

biological station at Lajolla, Cal., near San Diego.

The well known geologist, Charles S. Van Hise of the University of Wisconsin, gave an account of the cobalt silver district of Ontario, the only region where cobalt is found in important quantities. It occurs as smaltite and as cobaltite.

The session closed with the reading of a suggestive paper by Dr. Ellsworth Huntington of Harvard University, introduced by Prof. W. M. Davis, on the evidence of desiccation during historic times discovered by him in Chinese Turkestan. He set forth evidences upon which he rested with numerous photographic views thrown upon the screen. They seemed to be of a thoroughly trustworthy kind; but it was naturally impossible to subject them to any severe criticism. It may, however, be said that if they do not amount to demonstration of the curve of humidity which he exhibited, at least they are sufficient to call for new explorations. According to his curve, in the earliest times before the Christian era, the country was well watered, but was beginning to dry up. This desiccation went on faster and faster, till about A. D. 100; and the dryness reached its worst about A. D. 500. It then began to be less dry; and about A. D. 1000 reached a maximum of humidity, which, however, was not more than that at the epoch of our calendar. Since that date it has been gradually drying up again and is now nearly as dry as at A. D. 500. The reporter cannot, however, vouch for these statements as a correct report of the minuter details of Dr. Huntington's conclusions, who suggested, however, that the invasion of the Huns might have been due to the drying up of their own land.

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"Mars as a Place to Inhabit."

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MARS AS A PLACE TO INHABIT.

TO THE EDITOR OF THE SUN -- Sir: What can we know or confidently presume or reasonably guess as to the present existence of intelligent beings upon Mars?

It is natural to us to believe that this one little globe is not the sole theatre of reason in the vast multitude of the heavenly bodies; and what it is natural for us to believe about any practical matter, concerning which error might imperil the continuance of our race, can hardly fail to be, at least vaguely, true. Mind seems to us to be utterly unlike anything else; and if it really be so its appearance anywhere would seem to argue a tendency in it to spring up everywhere, though that there are some prerequisite conditions to be satisfied is evident from the fact that it is not everywhere actually found. It may possibly be that among the countless orbs in space there is some other than this earth where there live white men just like ourselves and speaking the English language. But it does not seem likely, because the conditions requisite for the formation of our language have been so very special. Now, it may be that what we think of as intelligence is almost equally special; so that just as the Greeks regarded those who did not speak Greek--the so-called barbarians--as hardly rational, we make a great mistake in thinking that what we call "intelligence" is the highest form of being. So it may be; but there are philosophical reasons for thinking that it is not so, and that reason really is something peculiar, unlike anything else, and therefore, since it is found somewhere, would be found everywhere where suitable conditions of a very broad kind were fulfilled; and the chances are as billions to one that such conditions are in fact fulfilled on many celestial masses.

But as to the planet Mars, the most minutely observable body outside the orbit of the moon and at the same time of all known to us the one on which conditions are most like those on the earth, is it not possible that we may reach more definite conclusions? If so, we must reason by analogy; and therefore the very first step upon which every competent reasoner must and will insist as precedent to all others will be to examine the respects in which the analogy between Mars and the earth fails. By far the most important of these respects is the smaller size of Mars. Its dimensions are only 0.53 those of the earth. Naturally, therefore, the material is less compressed, the mean density being only 71

per cent. of that of the earth. The consequence is that gravity on the surface of Mars is only 71 per cent. of 0.53, or three-eighths of gravity on the surface of the earth. The pint of water that on the earth weighs a pound would on a spring balance weigh but six ounces on Mars. In all terrestrial things the momentum of a body at any given velocity is strictly proportional to its weight. We have no familiar experience with any different state of things. Yet any moving body, say of flood of water, on the surface of Mars has the same momentum as it would have upon the earth, while it presses down on the ground with only three-eighths of its terrestrial weight, and is therefore retarded by friction by as much less. Hence anything which is projected with any force along the surface of the planet Mars must move much further, other things being equal, and along a much straighter path, and this will in particular be true of any streams of water.

Another consequence of the same facts is that the mass of Mars is only 71 per cent. of the cube of 0.53, or about one-tenth of the earth's mass; so that the force of gravity at any distance from the centre of Mars will be only one-tenth of the gravity toward the centre of the earth at the same distance. Or, since gravitation varies inversely as the square of the distance, in order that a body should be attracted to Mars as much as an equal body is attracted to the earth the distance of the former from the centre of Mars must not exceed $\sqrt{10}$ of the distance of the latter from the centre of the earth. Consequently were the temperature the same the upper limit of any given gaseous constituent of the atmosphere would be only one-third as high above the centre of Mars as it is above the centre of the earth. Now, since the very surface of Mars is much higher than one-third the height of the top of the earth's atmosphere, if Mars has any oxygen atmosphere at all it must owe this to the fact that the temperature of the upper atmosphere is lower than about the earth. Possibly, for example, the oxygen is there solid. We may suppose that Mars originally had relatively as much atmosphere as the earth had. If so, it has lost the bulk of it through the weakness of its attractive force; and it probably now retains excessively little except what is composed of substances partly congealed and so without expansive energy. In view of this slight atmosphere, very little erosion of any of the kinds that are familiar to us on the earth can be active on Mars. Erosion of a different kind there must, however, be; for the direct radiation of the sun on the surface of Mars must have a heating effect fully quadruple its effect on the solid surface of the earth; since, if we remember rightly, the late lamented Langley showed that nine-tenths of the sun's heat is cut off in the upper air (we may have the precise value wrong) Mars is half as far again from the sun as the earth is, and so receives on a given area only four-ninths as much heat. This refers to the top of the atmosphere. That of Mars absorbs hardly at all, that of the earth at least eight out of every nine parts; hence at the solid surface the sun's radiation has four times the power on Mars that it has on the earth.

In the spring of the Martian year (of 688 days) lofty ice caps cover its pole, and probably there are other places where ice has collected on mountain tops. Under the blaze of the sun,

instead of glaciers breaking off icebergs from their bases as on our own planet, avalanches of ice must come thundering down from the summits. If they did not find channels ready cut for them by myriads of former such masses they would begin themselves to cut such channels. But they must find them cut, and once cut, owing to there being so very little air, the surfaces of these channels must remain smooth and perfect. The almost frictionless ice, with a specific gravity only one-third that which water has here, must slide along this channel, rapidly melting as it goes, and carrying vegetative life beyond the equator. At the same time, owing to the absence of ordinary erosion and to the small gravitational attraction, the ice masses must at certain points be liable to strike rocks which sharply deflect those that happen to strike them, and thus furcations must occur in these channels.

So much for what as it would seem must happen. Now, what is actually observed? In the first place no kind of observation is so excessively difficult as the observation of the face of a planet. Not owing to defective instruments, but to the lack of sufficiently fine observers, it was not until 1877 that anybody saw anything that seemed to indicate the presence of a channel on Mars. Mr. Percival Lowell above all and a number of others have now been able to discern not the waterways themselves, but dark bands apparently of vegetation along the borders of unseen channels. These bands appear in the Martian spring, and reappear yearly in the same places. To Mr. Lowell, unquestionably the best observer of them, they have looked decidedly artificial, owing to their extraordinary straightness, to the smoothness and uniformity of each one, and to their radiating from special points. But the first two of these three characters must be in part illusions, due to well known and ineluctable laws of psychology. Beyond that the straightness must be largely due to the small gravitation on Mars as above explained. Since we do not see the channels themselves, but only the vegetation stimulated by the streams, and since vegetable growth is a natural process, one does not easily see how the apparent uniformity of the dimly made outmarking can be any evidence of artificiality. If they radiate from special points we may naturally suppose that there are mountains or places where for some reason ice is piled up in winter, unless, indeed, there be evidence of design in the location of these centres. The appearance of artificiality will strike everybody; but it will convince different people according to the quality of self-criticism which they apply to their reasoning. There is another feature of the channels that suggests artificiality, yet to which I have seen no other allusion than three words in biologist Morse's book, "Mars and its Mystery," page 142, where he speaks of their "angles of approach." They certainly seem to cross one another at angles such as one does not expect to see in natural streams. This may, however, be partly illusion and partly the effect of the ice masses of little weight but great momentum striking on certain faces of rock.

If these channels are artificial, how shall we eventually be convinced that they are so? What phenomenon will point unequivocally to their artificial origin? The intelligent race, if there be one, must either be multiplying or, more likely, dying out. In

the former case we ought to be able to detect some subservience to a purpose or to a convenience in the location of the cases, or vegetative spots; and the canals should multiply as the years go by. If on the other hand the race is dying out, the cases and the channels should, some of them, fall into desuetude; and those that remain should naturally form a clustered collection. Nothing of all this has, however, yet been noticed.

It may be that there is intelligence on Mars without its having produced any effects that man can as yet observe. It may be that there has been intelligent life on Mars but that it is now forever extinct, as that on this earth is going to be perhaps before another millennium has flitted by. It may be there never was and never will be an animal on that planet guided by anything but irreflective instinct. Is not reason, by the way, for the most part a rather futile makeshift? Mightn't a good sound instinct answer the purpose better?

As has been intimated above, a book has lately appeared on this subject of the habitability of Mars by a biologist--a fair observer of the old school, a writer of superabundant emphasis, but very little of a reasoner. His book is amusing, owing to the impertinence with which he treats everybody who deliberates at all or is not cocksure that Mars is inhabited by an intelligent race at this day. It is good for a laugh, at any rate. P.