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IS MARS INHABITED?

THE question as to whether the planet Mars is actually inhabited by a race of intelligent beings is frequently brought to our notice by the press. It is a most interesting question, not only in itself, but also in the manner in which it is debated. Victory seems to be uncertain as to which side it shall award the palm, since, as is natural to human beings, each champion will generally unwittingly commit himself to an erroneous or exaggerated statement, and thus expose a weak point to the shafts of his adversary.

Professional astronomers are almost all on the negative side. Percival Lowell, of the Flagstaff Observatory, Arizona, is the strongest advocate of the positive side, and as he is also the best observer of Mars and has at hand a larger and better mass of actually observed facts than any other astronomer, he is in a position to assail any argument that is claimed to be based on facts.

The only safe way, therefore, to study the problem is to take Lowell's own writings, to grant his observed facts, and then to analyze his deductions and examine his arguments. It is only in this manner that the battle may be fought on even ground, for when it comes to reasoning, a recluse in his cell is on a par with the best observer.

Lowell has collected all his observed facts and expressed his ideas in two popular books, "Mars and Its Canals" and "Mars as the Abode of Life," published respectively three years and one year ago. When quoting these works I shall call them I. and II., respectively, followed by the page number. But before proceeding to review these books it will be necessary briefly to recall the principal facts concerning our sister planet as they are given in astronomical text-books.

Mars, as we know, is the planet whose orbit is next outside the earth's. It requires 687 days, or one year and ten a half months of our reckoning, to complete its circuit about the sun. Its distance from this luminary is about fifty percent. greater than ours, so that it receives only about half as much light and heat per square mile as the earth does.

The planet itself is a globe like the earth, and is about as much flattened at the poles. It is certainly a solid, as the permanence of its surface markings proves. Its diameter is about 4,200 miles, a

little more than half the earth's. Its volume is only one-seventh as much, and its surface area about twenty-eight per cent., that is to say, 100 pounds on earth would weigh only 38 pounds on Mars. It turns on its axis in 24 hours, 37 minutes, 22.67 seconds, so that its day and night are only a little longer than ours. Its equator is inclined to its orbit at very nearly the same angle that the earth's is, so that its seasons are identical with ours, except that they are about twice as long.

Mars has a very rare and transparent atmosphere. The barometer which registers a terrestrial pressure of about thirty inches at sea level would sink down to less than four inches on Mars. Human beings, therefore, like ourselves could evidently not exist there. This is admitted by all. This rare atmosphere is seldom obscured by clouds, and these clouds are rather dust than water vapor. On account of this wonderful transparency of its atmosphere, combined with the fact that when Mars is nearest the earth it turns a fully illuminated disk towards us, it is that we are enabled to see so many details upon its surface.

Three kinds of surface features are generally distinguished upon Mars. The first are the white patches about the poles, which are formed during the winter and disappear during the summer. The second are patches of bluish gray or green, and the third are extensive regions of various shades of orange and yellow. While the first are still supposed by many to be snow and ice, the second were for a long time taken to be water and the third land, but modern observations have shown that the famous canal system to be mentioned later traverses both regions indiscriminately, and that therefore this division must be abandoned.

Lowell maintains that the green portions are vegetation (II., 106), and that the orange ones are deserts, and that these latter cover five-eighths of its surface (II., 186). Mars, he says (II., 142), "is a world-wide desert, where fertile spots are the exception, not the rule, and where water everywhere is scarce. So scanty is this organic essential that over the greater part of the surface there is none to quicken vegetation or to support life." And (II., 144): "Untraversable without water to organic life, and uninhabitable, the Sahara cuts off completely the planet's hemispheres from each other, barring surface commerce by sundering its supplies." Mars' water supply, he estimates (II., 141) as 1-189,000 as much as the earth's.

Owing to the low barometric pressure on Mars, water would boil (II., 40) at about 110 degrees Fahrenheit. It would for the same reason rapidly evaporate. It must, therefore, if it exists at all, be found to some extent in the atmosphere of Mars and be visible in our spectroscopes. Whether this is the case or not is at present under discussion, and scientific journals abound in statements made by the opposing parties. As our own terrestrial atmosphere con-

tains water vapor in ever varying quantities, we must ascend to the top of a high mountain in order to look through the least possible amount of air and vapor. Then by pointing the spectroscope successively to Mars and our moon at equal altitudes, we have a standard of comparison, because the moon is known to have only a most insignificant amount of water vapor on its surface, if it has any at all. Lowell maintains that under these conditions Mars shows the band of water vapor in its spectrum much more intensely than the moon, while Campbell, the director of the Lick Observatory, cannot see any difference.

Mars has no mountains. If any existed, they would be easily seen at the terminator, the sunrise or sunset circle, where they would cast conspicuous shadows, as they do on the moon, which for that reason is such an interesting object even in small telescopes. "Altitude must therefore be a negligible factor in Martian surface meteorological phenomena. Both density and temperature can be but little affected by such cause." (I. 63.)

Owing to the rarity of the air and the general absence of clouds, "insolation on Mars is more of a factor than with us" (I. 79). Hence during the long days of summer, which itself is about twice as long as ours, heat may accumulate to a considerable extent in spite of the rarity of the atmosphere. This is a point well taken by Lowell. There may, therefore, be sufficient heat for the support of life, which the equally long and extremely cold winter would only cause to hibernate without destroying. (II., 187.) "The Martian climate is one of extremes. . . . In summer and during the day it must be decidedly hot, certainly well above any possible freezing. . . . The maximum temperature, therefore, cannot be low. The minimum, of course is. . . . Organic life is not in the least debarred from finding itself there." (I. 380.)

And in reference to observations that he has himself made on the top of the San Francisco mountains near his observatory at Flagstaff, Arizona, Lowell says (II. 96) that "the fact of a few warm weeks made life possible, outweighing the impossibility of all the other long, cold, forbidding months."

He claims that "the mean temperature of the surface air of Mars should be about 48 degrees F.; . . . that of the earth is only 60 degrees F." (II. 86.) Here, however, he is at variance with Poynting (*Monthly Weather Review,* November, 1904) and the generality of astronomers, who say that the four terrestrial planets, Mercury, Venus, Earth and Mars, part with the sun's heat by radiation into space as fast as they receive it, and that therefore their surfaces must be at a constant mean temperature. This temperature is for the earth about 62 degrees F., and for Mars 36 degrees below zero. With such a low average temperature it is hard to see how life could endure. However, Lowell remarks (II., 103) that "man

can endure 70 degrees below zero F. if the air is still, but perish at 40 degrees below under the least wind. Even a breeze, therefore, is equivalent to a fall of 30 degrees F. in the temperature." The rarity of the Martian atmosphere precludes the possibility of violent winds, and in so far favors the existence of life.

Nor is this rarity of the Martian atmosphere such an essential bar to life as is generally supposed. "Another point the presence of the animals on the San Francisco Mountains serves to bring out—their indifference to thinness of the air." (II. 96.) Lowell says that the species of deer, bear and other animals are the same at 10,000 feet elevation, where the barometer is only 18 inches, as they are at sea level, with 30 inches. In the same way meadow larks at 8,000 feet in Colorado are the same as at 2,000 feet in Kansas. Moreover, many of these animals migrate semi-annually from the top of the mountains to the bottom or the reverse with the change of the seasons. And even men adapt themselves to live at various heights. The thinness of the air on Mars is consequently no obstacle to the existence of animal and much less of vegetable life.

The absence of mountains on Mars increases the probability of life. "That we do not find animal and vegetable life at the tops of our highest mountains" (II., 103) is because they are isolated peaks separated by impassable gulfs. This hindrance does not exist on Mars. These, we must admit, are points in which Lowell reasons well.

What shall we say of the polar caps of Mars, which grow during the winter and diminish during the summer? The northern cap diminishes from 78 degrees to 6 degrees, and the southern one from 96 degrees to nothing (II., 114), while on earth the north polar cap is never less than 20 degrees or 30 degrees, and the southern 38 degrees (I. 42). Lowell maintains these caps to be ice and snow. "As the north polar cap melts, there comes a season when an indefinite pearly appearance fringes its edge, obliterating its contours, which before were sharp. This persists for some weeks, off and on, and when at last it clears, the cap is seen reduced to its least extent. That it is mist caused by the melting of the cap there is little doubt." (II., 136.) This mist, he says (II., 82), is a blue belt and proclaims the presence of a liquid. "The substance composing the caps was therefore snow. For no other that we know of dons their snowy aspect with change of state."

The late Simon Newcomb said in the *Monthly Weather Review* for October, 1908. "For snowfall substitute frost fall; instead of feet or inches say fractions of a millimeter, and instead of storms or wind substitute little motions of an air thinner than on the top of the Himalayas, and we shall have a general description of Martian meteorology." The polar caps he maintains to be hoar frost. Even at the equator the sun cannot melt more than one or two inches of ice in a day, and this freezes at once over night. Snow and ice

evaporate at all temperatures; this explains the shrinkage of the caps. A planet radiates as much heat as it receives; air blankets very little.

Lowell maintains (II., 140) that owing to the peculiar topography of Mars "moisture would proceed poleward, to remain there." The sun's heat and the rare atmosphere would evaporate the water wherever it existed. At the poles there would be evaporation only in the summer time, while during the winter the moisture from other regions would distill over and be precipitated there. The water, he says, is returned to the equatorial and other zones by artificial means, as we shall see later.

He claims that the polar caps cannot be carbonic acid, as some have maintained, because although this when frozen is as white as snow, it changes from the solid to the gaseous state without passing through the liquid state. Now the polar caps of Mars are always fringed with a deep blue line, which cannot be anything else but water. (I., 39.)

This fine blue line fringing the caps seems to be Lowell's only real argument for proving the presence of water on Mars. It is a rather slender thread to support such a weighty conclusion. It is needless to say that he is alone in this contention.

And as water vapor is there, Lowell infers that therefore the less volatile gases—nitrogen, oxygen and carbonic acid—must be there also (II., 104). As all these gases, which are the constituents of our own atmosphere, found their presence on Mars ultimately on the fine blue line which fringes the polar caps, and which Lowell is the only one to have seen, the argument is rather weak and unconvincing. The direct spectroscopic proof of the presence of oxygen in the atmosphere of Mars, which Lowell claims recently to have obtained, still awaits confirmation.

We come now to the most interesting part of Arean topography—the famous canal system. Here we must trust Lowell almost implicitly, since no other person has ever been able, even with superior optical power, to see as much as he has depicted. The keenness of his eyesight, as well as his assiduity, are truly marvelous. According to Lowell the canals cover the whole surface of the planet (II., 194). They are extremely fine lines, almost entirely beyond the visibility of most obervers. They run in arcs of great circles, that is, to use an unmathematical term, they are perfectly straight. Their smallest width is about one mile (I., 181), and as to length, 2,000 miles is common; many exceed 2,500; one is 3,540 miles long (I., 183). This is one-third of a circumference (I., 183), or, rather, only one-fourth (II., 150), and as long comparatively as if it extended on earth from London to Denver, or from Boston to Behring Strait. They are to be found in all latitudes, longitudes and directions (I., 190). They are, however, visible only during the summer; they "hibernate" (I., chap. xxv.) and disappear during the winter (II., 197).

But the most wonderful feature of these canals is their gemination or doubling, two fine lines being perfectly parallel and equidistant throughout their whole length. Lowell estimates an average double canal to be about 2,250 miles long, each one being 20 miles wide and 130 miles from its fellow (I., 206). Out of the 437 canals (II., 151) on Mars only 51 have been seen double (I., 208; II., 159). He says that this gemination is seasonal (I., 212), and that doubles are an equatorial (I., 239) or tropical (II., 163) feature, since they are practically confined within 40 degrees of the equator, and that beyond 63 degrees north and 35 degrees south there are none at all. And all except one are confined to the light colored regions of the planet (II., 163). That these canals, single and double as well, are no optical illusion, but exist in reality, is now admitted by all, because they have actually been photographed (I., 277).

Intimately connected with the canals are the so-called oases, which are to be found only at their junctions (II., 195). There are seldom less than six canals to meet in an oasis (II., 194), and in one case (II., 157) there are 17. The oases are always true circles (II., 197). They vary in size from 20 to 75 or 100 miles (I., 253, 332). About 186 oases have been counted (II., 157).

We are now in a condition to consider Lowell's arguments for the presence of intellectual life on Mars. They are twofold—a priori and a posteriori.

The a priori argument he states boldly (II., 39): "From all we have learned of its constitution on the one hand, or of its distribution on the other, we know life to be as inevitable a phase of planetary evolution as is quartz, or felspar, or nitrogenous soil. Life . . . is only a manifestation of chemical affinity." And (II., 36): "There is now no more reason to doubt that plants grew out of chemical affinity than to doubt that stones did. . . . Spontaneous generation is as certain as spontaneous variation, of which it is, in fact, only an expression." And he proves it by the case of our own earth (II., 66): "Life did not reach this earth from without. No fanciful meteorite bore it the seeds which have since sprouted and overrun its surface." "The proof that life was here spontaneously evolved appears at every stage of its history. . . . Until the conditions were such as could support life, no life appeared. This is the first coincidence. . . . As soon as this (the land) was suitable, plants appeared to take possession of it." (II., 67.) "The last of this procession of coincidences, man, came on the scene at the time when the cooling of the globe rendered his own extension possible at the least expense to himself. . . . Thus all along the line we perceive that life and its domicile arose together." (II., 69.) He paints a graphic scene in this evolution (II., 53): "Then came the exodus from the sea. We may picture some adventurous fish,

spurred blindly from within, essaying the shore in preference to the main. . . . Finding the littoral not inhospitable, the pioneer reported his exploit and was followed by others whom mutation had specially endowed. . . . From this aboriginal crawling out upon terra firma the organism progressed until finally it came to stand erect and call itself a man."

Let me conclude Lowell's a priori reasoning with the strongest of his arguments (II., 39): "For proof of the continuity of the processes of both structure and change in the inorganic and organic alike, nothing at once more conclusive and more interesting can be recommended than the books of the great Haeckel." What an unfortunate reliance upon a man who has been forced to acknowledge that he has committed downright forgeries. Poor Lowell! When it comes to philosophic reasoning he is as much out of his element as his adventurous fish. As an able and persevering observer of facts he is unsurpassed. If he would only confine himself to his main and not essay the shore. It is evident that he is a rank materialist. In the two books under review there is not the least direct or indirect reference to a Creator. The word "providentially" occurs once (II., 211), and must have been an oversight; at all events it has no Christian meaning. Nature with a capital N is his god.

In his a posteriori arguments Lowell is more at home, and it is difficult and at times impossible to refute his contentions on account of his vast store of actually observed facts. Nor does the writer of these lines arrogate to himself such superior wisdom. His object is rather to present the question fairly and let the reader judge for himself.

Lowell says (II., 187) there are two most essential prerequisites to habitability, water and warmth. There is water in the polar snows, and there is also heat enough for life. Neither of these two is granted by astronomers. The presence of water has not yet been proved. That the requisite amount of heat is there can be claimed only by mathematical inference; it is certainly no fact of observation.

Vegetable life can reveal itself directly (II., 188) by the coloring it imparts. Such color effects actually exist on Mars (II., 106). This astronomers are willing to concede, although most of them would grant only the lower and creeping forms of vegetation, as W. Pickering claims for parts of the moon. But animal life can reveal itself only indirectly (II., 188), not by its body, but by its mind, by the imprint it has made on the face of Mars. "Already has man begun to leave his mark on this his globe in deforestation, in canalization, in communication. . . . But the time is coming when the earth will bear his imprint and his alone. What he chooses will survive; what he pleases will lapse, and the landscape itself become the carved object of his handiwork." (II., 109.) That this is true to the extent that the results may be seen from other planets is open

to objection. Let us, however, grant it. Now, Mars bears such an imprint in his canal and oasis system. "That the canals and oases are of artificial origin," says Lowel (I., 366), "is suggested by their very look." And (I., 376) "that Mars is inhabited by beings of some sort or other we may consider as certain as it is uncertain what those beings may be."

And then he gives eight reasons to prove that the canals are the work of intelligent beings (I., 368, 369): "1. Their straightness. 2. Their individually uniform size. 3. Their extreme tenuity. 4. The dual character of some of them. 5. Their position with regard to the planet's fundamental features. 6. Their relation to the oases. 7. The character of these spots. 8. The systematic networking by both canals and spots of the whole surface of the planet."

He says the canals cannot be natural features. They cannot be rivers or cracks, because they are of uniform size and straight (I., 186; II., 191). Nor are they meteor welts (II., 194), that is, the scarred furrows made by glancing meteors, as Wallace oddly maintains.

Lowell's ingenious theory is that the scanty moisture is precipitated only at the poles during the winter time, where naturally it ought to remain (II., 202). It is diligently gathered there by the Martians, who value it at an immense price on account of its great scarcity, pump it in covered pipes to the oases all over the planet, even across the equator to the other hemisphere, and dole it out for irrigation purposes along the canals and oases, which latter are the centres of population (II., 213). He says that the fine lines we see are not canals in our terrestrial use of the word, but narrow strips of land irrigated by these concealed pipes and covered with verdure. The increase of the visibility of the canals, or their apparent swelling, in spring and summer, shows him the progress of the irrigation, and tells him that the water travels 51 miles a day, or 2.1 miles an hour (I., 375). He says the speed is remarkably uniform (I., 375).

He admires the "intelligent and non-bellicose character of the community which could thus act as a unit throughout its globe" (I., 377). War "is something a people outgrow. . . . Whether increasing common sense or increasing necessity, . . . we cannot say, but it is certain that they reached it, and equally certain that if they had not they must all die" (I., 377). "In an aging world . . . mentality must characterize more and more its beings in order for them to survive" (I., 382). And he ends with the prophesy that in Mars we see the future of the earth (I., 384).

The fundamental assumption of Lowell's ingenious theory is that Mars is much older than the earth. This is entirely gratuitous. It is an essential phase of the now rejected nebular hypothesis of Laplace. Nor do geologists accept the proof he bases on the widespread deserts of Mars, when he claims that deserts are a result of

planetary evolution (I., chap. xiii.); that the oceans have diminished and the continents have increased in area on the earth (I., chap. xii.). That Mars should age faster than the earth because it is smaller and must therefore have had a lesser sum total of the original supply of heat which all planets are losing rapidly, is another gratuitous assumption, since, as was said before, the mean temperatures of the four terrestrial planets are generally supposed to be constant, the sun supplying them with heat just as fast as they are losing it by radiation into space.

The *Scientific American Supplement,* No. 1764, reprints an article from the New York *Sun,* in which the question of the water supply of Mars is well discussed. It says: "It is argued that if the Martian atmosphere was so rich in aqueous vapor as to form these vast polar areas of ice, it would be so rich that, under any comprehensible theory of connection and atmospheric circulation, it would be impossible for it to be so arid in its equatorial and midway regions as to call for any system of irrigation at all.

"Furthermore, in opposition to the canal theory, it is held that if it really be ice at the polar caps, and knowing as we do the number of thermal units effective when the sun returns to shine upon each cap after its winter night, we cannot account for the rapidity with which the cap disappears in the sunlight. It vanishes with such speed that some observers have spoken of it as almost an evaporation, some such process as in the physics of the terrestrial atmosphere is observable in the warm Chinook winds of our northern Rocky Mountains, where whole fields of snow vanish as if dried up, the same phenomenon on the European Continent being equally familiar as the Foen of the Alps.

"So rapid is the disappearance of the bright spots in the circumpolar region when the sun dawns upon it, that it is too rapid even to admit of the inference that it is only snow. It is said that nothing but hoar frost will at all answer the conditions observed. If the Martian atmosphere has so little vapor of water that its maximum polar deposits amount to no more than frost, it is clear that the evaporation constant must be so high that no canal could possibly carry the collection of drops from a region of melting rime as far as the equator of a planet as great as our own, or beyond the equator into the cold atmosphere, as the theoretical conditions demand.

"This dilemma may thus be stated. If the water vapor in the Martian atmosphere is sufficient in amount to yield an ice cap at the polar bright spots, the tension over the rest of the planet must be such that canals will not be needed because of a sufficient precipitation; if the water vapor content is so slight that the polar caps are nothing but frost, no amount of engineering skill could cope with the tension which would evaporate whatever water may have started in the canals."

Coming back now to the character of the canals, their straightness, uniformity and tenuity may perhaps be consistent with their being true cracks, whose irregularities cannot be distinguished at this distance, since the canals are generally beyond the powers of visibility of even skilled observers, even when provided with larger telescopes than Lowell's 24-inch. In fact, in a recent number of the *Astronomische Nachrichten,* A. N. 4348, Baumann maintains that they are cracks in icy oceans. He says the ice drifts and packs may extend in perfect straight lines from one oasis to another. Should the drift come from both sides, a double canal may result, whose interior space may be smooth ice. The oases, he says, are volcanoes which cause the cracks, and which while abounding on the greater earth and lesser moon, ought reasonably be supposed to abound also on the intermediate Mars. The varying coloring of the surface he ascribes to creeping plants, which get their moisture from the hoar frost which is deposited during the night and melted during the day. Or it may be owing to volcanic dust, which changes its color with moisture or heat. This explanation seems to fit most, if not all, of Lowell's observed facts. It is possible, however, that it may meet the fate of previous interpretations of the canal system, as Lowell may find some facts to contradict it. In this wise the merry battle goes on.

It would be rash to pretend to be able to answer every one of Lowell's a posteriori arguments. This no one has yet succeeded in doing. All we can say at present is that Lowell's proofs of the actual occupation of Mars by intelligent beings are judged by astronomers generally as entirely insufficient. Lowell is a most assiduous observer and the greatest living authority on Martian matters, and as he is also an eminent mathematician, it is a hazardous venture to attack him on observed facts or mathematical deductions. We must, for the present at least, grant all the facts he adduces, and then contend with him on their interpretation. His interpretation of the canal system is surely original and ingenious. It seems to fit all his facts, as far as we can see. But as most of these facts are furnished by him alone, that does not establish it on a sufficiently firm basis. The whole scheme is rendered somewhat doubtful by the fact that he has seen similar markings on Mercury and Venus. It is not likely a priori that all these planets have similar constitutions, since they are at such different distances from the sun and receive such different supplies of heat.

Here we must leave the subject for the present until further facts are discovered or further interpretations devised.

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