

# THE OMAHA SUNDAY BEE MAGAZINE PAGE

## Moon Not Yet a Dead World, Says Camille Flammarion

**Famous French Astronomer Tells Why He Believes the Satellite Still Has an Atmosphere and May Be the Home of a Monstrous Vegetable Life.**

**By Camille Flammarion,**

*The Famous French Astronomer.*

THE human soul always goes to extremes. Only a hundred years ago astronomers and poets alike wrote of the inhabitants of the Moon, the Selenites, with all of the assurance of witnesses who had really seen them and recognized in them creatures organized just like the inhabitants of our planet, without stopping to think that other worlds might not be like ours, the conditions of existence being so different. They even described the landscapes, the streets and the great cities, the fortifications, the industrial establishments, the smoke of factories, even the weekly day of rest.

But all at once ideas changed. From 1830 to 1840 the German astronomer Maedler devoted himself to a careful study of the moon and his beautiful map became a classic. His work was followed by that of Schmidt, director of the observatory at Athens, who issued a "selenographic" chart which was even more complete. Maedler thought that the terrestrial globe would pass through no geologic changes from our time onward, and as to the moon, in his eyes, it was an ankylosed world for ages, upon whose surface there were no variations.

Upon the authority of this eminent observer an aphorism soon appeared in the classic works: "The moon is a dead star." And for more than half a century most books repeated this legend, with the exception of some few thinkers who do not give themselves up to generalizations which have not been demonstrated, but seek the truth independently, setting aside all preconceived notions.

Solitary torch of night, as it moves through the heavens, this star is the pale witness of the vicissitudes of our earth. Its tranquil clarity seems enveloped in mystery. Its landscapes and monuments are all transfigured.

But this was light, even if it be the image of nearing lethargy, is not, as has been supposed, the absolute image of death.

Of course the aspects of our satellite do not resemble those which our earth would offer at the same distance.

Nor have we, in our observations of the moon, the moving variations which appear on the planet Mars, an intense activity associated with marked seasons and almost daily metamorphoses.

Nor are there the fantastic and formidable revolutions, such as we observe on that giant world, Jupiter, just now passing through its period of primordial elaboration. But the attentive study of the moon holds many surprises for naturalists and astronomers.

It seems interesting to analyze the most precise observations made, to compare them carefully, and to prove in how far our notions should be modified. I am especially interested because the very first subject which I presented to the Academy of Sciences was on the variability of the lunar crater of Linnaeus, and that was in 1867. So I have been working upon this article for some forty-seven years.

I was not the only one at that time to hold that the moon was not yet dead, and since then Webb, of England; William Pickering, of the United States, and Klein, of Germany, have agreed with me, but they are the exceptions. Some even go so far as to say that the moon never had air, water or life.

The first classic affirmation that must be disputed is that the moon has no atmosphere.

This statement is founded upon a calculation by the great astronomer Bessel, which has to be entirely recast. Inasmuch as when the moon, by virtue of its own motion in the heavens, is about to pass a star, we may fix the precise moment of the disappearance of the star as well as the exact instant of its reappearance, and so arrive at the duration of the occultation, or hiding, of the star.

On the other hand, we can determine absolutely by calculation what line the star follows behind the lunar disk during its occultation and thence deduce the time which the moon takes to move forward in the heavens a distance to that line. For, during the eclipses of stars, if the rays of light were deflected ever so little by the refraction of a lunar atmosphere, in place of disappearing at the precise instant of geometrical contact, the star would remain visible sometime afterward, because the rays would be infected by that atmosphere; by the same reasoning, the star would begin to reappear on the opposite side of the lunar disk some time before the interposition had completely ceased; the duration of the occultation would necessarily be decreased in this way.

About 1830, Bessel thought that he might state that the diameter of the moon figured from the duration of the occultations differed by less than a second of an arc of the diameter directly measured, and that the refraction produced on these occultations by a supposed

lunar atmosphere is insignificant, whence the German astronomer concluded that this atmosphere, if it exist, must be at least 900 times rarer at the surface of the moon than at the earth.

But this conclusion is excessive, for the occultations observed since then with the greatest precision prove that this difference is sometimes two seconds to two and a half seconds. The received reason raised since Bessel's time against there being any lunar atmosphere has no more value to-day, and the probabilities all point in the other direction.

He relied with too much confidence upon the telescopic determinations of the diameter of the lunar globe. No one can have forgotten the central eclipse of the sun which took place near Paris, especially over Saint-Germain, April 17, 1912. That eclipse was neither annular nor total, and I suggested for this special case a name which has been generally adopted, "pearled eclipse," because the edge of the sun remained visible in the intervals between the irregularities of the lunar edge produced by the mountains of the moon projected upon the luminous edge, and because these slopes presented the appearance of a string of pearls.

I showed at the same time that, henceforth, we should distinguish in our calculations three diameters of the moon: 1. The inside circumference, passing over the plains and valleys; 2. The outer circumference, passing over the summit; 3. An average circumference between these two extremes. The extreme circumferences differ by at least two seconds, or about 15,000 feet, and give for the three diameters, 2,152; 2,154; 2,153 miles.

We see now how far we are from the absolute circle of Bessel. We may also remark that the mountainous contour changes in perspective according to the epoch and the librations or balancings of our satellite.

The moon may hide a star either by its illuminated edge, or by the dark side. The duration of the occultation may reach one hour and fifty-five minutes, if it be central. The star disappears almost instantly, even when it is of the first magnitude, which may be true of four stars in the zodiac before which the moon may pass: Aldebaran, Spica Virginis, Antares and Regulus. When the occultation is made by the dark side of the moon, which is absolutely invisible, this sudden disappearance always surprises the observer, although he expects it.

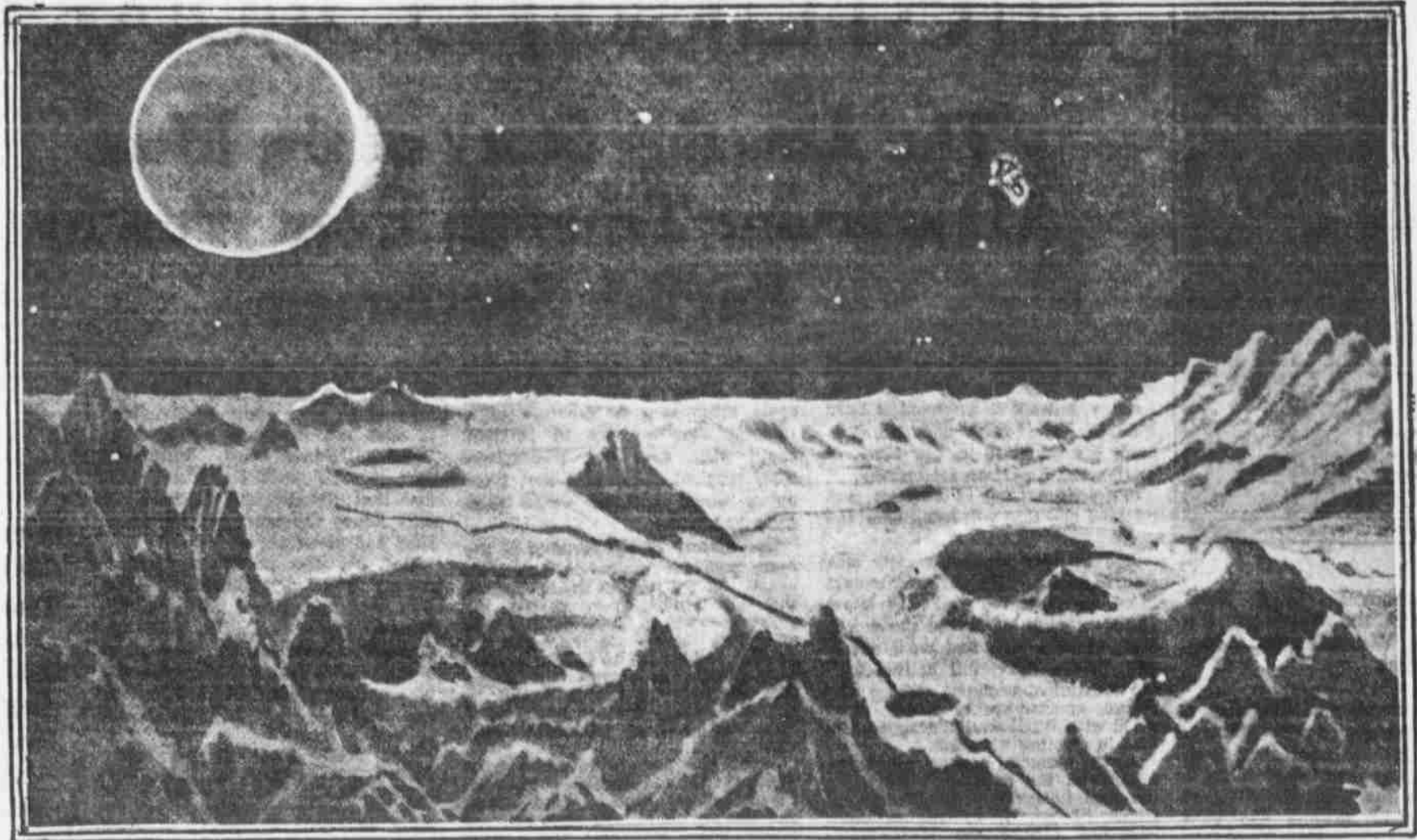
Sometimes, instead of disappearing instantaneously, the star shines through one of the valleys of the moon, of which I have just spoken, and is hidden only after some delay. Sometimes it is projected, like a small light on the dark side of the moon, and only disappears a few seconds later.

On February 24, 1904, I observed the occultation of Aldebaran, which was almost central. Aldebaran seemed like a reddish torch by the side of the moon's golden light. The star disappeared instantly behind the dark side of the moon which was invisible. But another observer, looking at the same phenomenon from another part of the earth, observed that Aldebaran was projected upon the dark side of the moon for two or three seconds before it disappeared. The moon is so near our earth, only thirty diameters of the earth away, that these variations are common, because of the different angle presented to observers.

April 24, 1913, Gheury, observing from Eitham, England, studied the occultation of the star Pi of Scorpio, of the third magnitude, and he saw a very dim star issue from the disk, which became more brilliant a second later. The observer attributed this phenomenon to a lunar atmosphere sufficiently dense to have settled down into a valley behind which the star was hidden at the moment of emergence.

The occultations of stars lead us, in certain cases, to attribute an atmosphere to the moon varying in density. This density may vary considerably as the temperature of the soil of this neighboring globe changes greatly. The rays of the burning sun heat it for a long period of fifteen times twenty-four hours, and should raise the temperature higher than that of boiling water; and a night just as long should make the temperature fall every month below freezing, possibly to 100 or 200 below zero. The stratum which may exist on the surface of the lunar globe, and especially in the valleys, is subject to these great variations.

Moreover, although during solar eclipses the edge of the lunar disk is absolutely clear and cuts the solar disk by a sharp intersection, there are, nevertheless, exceptions. Thus, during the eclipses of September 29, 1875, and May 17, 1882, the English astronomer, Noble, saw at the two ends of the curve of contact



The Fantastic Craters of the Moon Which Astronomer Camille Flammarion Thinks May Be the Homes of Life. Our Earth Is Seen As It Would Appear from the Moon's Surface.



Diagram Showing How Many Earths It Would Take, Laid Side by Side, to Reach Our Satellite.

of the moon eclipsing the sun the solar edge slightly thrown back in two little points. Tholou observed the last eclipse also in Egypt, where it was total, and noted a thickening of the rays of the solar spectrum, appearing to indicate an absorption due to a light lunar atmosphere.

I have often observed, especially on that part of the moon to the north of the groove of Hyginus, on a lunar landscape well known to selenographers, a grayish tint indicating a variation of the soil independent of solar light.

Besides, I have observed a twilight effect when studying the vast east plain of the Sea of Serenity on the third day of lunation. The dark spots on the moon, spoken of as seas, are not, as we know, real watery expanses, but gray plains.

Well, in that plain to the north, the irregular circle of the Caucasus, and south, the chain of Menelaus emerge like two luminous points visible through an ordinary opera glass. The lighted edge of the plain is not cut off sharply by an abrupt line separating the lighted country from that which is still in darkness, but it melts gradually, as if the summit dropped. It is a real penumbra. Calculation shows that the solar disk should produce, by its size, a penumbra of 32° of the arc of the great circle on the moon, which would be about ten miles. But I have often observed a much larger penumbra.

The question of a lunar atmosphere is very closely connected with that of volcanoes and eruptions, attended as they are by vapor and gases formed in some way. It seems as if the craters scattered all over the moon are not active, and that they emit no vapors. But this is too radical and premature a statement.

William Herschel considered Aristarchus to be active, stating in 1787 that it burned with great brilliancy, lighting up all around it. But there are other reasons for holding that the moon is not a dead star.

A dead star is one upon which there is no motion, no variation, an unmoving globe, but many instances may be cited to the contrary.

The crater Linnaeus has been proved by latest observers to be subject to wide variations, possibly due to increase or diminution of snow, and the double crater, Messier, has changed greatly since it was so carefully studied between 1829 and 1837. The crater Taquet disappeared altogether in 1911, according to Korn, although neighboring and lower craters are still visible.

The observer notes variations dependent upon the date of lunation, but independent, of course, of those which are caused by the variations of solar lighting, which may be more or less oblique, and concludes "that under the action of certain geological phenomena, of the exhalations of vapors escaping from great depths, the crater is masked." Siemmler writes that on January 25, 1912, Taquet seemed to him to be covered by a transparent vapor through which he could dimly see the shadow of the walls of the crater.

What is the nature of these emissions? Are they geysers of water? Are they smoke? Vapors of carbonic acid? Jets of pulverized matter? No matter what it be that is thrown up from the eruptive mouth, that which is thrown up only hides the crater from the earthy observer, and this makes the examination all the more difficult. Besides we see these activities from a great distance. The moon is

238,850 miles from us; an enlargement of 1,000 times would bring it only within 238 miles of our vision. We have to study it usually from a still greater distance, of nearly 500 miles. What can we distinguish at such a distance? For the eruptions to be visible at all they must be very violent.

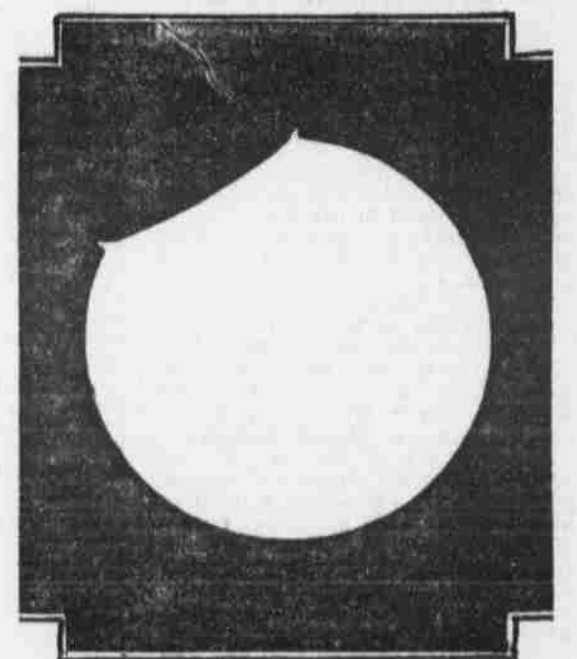
We have no right to say that there are not still fiery volcanoes there in full action. Temple, while studying the Mont Blanc of the lunar Alps, noted that while the district was in shadow there was one luminous point, burning with the brilliancy of a star of the fifth magnitude, for fifteen minutes, then disappearing irrevocably. Had the astronomer seen a rare eruption? This same luminous point was seen again by the English astronomer, Grover, lasting for thirty minutes, with the brilliancy of a star of the fourth magnitude. This was years later.

Instances of the shadowing of the soil, in many regions of the moon, during the long solar day of fourteen times twenty-four hours are numerous, and I have selected some of the most characteristic after studying the seventy-one admirable photographs of the Moon-Atlas issued by the Paris Observatory, in which the astronomer Pulisux has indicated the intrinsic variations which differences of illumination do not explain. We may cite especially an oval spot near the circle of Vitruvius, which measures nine by fifteen miles, and another near the circle of Ball, having the form of a V, varying in size, but being greatest on the nineteenth day of lunation; another near Licetus, which the heat of the sun develops or shades, attaining its maximum after the insolation has begun to decrease; another near Struve, which increases inversely to the action of the sun's heat, which sometimes looks like a lizard, etc.

Since 1887 the Flammarion lunar circle, a great circular plain fifty-five miles long, near the central meridian of the disk, has been carefully observed by the astronomers of every country, and all of these astronomers agree that most strange variations in color appear when it is exposed to the solar rays. M. Desseigny claims, after years of observation, that he has found clear furrows and regions which vary in shade according to the quantity of solar heat they receive. He has gathered some 120 drawings under the title of "Palus putredinis" (a locality on the moon), which prove the following: In proportion to the height to which the sun mounts their horizon the valleys take on a sombre appearance, at times very dark, when the sun is declining, they begin to get lighter, and they return their gray tint toward evening, before sunset.

Without insisting further on the variations of the lunar sun I have only to conclude that they are certain, and that the soil can no longer be considered a block of unvarying mineral. We may ask ourselves, what is the nature of these variations, and may begin with the most simple.

In February, 1914, I noted some very simple variations around me. In January we had passed through a very cold period and the soil had been frozen to a considerable depth. For fourteen consecutive days, from the 12th to the 26th, the average temperature of the twenty-four hours was below zero in Paris, going as low as 5 or 10 below. Between the 23 and 26th of February we had a radiant sun, clear, cold nights, white frost in the mornings. We saw some peculiar things on the earth. The pavements, in all this fine weather, remained damp and dark all day, except those which were dried by the sun and wind. In the parks we walked on mud made by the earth and ice. The condensation of the humidity fixed by the frost in the morning gave the asphalt pave-



A Photograph of an Eclipse of the Moon, Showing Atmospheric Distortion of the Image at the Ends of the Points of Contact.

ments a coating of glassy mud. Can not the same conditions prevail on the moon? Very simple and easy causes may bring about apparently great results.

This explanation may apply to some cases. We can imagine easily how insulation may produce variations of a chemical order. Photography illustrates this. If there are on the surface of the moon such substances as will blacken under the rays of the sun, which are so luminous, so hot, actinic, electric, etc., this hypothesis is not improbable. The solar action may also produce other effects, which are no longer only of a mineral or physical order, as the fusion of the frozen surface saturated with water, or of a chemical order, as the darkening of certain salts, but of a vegetable order, such as the production of mosses, grass, mushrooms, lichens, rudimentary plants developing swiftly under the warming influence of the sun, which takes an hour to rise and eight days to reach the meridian.

But why should we talk of minute plants, of mosses and poor rock-lichens? Can not this long solar irradiation produce some gigantic effects? Seen from the earth mosses and oaks are identical. I have always been struck, during my balloon trips, by the aspect of landscapes when seen from above. Whether they are lofty forests, or grass-grown plains, they look alike, and the hills themselves are edges of valleys, the surfaces which spread out below seeming an immense plain, varied only by the colors and tones of different plants.

And besides earthly conditions do not prevail on the moon. May not those variations be neither mineral nor vegetable? We are very far from knowing everything or being able to understand all things.

What I have tried to establish here is that these variations exist. They indicate the presence of mobile elements, water, air, liquids, gases, atmosphere, no matter what their chemical composition may be. Are those deep shadows only thick ice—that is something at least. The occultations, the changes observed in the craters, the glimpses between the clouds or occasional mists or smoke-masses, the darkening of vast regions under the action of the sun, all join in proving to us that THE MOON IS NOT A DEAD WORLD.