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## Other Worlds.

By Camille Flammarion.



MANY people mistake the fact of their revolving with the earth under the heavens for that of the heavens revolving around them. This misconception is often coupled with the intolerable conceit of those who think that all nature was only made for them, and that the sun, a great body four hundred and thirty-four times larger than our world, was only created to ripen their fruits and cabbages.

But, far from sharing this absurd idea, I believe that some of the planets which roll round the sun are inhabited worlds; and that all the fixed stars are suns, having their own planets; that is to say, worlds which we cannot see from here on account of their size, and because their borrowed light fails to reach us. How, in good faith, can one possibly imagine that those spacious globes are only deserted spheres, and that the planet in which we happen to live was the only one made for its complement of pretentious beings? What! because the sun rules our days and years, is that to say it was only created to keep us from knocking our heads against the walls? No, this visible god gives light to man, as the torch-bearer of a king might give light to a rag-picker in the street. And if this be rather an extravagant figure of speech it is nearer the truth than the opposite idea.

Let us return to our planets. Let us take into consideration the density and mass of planetary bodies, and we shall see that the earth has not received any privilege at the hand of Nature which exalts it over its fellows. We can gain an approximately accurate idea of the density of planets by comparing them with those of substances known to us. Thus the density of the sun is a little superior to that of pit-coal; that of Mercury is a little less than that of tin; and the density of Venus and of the earth is equal to that of magnetic oxide of iron. Mars has the weight of the eastern ruby; Jupiter is a little heavier than oak wood; and Saturn has the weight of the pine—it would float on the surface of the water like a light wooden ba.—Uranus has the weight of lignite, and Neptune that of beech.

If the density of the earth be put at unity, the lightest (i. e., Saturn's) would be one-seventh as great, and the heaviest (Mercury's) one-third greater; so we see that the density of the earth is neither the least, nor the mean, nor the greatest.

Surprise is sometimes expressed that astronomers can calculate the weight of bodies on the surface of other worlds. To give an idea of the way in which this calculation is made, we may say that this weight depends on the mass of the globe and its size. The attraction exercised by a planet on bodies placed on its surface determines the weight of these bodies—in other words, this attraction is proportional to the mass of the planet, but inversely proportional to the square of the distance from the centre of the planet.

Let us take Jupiter for example. The volume of Jupiter is 1,279 times greater than that of the earth; if the materials constituting this globe were analogous in density to the materials constituting the world, its mass would be 1,279 times greater than that of the earth, and the attraction it would exercise on a body placed at a distance from its centre equal to the earth's radius would be 1,279 times stronger than that exercised by the earth on the bodies on its surface.

But the bodies placed on the surface of Jupiter are not situated at a distance equal to the terrestrial radius, but at a distance equal to Jupiter's radius, which is eleven times greater than the former. Therefore the attraction which Jupiter exercises on a body placed on its surface is diminished in the proportion of the square of 11, or of 121 to 1.

### The Relation of Weight and Energy.

The density of the worlds and the

weight of the bodies on their surface are certainly very important elements in the analogies between the different planets and the earth.

All organized beings are constituted according to their weight, for it affects their form of life, as a certain amount of bodily force is necessary to all. With animals the force is according to their size, their weight, their mode of action, and the amount of movement which they expend in the ordinary functions of life. This force is, moreover, in accordance with their possible needs, and it allows them a necessary reserve force when there is an extra demand on it for work, for running, or for any of the manifold operations of life.

This same force is equally necessary for vegetables, to enable them to support their own weight, and resist the external shocks to which they are exposed on all sides. Now this physical strength, corresponding to their weight, depends, in the first place, on the attraction of the globe.

Therefore the relation between the strength and weight of animals and vegetables results from an intelligent relation between the force of organized beings and the density of the globe they inhabit. The slightest disturbance in this combination would upset the reigning order, and transform harmony into disorder. Accordingly the widely differing intensity of the weight producing attraction in different planets points to the great difference in the organisms that inhabit them; and since these organisms are here in harmony with this attraction, due to a state of matter anterior to organization, we must conclude that nature has not had much difficulty in establishing on other globes beings whose constitutions are equally in harmony with the intensity of the worlds they inhabit.

Where the weight of bodies largely differs from what it would be on the earth, beings must also differ in the same proportion in their amount of energy, and this difference must affect the laws of organization in a striking manner.

We see this in terrestrial nature, where our conditions fail to produce animals much larger than the elephant, because the muscular forces, not increasing in proportion to the increase of weight, would not proportionately facilitate the movements of such enormous masses; whilst in the bosom of the sea, bodies losing a weight equal to the volume of water they displace, creatures can swim with agility in the environment for which they were born.

### Jumping in the Sun.

Applying this principle to the idea of the diversity of environment of beings in other worlds, analogy extends to planetary worlds in general what observation shows to be true for the world in particular; and we have thus a ground for the estimate of the possible variety of beings resulting from the differences of gravity observed in different globes.

Thus a kilogram\* of matter on the terrestrial globe would be only a few grams on small planets, whilst it would rise to more than twenty-seven kilograms on the surface of the sun. A man of seventy kilograms would be extremely light on the former, whilst he would weigh nearly two thousand kilograms on the latter. He could fall from a fourth floor on the surface of Pallas without hurting himself more than jumping off a chair here, whilst the least fall in the sun—supposing that he could stand upright for a single instant there—would break his body into a thousand pieces as though he had been pounded in a mortar.

However fantastic these remarks may seem, they give some idea of the countless effects exercised by the same natural force, and show us that the effects we see on earth may be far from being the only ones in the universe.

Therefore the self-evident proposition drawn from all these considerations is that the planets have neither collectively or individually been merely made for the inhabitants of our little world, to which Nature has not accorded the slightest exclusive privilege.

\*A kilogram is 2.2046 lb.