be made.

One could ask—does such emigration into space make sense? It might appear simpler to restrict the proliferation of the human race and stay in our old homeland—our Earth. To this one could point out that a lasting limitation of the birth rate, and especially on a voluntary basis, is not feasible. Prolificacy depends on heredity and tradition. In a population there will always be strains with a higher birth rate which do not want to be restricted; their number would increase faster than the rest of the population until they become dominant. Ultimately the logic of Nature will step in, and the three Horsemen of the Apocalypse—Famine, War and Plague—will take over control. Such forcible natural restrictions will inevitably be at work when the voluntary method fails. Until now this has been always Nature's way of population control, while the colonization of celestial bodies would greatly defer the critical phase of population growth for our Humanity.

A larger population, or a greater Humanity not only has the advantage of a greater technical and economic power (which is also a pre-requisite for the colonization of space); it also leads to a greater cultural and technological diversity. Geniuses are a relatively rare occurrence; the larger the population, the greater is their expected number. Although but single individuals, each of them is capable of influencing the entire population irrespective of its size. The cultural progress of humanity depends chiefly on the absolute number of geniuses, not so much on their relative number. Therefore one could surmise that the qualitative progress of a humanity depends on its size; larger populations should advance faster than the smaller ones because there would be more individual stimulants, each affecting the entirety of the population in contact with them. That is why one could assume that a more populous humanity would evolve technically and culturally faster than a less numerous one. One could expect therefore that, with the colonization of other members (planets) of the solar system, a more populous humanity would evolve faster towards perfection than a smaller one of the same quality—toward the imaginary goal of "demi-gods" and this simply because of a greater number of outstanding individuals, each capable of transmitting his creations to the entire Humanity.

It may be noted that theoretical research in this direction, culminating in conferences, is already proceeding. Sponsored by NASA and originated by Princeton (New Jersey) Physics Professor Gerard O'Neill, the project is concerned with placing artificial habitats for populations of millions in the Lagrangian Point "L5" on the lunar orbit, trailing behind the Moon at equal distance from Moon and Earth. Because of planetary perturbations, this position is somewhat unstable over long periods of time, but with very small amount of "steering" the space city can be kept there indefinitely, much easier than keeping a car on a road.

To be considered next after the Moon are the asteroids. The solar system contains a great number — hundreds of large and thousands of smaller size planetlets, from a few hundred to a few tens of kilometres in diameter. Of course they are without an atmosphere, lifeless like the Moon, but equally suitable for transforming them into celestial greenhouses by enclosing into glass shells. However, despite the large number, their total area is only about one-tenth of the lunar area, and the distances are some 1000 times greater, so that it would take about two years for a space vehicle to reach them, while a trip to the Moon would last but a few days. Therefore, colonization of the asteroids would only be of secondary importance, the Moon taking unquestionably the precedence. The asteroids could be chosen as domiciles by secluded groups of space settlers, thus creating greater variety in the future humanity of space in the shape of small nations or ethnic communities with their originality, as at present is also the case with the human population on Earth. The asteroids could also be used as intermediate stations or bases on more distant voyages: most of them are in the space beyond the orbit of Mars, half-way to Jupiter, the dominant planet and "Rosetta Stone"* (*The stone with simultaneous Egyptian and Greek inscriptions which furnished the clue to the Egyptian hieroglyphs.) of the solar system. These minor planets could be compared to the islands and archipelagoes of the Pacific, the stepping stones to the continent of Australia.

It may appear somewhat odd that in the proceeding, our first concern was for the small lifeless bodies of the solar system — the Moon and the asteroids. Yet because their surfaces are completely airless and lifeless, there is no locally established hostile environment except a dry desert surface covered with dust, sand and rocks. There is no need to fight the inimical surroundings — the environment can be created at will as desired when there is solar or nuclear energy and the advanced technical skill. The required know-how and material power will undoubtedly be available after thousands or millions of years of technical and moral progress — unless destructive instincts taking hold of the atomic bomb (the super-bomb) will sweep us off our planet.

Different is the situation with the larger bodies of the solar system, the "full size" planets. Except for Mercury, the smallest of them, the nearest to the Sun and devoid of any significant atmosphere, the other planets have their own atmosphere, climate and weather. This makes their visiting and colonization much more difficult than in the case of a completely lifeless empty desert surface in a vacuum. Of course, we need not reckon with hostile living beings within the boundaries of the solar system, and certainly not with intelligent species, attacking and fighting us humans; not even on Mars, the most popular of the planets and the object of so many fantastic suggestions and stories. A much greater real danger is presented by possible virulent microorganisms to which humans are not immune, and especially by their importation to Earth. Yet undoubtedly our modern medical science should be able to keep new epidemics under control — new diseases or bacterial mutations appear from time to time on Earth, too, and are successfully tackled. And, perhaps, H.G. Wells may be right in his fantastic story, "War of the Worlds," picturing an imaginary invasion of Martians equipped with ultra-superior weapons; the story tells that they succumed to the most common terrestrial bacteria for lack of immunity because they were not subject selectively to infection in the dry sunny and "healthy" Martian climate. We earthlings have been tried by all kinds of germs, and viruses of our common cold could affect the Martians as a deadly plague. Although those gigantic spiderlike Martians of Wells were but a creation of the writer's brain, his argument about germs and immunity appears to be quite plausible.

Our present information regarding Mars is sufficient to assert that, after the Moon, this planet could come next as a favourable and desirable seat of settlement for a humanity of the future. Setting aside all kind of wishful dreams about this planet, either based on insufficient knowledge or simply on fantasy, the situation is at present more or less clear.

There are no "canals" on Mars nor intelligent beings who purportedly have built them — not even in the past. The conditions for life to exist there are harsh if not quite forbidding. With the extreme scarcity of water, only available as thin vapour in the atomosphere, or as a snow deposit mixed with dry ice (carbon dioxide snow) at the poles, and with an atmosphere 100 times thinner than ours (as in our stratosphere 36 kilometers above the ground), some primitive life could still exist on Mars, such as algae, mosses and perhaps unicellular species of the animal kingdom. The climate is full of sunshine but cold with extreme diurnal and seasonal fluctuations, rising to 15 or 20°C (59-68 deg F) in daytime but falling to a Siberian winter low of - 60°C (- 76 deg F) each night even at the equator. On Earth there is nothing comparable to such extremes. There are no seas which, on Earth, were essential for the development of life from lower to higher forms: fish were the ancestors of our land animals, until their descendants could crawl out of the water. Even the very presence of any life on Mars is subject to doubt and requires direct confirmation. In all appearance there will be no challenge to the human settlers of Mars except the natural environment. The atmosphere consists mainly of carbonic acid gas (carbon dioxide) — same as arises from burning coal or is exhaled in breathing. The gas itself is not very poisonous except in large quantities (not as carbon monoxide) but is unfit for breathing. Oxygen is pratically absent from the Martian atmosphere. However, the actual composition of the Martian atmosphere is of little consequence for visitors from Earth: even if it were pure oxygen, when exposed in "open air" we would die there instantly, blood boiling into our lungs at the low atmospheric pressure. Therefore on Mars, as on the Moon, one should build airtight glass covered habitations, hermetically isolated from the free atmosphere. Oxygen could then be obtained electrochemically from the atmospheric dioxide, a much easier procedure than from the rocks on the Moon. The surface or settlement area of Mars is four times that of the Moon and considerably exceeds the area of terrestrial continents. The meteoritic hazard is there very much less than on the Moon because of the protection offered by the atmosphere, however thin it is. From all this one could infer that Mars may perhaps become the most important place of emigration for a future superhumanity. And this despite some setbacks — the large distance which would require 9 months for a one-way trip, and the considerable gravitational field which would make descent and separation much more difficult on Mars than on the Moon, but still easier than on Earth. Martian surface gravity, 21/2 times weaker than on Earth, is intermediate between that of our planet and the Moon.

Of the other planets Mercury, the first and closest to the Sun, is most similar to our Moon, lifeless and with an almost negligible atmosphere. Its size is also intermediate between Mars and the Moon. The surface, covered with craters as that of the Moon, could also be suitable for erecting the cosmic glass dwellings. The area of Mercury is about twice that of the lunar surface, and a trip to Mercury would take several months — not much shorter than one to Mars. Because of closeness to the Sun, Mercury receives about six times more solar heat per unit area than the Earth, so that the glass roofs of the cities should be protected against excessive heat by reflecting mirrors, or refrigerating machines working with solar radiation could be used for air conditioning and control of the climate. In the latter case there should be large external surfaces radiating the excess heat back to space, something which renders things on Mercury more complicated than on the Moon or Mars.

The next planet, Venus, the second from the Sun and our sunward neighbour, the bright evening — or morning star, Vesper or Lucifer, is almost the size of the Earth and has a very thick atmosphere. Quite recently it had been the object of wistful dreams, pictured as an earthlike seat of life but with a warmer climate, or something of a garden of paradise. The evidence gradually acquired over the past decades has led to a great disappointment: not a paradise, but a virtual burning-hot, poisonous hell! There is definitely an atmosphere, even too much of it — 40 to 90 times denser than ours. Yet it is devoid of oxygen, its moisture content is extremely low, and it consists chiefly of carbon dioxide as on Mars but in several thousand times greater amounts. There is no liquid water on Venus, and its surface temperature, + 470°C or 880°F, is that of red-hot iron. The atmosphere is filled with dust or haze, shielding the surface which is invisible in ordinary light but can be explored by radar or radio (microwaves). Outwardly the haze presents itself as an impenetrable everpresent cloud layer, consisting — not of water droplets of ice crystals, but of hydrated sulphuric acid! No astronaut could ever land on this infernal hot and poisonous cauldron unless its climate and atmospheric composition could be transformed by injecting a whole oceanful of water (the indigenous water of Venus is not available, being probably locked in its near-surface unsaturated magma). This would create true clouds and purifying rain, clearing the atmosphere and lowering the temperature of the surface. The excessive amount of carbon dioxide could be removed through vegetation and oxygen set free as on Earth: however, even with abundant availability of water the process could take hundreds of millions of years to accomplish. It may be superfluous to say that such an imaginary project of improving Venus, the goddess of love, and transforming hell into paradise, must be virtually an impossible task even for a most advanced technological civilization. It is only a "mental experiment", to remain "on paper" forever as many other interesting but unreal projects. Venus is incorrigible!

The other, outer planets — Jupiter, Saturn, Uranus, Neptune and Pluto — are too far away, with very cold extended gaseous envelopes, partly "bottomless" or without a solid or liquid surface underneath. They are unsuitable for terrestrial type of life, nor can they be transformed properly, at least not within the foreseeable limits of human technology. Nevertheless, on Jupiter, in the depths of its bottomless atmosphere, some possibility of non-terrestrial type of life has been suggested. The basic substances of organic matter, such as ammonia and methane, are there present, and some biologists think that there, in the outer parts of the thick dense envelope to which some sunlight reaches, could float, swim or fly organisms which do not need water as a body liquid but are using liquid ammonia instead at temperatures well below the freezing point of water. In the deeper, denser and warmer but dark layers, there could float water-based organisms feeding on the detritus of organic matter sinking downwards from the upper layers in the same manner as some life is sustained in the deep dark waters and bottom of our oceans. However, from the standpoint of terrestrial life the conditions must there be very strange, and we will not further concern ourselves with them.

We have now finished with a review of our "nearest" surroundings called the

"Solar System".

To be continued. In the next issue the author looks beyond the solar system to the stars.

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Ernst J. Öpik, an astronomer at the Armagh Observatory, North Ireland, has written numerous articles on life and intelligence in the universe. Dr. Öpik, who is now 88, was Editor of the Irish Astronomical Journal until last year. This article is based on a talk Dr. Öpik gave to the Estonian All-World Women's Club in New York, June 10, 1974, and is reprinted from volume 11 of the Irish Astronomical Journal with the author's permission.

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