

Habitability of the Planets.

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When we cast our eyes on the different planets wending their periodical course round the Sun, a question naturally arises in our mind, whether the Earth is the only planet in our system in which the Creator has centred all the animals and planets of the world, making human beings an image of himself. This is a question which can only be solved by direct observations with most powerful telescopes and other instruments at our command. But there is a limit to the magnifying power of the telescope. To have a cognisable view of a being like ours on any planet, the object must be brought at least to a distance of 10 miles from us. But the largest telescope hitherto constructed has not been able to bring an object on the Moon, which is the nearest body in our solar system, to a less distance than 150 miles. Attempts are being made to increase the magnifying power every day, but the more this power is developed the greater becomes the disturbance in the outlines of the images, owing to the constant motion of our atmosphere, through which the observations are made. Direct observation of beings like ours on the different planets by earthly instruments thus seems a hopeless task. But this should not deter us from investigating into the physical conditions of some of the planets, and see in what respect these planets seem to be adapted to be the abode of life like ours. The physical conditions of our Earth are in many respects similar to those of other planets, and it does not seem unreasonable to suppose that there might be creatures like ours or somewhat like ours on other planets of our solar system. Mr. H. C. Wilson has recently read a paper on the "Life in Other Worlds" before the Astronomical Society of the Pacific, and came to the conclusion that there is not a single planet in our solar system on which a life like ours can possibly exist. But one hesitates to accept such a sweeping conclusion, when we on our own planet find life flourishing under different conditions of temperature and pressure. Travelling over the Earth from the polar regions to the torrid zone, one finds in the severe cold of the arctic regions, with its perpetually frozen seas, long summer days and winter nights and scanty vegetation, life abounding in hundred different forms. Esquimaux there feel themselves comfortable with seal flesh and do not hanker after dainty vegetable dishes. On the other hand, in the tropical zone, with its scorching heat, absence of rain and fearful hurricanes,

one meets with even more abundant forms of life. Mountain summits clad with perpetual snow, and deep seas with temperature some degrees below zero, and pressure of several atmospheres are not devoid of living creatures. This is not all. As the conditions of the Earth change from age to age, different forms of life appear more adapted to the altered circumstances and old forms disappear; thus making our globe a permanent abode of successive forms of life. Thus the mammoths and vegetables of the pre-historic age have gone and their places have been taken by new types of animals and vegetables. So that one cannot help concluding that although the physical and other conditions are different in different planets, it is not impossible to have life of different stages of development and more suited to their conditions living therein.

Let us now examine the physical conditions of each of the planets and see in what respect they resemble or differ from our Earth.

Passing outward from the Sun, the first planet we meet with is Mercury. It circles round the Sun in 88 days. Its distance from the Sun varies according to the eccentricity of its orbits, the maximum distance being 43,000,000 miles and minimum distance 29,000,000 miles. When nearest to the Sun it gets 9 to 10 times more light and heat than we do, and when furthest from it the light and heat are reduced by more than one-half. It circles round the Sun at an average speed of 29 miles per second. Schiaparelli is of opinion that the planet rotates upon its axis in the same time that it revolves round the Sun, and this has since been verified by Lowell's Observations at Flagstaff, but there is a difference of opinion about this as according to Schroter it seems to rotate round its axis and the Mercurial day is a few minutes longer than ours. Its equator is said to be much more inclined towards its plane of revolution than the Earth, making its days and nights almost equal in all places and at all times. Its density cannot be accurately determined owing to the absence of any satellite; it has, however, been roughly calculated by the perturbation of Euche's Comet when in its neighbourhood that its density is not more than one-sixth greater than our Earth. As its diameter is 3,000 miles, its weight is $\frac{1}{15}$ of that of the Earth. The force of gravity on its surface is such that a pound weight of ours would weigh less than 7 ounces on Mercury.

If the equality of the periods of rotation round its axis and revolution round the Sun is to be believed, it would show the same face to the Sun like our Moon, and there will on the one hemisphere be an eternal day and on the other an everlasting

night. There would thus be 9 to 10 times the heat on one side raising its temperature to an enormous extent, while on the other side there would be as low a temperature as of the space. There may be a temperate zone about 45° on the other side, owing to librations. If on the other hand the rotation theory round its axis is to be believed, there would not be much variation in the Mercurial seasons at any particular spot like our Earth, but there would be a difference of climate in different parts of the planet making it habitable like our Earth. Of course everything depends upon the presence of atmosphere and water on its surface. Astronomers largely differ in this respect as its atmospheric conditions cannot be satisfactorily examined with the telescope owing to its proximity to the Sun. The recent investigations of Mr. Percival Lowell show that there are no signs of clouds nor of any atmospheric envelope. If so, there is a great doubt about the planet being habited by beings like our own.

The planet next to Mercury is Venus. It has a year of 224 days, 17 hours, and its distance from the Sun is somewhat less than $\frac{1}{4}$ ths of that which separates us from the Sun, being 67,000,000 miles. It travels nearly 22 miles per second. Its day is about 35 minutes shorter than ours and its globe somewhat smaller than the Earth's. According to some eminent astronomers, its axis is inclined only 15° to the plane of her orbits, causing thereby an existence of different seasons somewhat resembling ours. Gravity on its surface is nearly equal to the gravity on the Earth. It has got an atmosphere far more intense than ours. The diameter of Venus is about 7,700 miles, against 7,918 miles of the Earth's diameter. Its mass is $\frac{1}{4}$ of that of the Earth or $\frac{1}{425,000}$ of that of the Sun. Its density is about .850 of that of the Earth. It would weight 4.81 times as much as a globe of water of the same size. The force of gravity on its surface is slightly less, as a body there falls about 13 feet in a second against 16 feet on the Earth's surface.

It will thus be seen that in matters of size, situation, density, and the length of her seasons, as well as in the shape of its orbit and in the amount of light and heat it receives from the Sun, it resembles the Earth more than any other planet. We might therefore expect conditions here suitable for life like ours. There is, however, some difference of opinion among astronomers as to the period of rotation round its axis. In 1888 Schiaparelli came to the conclusion that Venus, like Mercury, keeps the same side always towards the Sun, rotating once in exactly the same time in which it revolves round the Sun. Mr. Lowell's recent observation also confirms this view.

If the theory of equality between rotation and revolution periods be accepted there would be very little libration in longitude owing to the nearly circular nature of its orbit, and the conditions of the side exposed to the Sun, and that on the other side of it would be even more contrasted and constant than Mercury. Prof. Lowell is of opinion that the constant atmospheric currents would carry away the moisture from the sunward hemisphere and deposit it in the form of snow and ice on the other side. This process kept up from age to age would make one part altogether devoid of water and the other part full of perpetual ice; and such extreme rigours of climate would make the planet quite unsuitable for a habitation of beings like those on the Earth.

But this theory is not accepted by the general body of astronomers, and a rotation period of a few minutes less than ours is ascribed to it. As such there is an alteration of day and night on different parts of the globe. But as its axis is inclined only 15° to the plane of its orbit, a number of singular and somewhat complicated relations are presented. Further, the arctic regions extend within 15° of its equator while the tropics extend within some degree of its poles—so that two zones larger by far than the temperate zones of our Earth belong both to the arctic and tropical regions. An inhabitant of the polar regions has therefore to endure the extremes of heat and cold. During the summer the Sun circles continually close to the point overhead, so that every day a continuous stream of light and heat of nearly two-fold intensity is found on its surface. Only for a short time in autumn and in spring does the Sun rise and set in the polar regions. A spring or autumn day like one of our days at those seasons lasts about 12 hours, and the Sun attains at noon a height of only a few degrees above the horizon. Then comes the terrible winter season lasting about 3 of our months. The Sun approaches the horizon at the hour corresponding to noon, and, though it does not show its disc, it brightens up the southern skies with a cheerful twilight. During the greater part of the long night the Sun does not approach within many degrees of the horizon; an intense darkness prevails. These alternatives of extreme rigour of polar winter and summer heat are of course too much for human beings like ours.

The conditions of equatorial regions are also different from ours. Here are two summers corresponding to the spring and autumn of the polar regions. At these seasons the Sun rises overhead each day and the weather corresponds to what prevails in our tropical regions. But between these seasons the Sun passes alternately to the northern and southern skies;

it attains no great elevation, travelling always in a small circle close round the northern pole. During winter the Sun is above the horizon only for a short time each day and is always close to the south, attaining only an elevation of a few degrees at noon. In such regions the change of climatic conditions are so rapid that no races subsisting upon our earth could possibly endure them comfortably.

But astronomers are yet far from finally accepting the above inclination of the axis. If that inclination somewhat resembles that of the Earth, there is every reason to believe that the physical conditions resemble those of the Earth, and the planet becomes quite suitable for habitation by creatures which exist on the surface of our planet.

Extracts from Publications.

On September 16 and 17, 1896, any one observing the Sun with the naked eye would have seen upon it a long, straight "canal," as straight, as regular, as hard and sharp as any "canal" that Mr. Lowell ever saw upon Mars. (Three photographs of the Sun on September 16, 1896, on different scales, shown on the screen). A field-glass would, however, have shown it as a chain of round dots, and a good telescope as a succession of small spots of great complexity and beauty. What did the apparent straightness of the group as seen with the naked eye mean? Simply that the observer had not a sufficient magnifying power to show the great irregularity of the details. Yet the very best circumstances under which any one has seen Mars is only relatively equivalent to seeing the Sun or Moon with a magnifying power of 3 or 4 diameters. Where is the reasonableness of assuming that because we are at present not able to detect irregularities in certain markings upon the planet Mars, that, therefore, no possible improvement in our means of vision will ever show any details there? The attitude is the more unreasonable because Schiaparelli himself, long before Mr. Lowell took up the study of Mars, had already succeeded in seeing some, at least, of the canals as knotted, somewhat sinuous, lines. And, in more recent years, the most experienced observers of the planet and the most favoured in the power of the telescopes at their disposal, and in the situation of their observatories, have abundantly confirmed Schiaparelli's