

ANNUAL REPORT OF THE  
BOARD OF REGENTS OF  
THE SMITHSONIAN  
INSTITUTION

SHOWING THE  
OPERATIONS, EXPENDITURES, AND  
CONDITION OF THE INSTITUTION  
FOR THE YEAR ENDING JUNE 30

1926



(Publication 2879)

UNITED STATES  
GOVERNMENT PRINTING OFFICE  
WASHINGTON

1927



# EXCURSIONS ON THE PLANETS<sup>1</sup>

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[With 10 plates]<sup>2</sup>

May we some day be asked to leave this modest planetary globe upon whose surface we now pass our lives? We will not stop to discuss the pros and cons of such an eventuality but suppose the question has been answered affirmatively. In other words, some dweller on our earth is to set foot upon other worlds. Upon such a voyage will the reader be conducted. To simplify matters we will abstain from any scientific speculations as to the actual itinerary of such a voyage. Let us disdain all ordinary methods of journeying, too slow for our purpose, because of the immense distances to be traversed. We will suppose ourselves—as our imagination can allow us—transplanted in the twinkling of an eye to the various neighboring worlds—the moon and the planets of the solar system, the “earths of the heavens,” as they have been expressively called by Camille Flammarion.

Can we, by any chance, describe the scenes we will see except as pure phantasies? Yes. Within certain limits, we can approach the subject and reply positively to some of the questions which will be asked in the contemplation of the heavens. If, despite the perfection of the methods of research in modern astronomy, there yet remain many unsolved problems relating to an intimate knowledge of the celestial worlds, nevertheless we do have at present precise data which make possible a visualization of the general physical conditions on each of them. That we may keep on ground where we are surest of not going astray, we will try to indicate simply the essential differences in the aspects of nature which meet the eye of the human voyager.

Let us start on the moon. We know that its surface is broken by thousands of rings, or craters, of various depths, numerous mountains, and vast plains improperly called seas. This general view is so well known that we need not dwell upon it. But we must consider how all this would appear to a voyager landing upon the

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<sup>1</sup> Translated by permission from *La Nature*, June 19, 1926.

<sup>2</sup> Halftone reproductions of drawings by the author.

ground—that is, what manner of landscape would greet his wondering eye.

The very accurate data which astronomers possess as to the structure of the lunar terrain greatly facilitates this problem. For geometry enables us to put easily into actual perspective all the details which the telescope allows us to see in relief under an oblique illumination. Remember, in passing, that the shadows are sharply delineated and that they may be seen to elongate as the sun rises or sets for different regions of the lunar surface. This enables us to calculate exactly the heights of the various parts of this surface.

It is astonishing, despite these exact data, what phantastic representations have been drawn of the landscapes of this lunar world. Numerous astronomical treatises have represented them as embellished with mountains and peaks made of jagged sugar loafs, at the feet of which are heaped numerous small vatlike formations having the appearance of volcanic molehills. Actually the lunar mountains have profiles comparable in their steepness to our own terrestrial mountains. The great majority of the circular formations are of such size that we would be unable to see their whole extent in a single glance. It would be necessary to turn around in order to see their circular walls which would appear like a long chain of more or less irregular mountains. For some of them, if we were at their center, their ramparts would be so far distant as to be invisible, lost below our horizon. We must further remember that on the moon, because of the greater curvature of its globe, relative to the stature of man, the horizon is closer, and therefore objects disappear behind it at a shorter range. Only those craters which are very small and numerous and whose diameters are of the order of a kilometer may be wholly seen from one place. We should in no way compare them with the ordinary volcano whose crater is a cavity at the top of an elevated cone. The lunar craters, despite this name with which they are often designated, are comparable to excavations whose bottom levels are very much below the surrounding lunar surface above which the exterior surrounding walls rise very little.

As to the extended gray plains, erroneously called seas, their great smooth surfaces must present a remarkably monotonous aspect broken here and there by immense fissures whose gigantic proportions have no parallel upon our earth.

We can reproduce the contour of any given region on the moon since we have comparatively precise measures. Though such views can not lay claim to an absolute fidelity, they are probably nearly true. They contain a certain dose of imagination indispensable to fill the gaps in our knowledge of the minuter details. They, however, can show us in an expressive fashion the general character of these extra-terrestrial regions.



But it is not the contour, the general outline of these moonscapes, which strikes the human eye with astonishment; it is the atmospheric conditions. We know that this globe, if not totally without an atmosphere, at least possesses none which we can detect. Consequently, since there is no air to scatter the light coming from the sun, this orb of day is enthroned in a black sky, dotted with stars as if at night. Moreover, a harsh light marks every detail, near or distant, with the same dry and insistent sharpness. How different is this view from those on our earth where the different distances merge harmoniously in blending vapors. It is surely in this manner that the eye will be most surprised, even though it is the eye of the most rabid impressionistic artist. Let the eye be that of an astronomer and his marvelling will be without end. Here our atmosphere interposes a serious obstacle to his contemplation of the heavens; it obstructs greatly the light coming from the stars, troubles their images, and even limits their visibility. It is, indeed, a real veil placed before his eyes. Upon the moon this veil is absent and the heavens shine in striking majesty. If the eyes are not dazzled by the blinding rays coming without hindrance directly from the sun, the unfathomable space will appear riddled with stars, more countless than on the earth, and these myriads of stars will show no scintillation. What a wonderful richness and what facility for observation would be the lot of the fortunate astronomer inhabiting the moon. Further, because of this same lack of an atmosphere, the rising and setting of the sun would offer appearances entirely unknown on the earth. At sunrise there would first appear the radiant glory of the sun's corona; next those gigantic rose-colored flames, the protuberances, will rise above the horizon. On the earth these phenomena are visible to the unaided eye only during the short duration of a solar eclipse. Stretching far upwards, like a great extension of the corona, will be seen the immense spindle-shaped zodiacal light, a phenomenon about which our ideas are still somewhat confused because of the difficulties in the way of its observation from the earth.

This grand spectacle, of which Plate 1 is a very unsatisfactory replica, we can leisurely admire. For the rotation of the moon takes the same length of time as its revolutions about the earth—for which reason she always turns the same face toward us. This rotation time is twenty-seven times less rapid than that of the earth. The apparent movement of the heavens is of course slowed down in the same proportion and the stars will appear to rise and set with a majestic slowness. Though the sky itself seems almost motionless, there is one celestial body which will appear to be at rest—our own earth. This is really not quite true, since, because of the unequal movement of the moon in its eccentric orbit, the terrestrial globe appears to oscil-

late about a mean position. The sun and the stars appear to file slowly back of it, while all the time we can see it rotating upon its own axis and changing phase, like our moon, with the varying position of the sun from which it receives its illumination. The position in the sky where the earth will be seen changes with the position of the observer. From the central region of the lunar disk visible from the earth, it is enthroned in the lunar zenith. At the periphery, it will be seen on the horizon. (Pls. 3 and 4.) In each position, it will have an aspect thirteen times greater than that of our moon. At the time it is full it will shine with intense brilliancy.

Let us now leave this strange world, so near to us—only 384,000 kilometers (239,000 miles) distant. It is the excursion outside of the earth about which we can foretell the most. The facts we possess about the other planets of the solar system are fewer, and to avoid pure phantasy we must limit ourselves to more general considerations. Let us remember that with regard to the worlds which we are to consider, though the facts relative to the appearances in the sky are exact, coming from mathematical deductions of measures, further than that we can offer only details which seem reasonable. We can not, for instance, say: Behold a landscape of the planet Mars! but, rather, a landscape which is theoretically possible on the planet Mars; or, better yet, what we conceive should be certain landscapes upon that planet.

The "fixed stars" are so distant that their relative positions appear the same from whatever planet they are observed. Therefore, for each of these worlds the starry firmament would be the same as ours. However, from each one the other planets are seen with differing brightness, there are different moons, and, finally, the sun appears of very different size (pl. 5).

Thus from Mercury, the planet closest to the sun, this central star appears enormous, in such proportions as Plate 5 indicates. Further, this great size varies notably because the orbit of Mercury is very eccentric. The apparent diameter of Mercury's sun indicated (relative to that seen from the earth) is that when Mercury is in perihelion; that is, when it is nearest to the sun. What manner of landscape is lighted by this colossal furnace the heat of which we are certainly not so constituted as to be able to bear, especially since it stays immovable in the sky? For Mercury revolves about the sun, always turning the same side toward it. In order to enjoy the freshness of night we would have to travel around into the opposite hemisphere.

Our knowledge about this planet is insignificant. Probably its surface has high mountains, but we can not estimate the importance of its atmosphere. Let us not delay upon this inhospitable world,

because of the great heat of the sun, but travel to Venus, farther off from the sun. Seen from Mercury, Venus at certain times would appear a truly blinding star.

Again we have reached a planet about which we know very little. It appears from without of a brilliant whiteness, but we can detect no detail upon it probably because its thick cloudy atmosphere hides its soil from our eyes. Some astronomers believe that this atmosphere is very rich in water vapor, others that it contains none! At any rate the density of its atmosphere is very great, almost double that of ours. Upon the surface of Venus, covered with this dense atmosphere, diffusing the intense light from the enormous sun as seen from there, a sort of luminous and troubled fog must singularly limit the range of vision, doubtless preventing the enjoyment of any extended landscape. What are these landscapes? In lieu of anything better, let us suppose there exists here a surface with some land but much water. Through the dense atmosphere, the stars are either only slightly or not at all visible. If the sun can be observed at setting, the phenomena of refraction will be noted as on the earth but much more in evidence, modifying strangely the appearance of the solar disk. (Pl. 6, fig. 2.)

Farther away than the earth from the sun, upon the planet Mars, we should feel more at home. Day and night are scarcely longer than on the earth. Through an atmosphere very similar to ours although less dense, the stars will appear in splendor, enriched with two small moons. The smaller of these not only will appear to move with great speed but in an opposite direction from the apparent movement of the stars; indeed it revolves about Mars faster than the latter rotates upon its axis. At certain epochs, either in the morning or evening, the earth will be visible as morning or evening star, respectively, brilliant in the dawn or evening dusk, the latter of short duration because of the rarity of the Martian atmosphere. The sky will appear darker during the daytime and the sun, a third smaller than from the earth, will illumine less brilliantly the doubtless more monotonous landscape. The most reliable observations indicate a ground with very little relief, probably almost everywhere level, cut here and there with immense swamps. Incontestably in every respect we should feel the most at home on this planet.

But let us pursue our journey toward the giant planets. Upon them—Jupiter, Saturn, Uranus, and Neptune—we would no longer find ourselves upon solid ground, at least in the literal sense of the word. For it is very probable that these worlds are yet fluid, at any rate in a condition which would not admit of a solid surface. It would be impossible to find a landing place. Because of this circumstance, we will suppose ourselves changed into immaterial beings though still retaining our organs of sight. If Jupiter should possess



a surface of any kind, it would appear of great extent to us because of the colossal dimensions of its globe. Would we be able to see the heavens through the thick and dense atmosphere whose storminess we can observe from our earth? Let us suppose so, and then we would see the sun as a very small disk shining with light twenty-five times fainter than as seen from the earth. That would be very meager for a sky so heavily clouded. Jupiter's globe turns upon its axis once in nine hours and fifty minutes. The succession of day and night is therefore very rapid; only five hours elapse between the rising and setting of the diminutive appearing sun which passes rapidly across its sky.

Jupiter has nine moons but only five are visually of any importance nor can all be seen at the same time. Their apparent size, reckoned from their actual size and distance from Jupiter, shows them to be comparable to our moon. They are of greatly diminished brightness since the sun illumines them much less intensely.

Suppose we now quit Jupiter to stop a moment, say, upon the nearest of its moons. From it the appearance of Jupiter will be immense because of the nearness of the giant globe as seen from this first satellite. Jupiter would indeed look like a formidable moon, one hundred times greater in diameter than our own, ten thousand times greater in extent of surface.

Along with this same order of grandeur of ideas, an even more astonishing spectacle awaits the traveler who sets foot upon the satellites of Saturn, the nearest one especially. Situated in the plane of Saturn's ring, this ring would appear only as a bright bar crossing the enormous globe of Saturn, but excessively distorted in dimensions by perspective, the whole system presenting very different aspects than as seen from the earth. Add to this the eclipse of a portion of Saturn by the shadow of the rings (pl. 9), the phases of the enormous globe changing with the direction of the light from the sun, and we will still have only a partial conception of the views that would be presented to our eyes. If it were possible to land upon Saturn—and here the same doubt arises as in the case of Jupiter—the sky would have an aspect equally strange. From different points of the globe, this sky, dotted with numerous moons, would be traversed by the luminous ring in varied aspects. At the Equator it would appear as a luminous thread passing through the zenith from one horizon to the other. At higher and higher latitudes toward the poles, it would appear as an arch, deformed somewhat by perspective, and according to the season, which here are terrestrial years long, it would be cut by the shadow of Saturn itself. And further, depending upon the relative diameter of Saturn and the annular system and because of the marked polar flattening of the former, beyond latitudes  $65^{\circ} 11'$ , north or south, this marvel-

ous celestial arch would cease to be visible so that the polar inhabitants of Saturn must be completely ignorant of its existence.

We are now very far away from the sun which will appear in the sky of Saturn only as a small disk ten times smaller in diameter and shining with one hundred times less light. For us earth dwellers that would be a melancholy illumination. But what would we say if there were possibilities of going yet farther off toward the planets Uranus and Neptune, where our sun would be reduced in grandeur to the appearance of a bright star shining with respectively four hundred and nine hundred times less light than we receive on the earth.

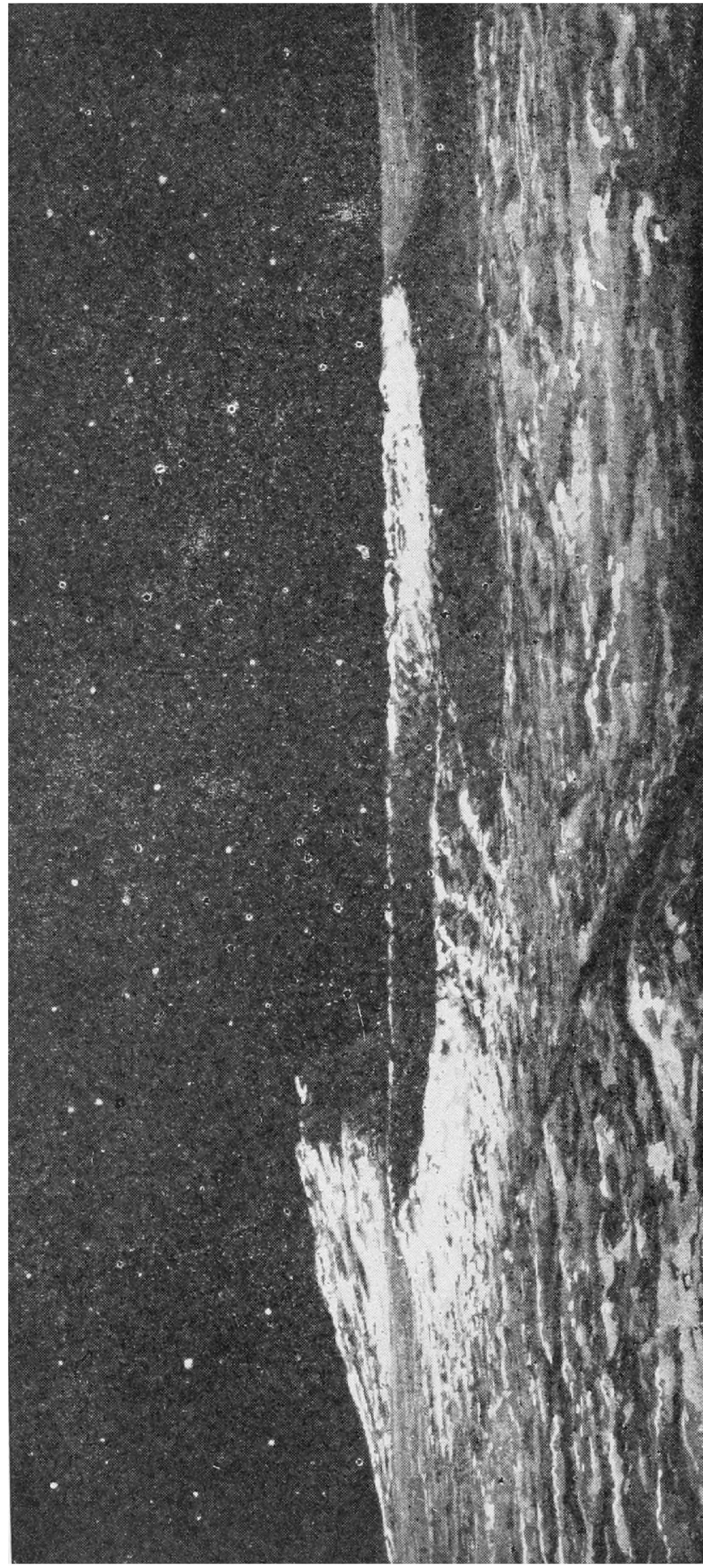






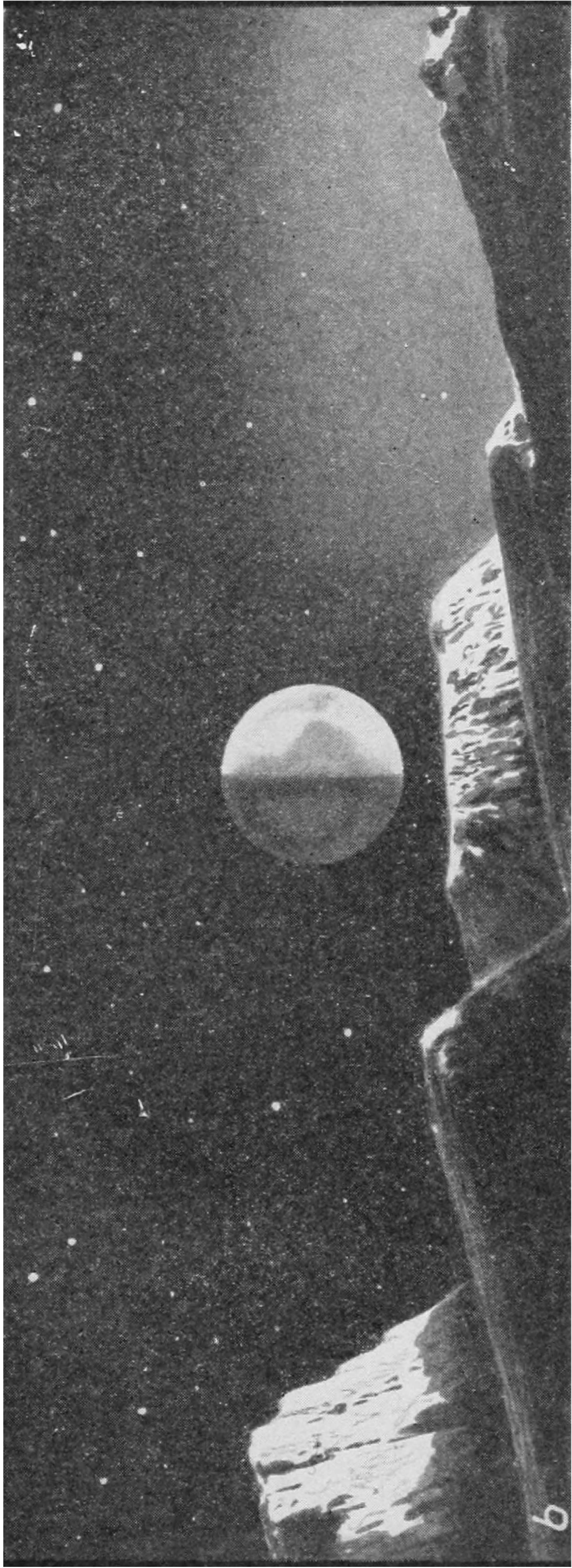
SUNRISE UPON THE MOON: SEEN FROM A PLACE SITUATED AT THE EQUATOR: THE CENTRAL REGIONS  
ARE ILLUMINATED BY THE EARTH SITUATED IN THE ZENITH





TYPICAL OF A SMALL LUNAR CRATER



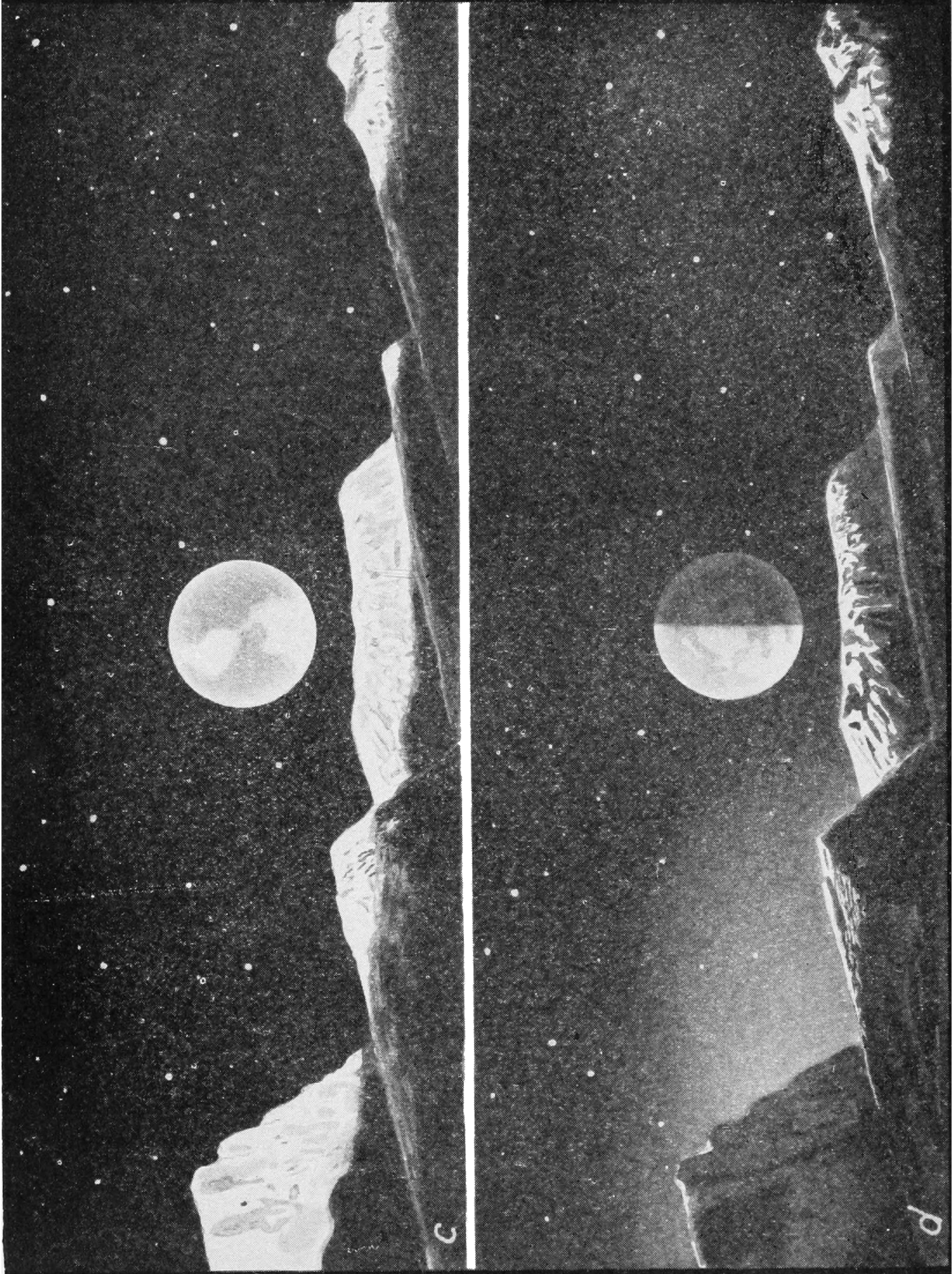


THE EARTH AND ITS PHASES SEEN FROM THE SOUTHERN POLAR REGIONS OF THE MOON. ALTHOUGH THE EARTH APPEARS AT REST IN THE SKY, THE SUN MOVES ALONG HORIZONTALLY BENEATH THE HORIZON, HID BY THE MOUNTAIN WHOSE SUMMITS ARE ILLUMINATED BY IT

*a.* Epoch of “new earth”; our globe, surrounded by the brilliantly illuminated ring of its atmosphere, is projected upon the corona and upon the zodiacal light

*b.* Epoch of the first quarter

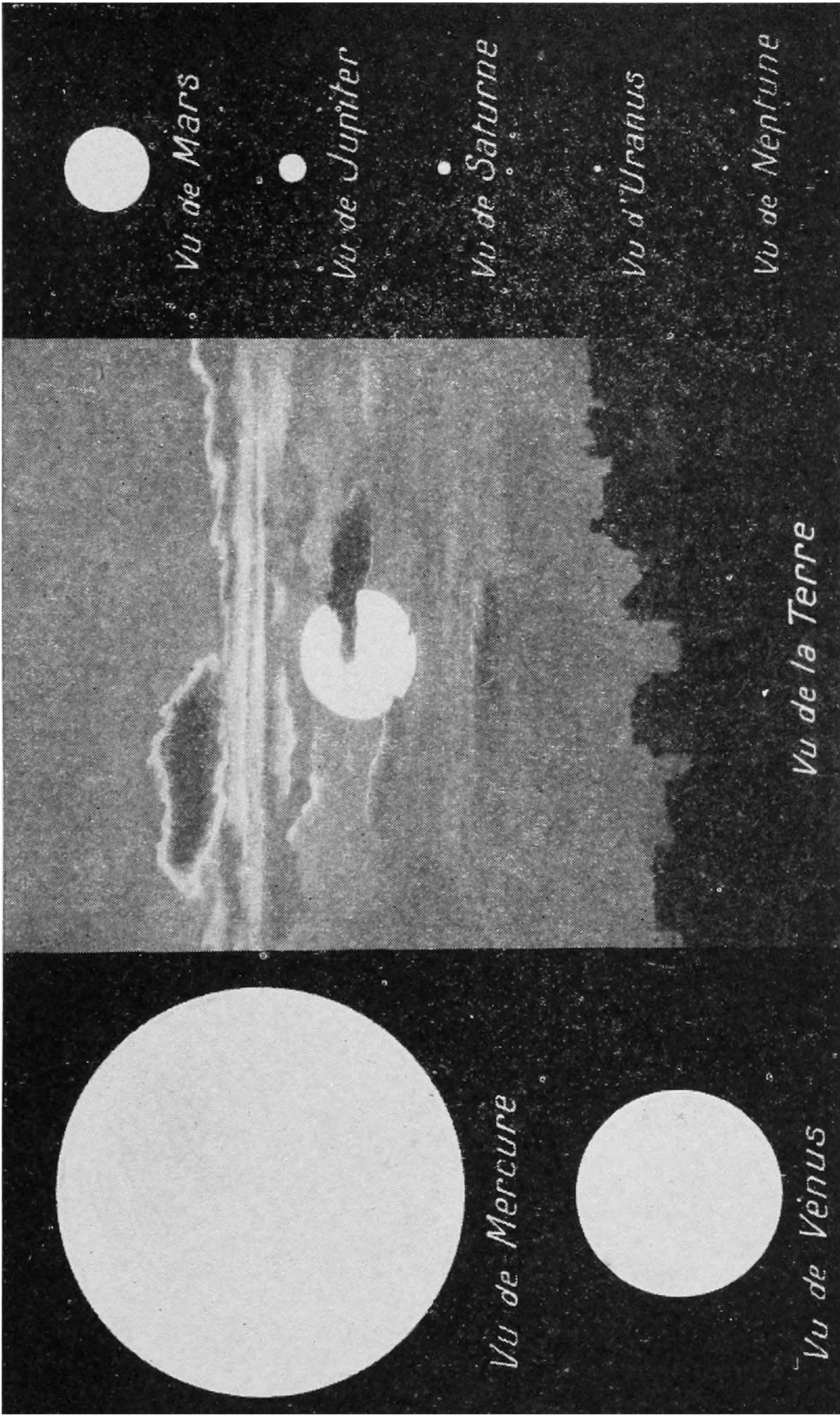




THE EARTH AND ITS PHASES SEEN FROM THE SOUTHERN POLAR REGIONS OF THE MOON

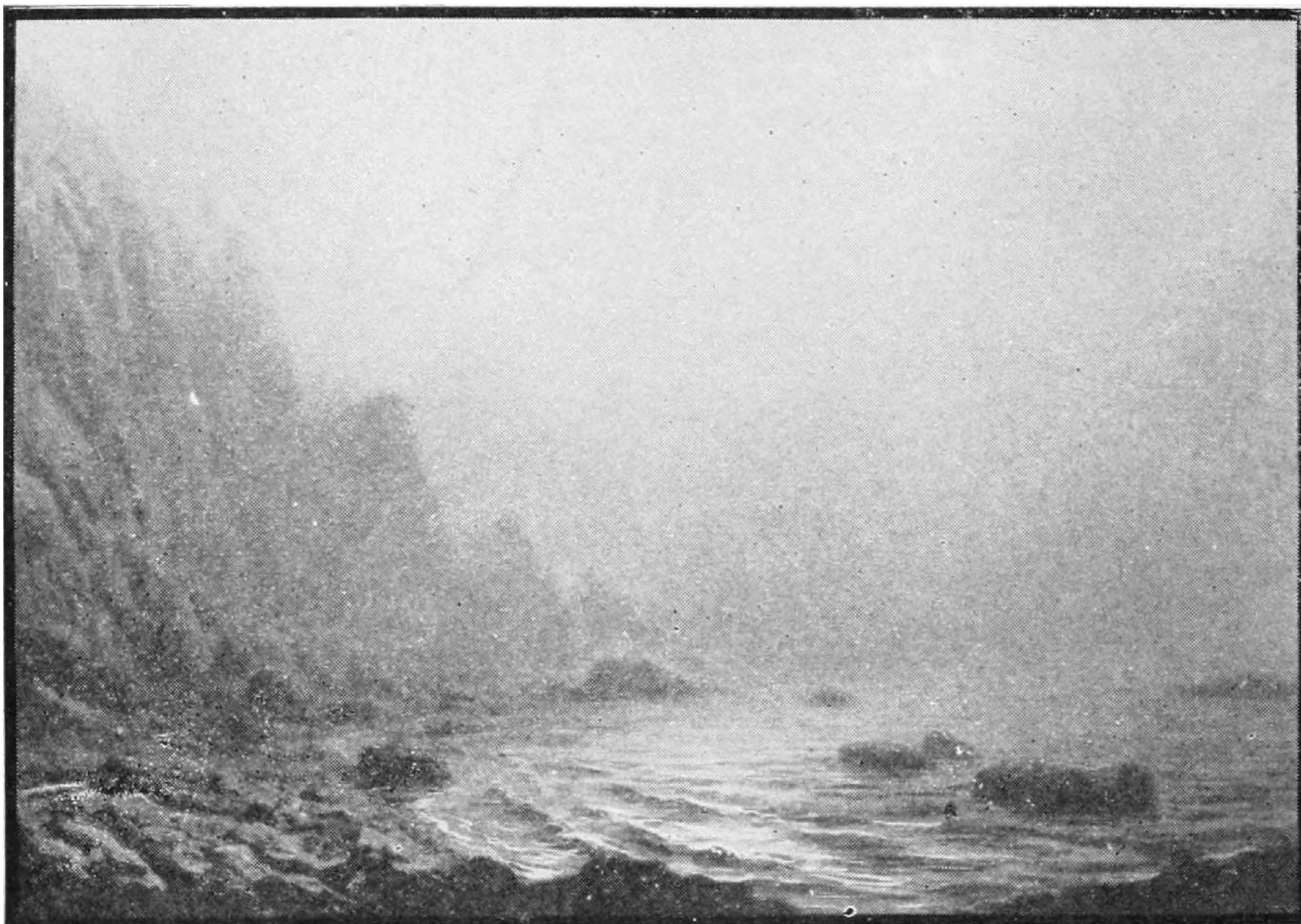
- c. Epoch of the “full earth”
- d. Epoch of the last quarter



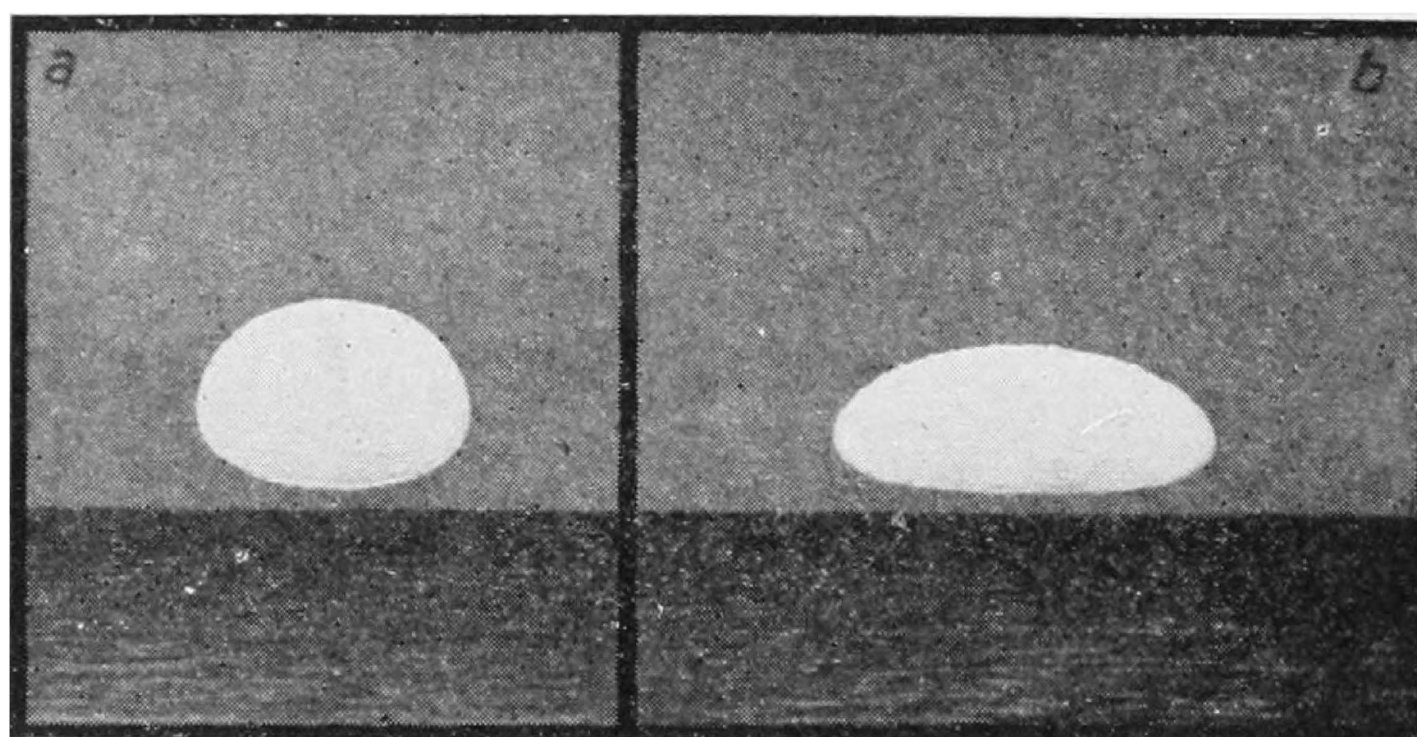


THE VARIATION IN THE APPARENT SIZE OF THE SUN AS SEEN FROM THE VARIOUS PLANETS  
OF THE SOLAR SYSTEM



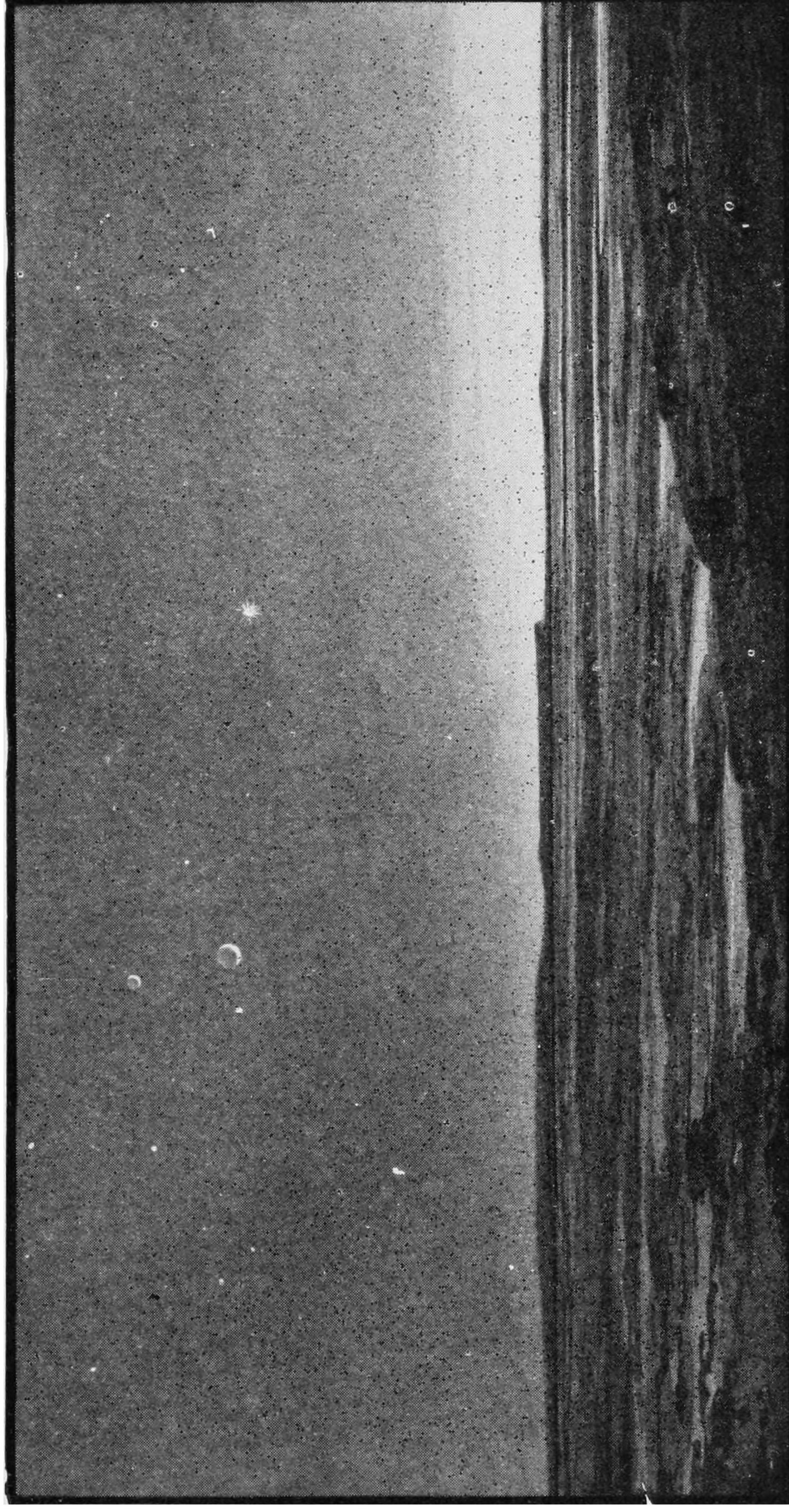


1. THE PROBABLE CHARACTER OF THE SURFACE OF VENUS



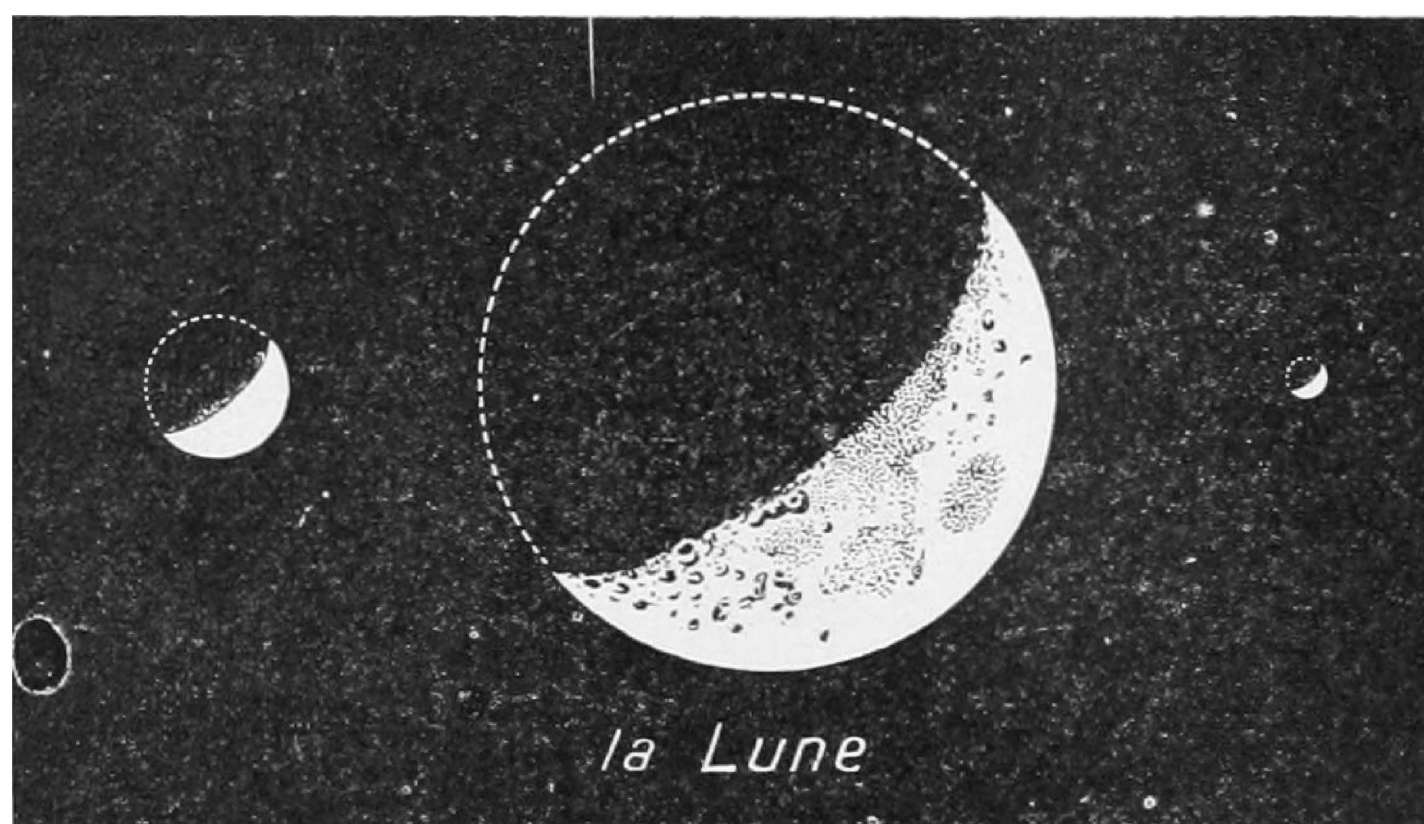
2. THE SOLAR DISK DEFORMED BY ATMOSPHERIC REFRACTION:  
(A) UPON THE EARTH; (B) UPON VENUS



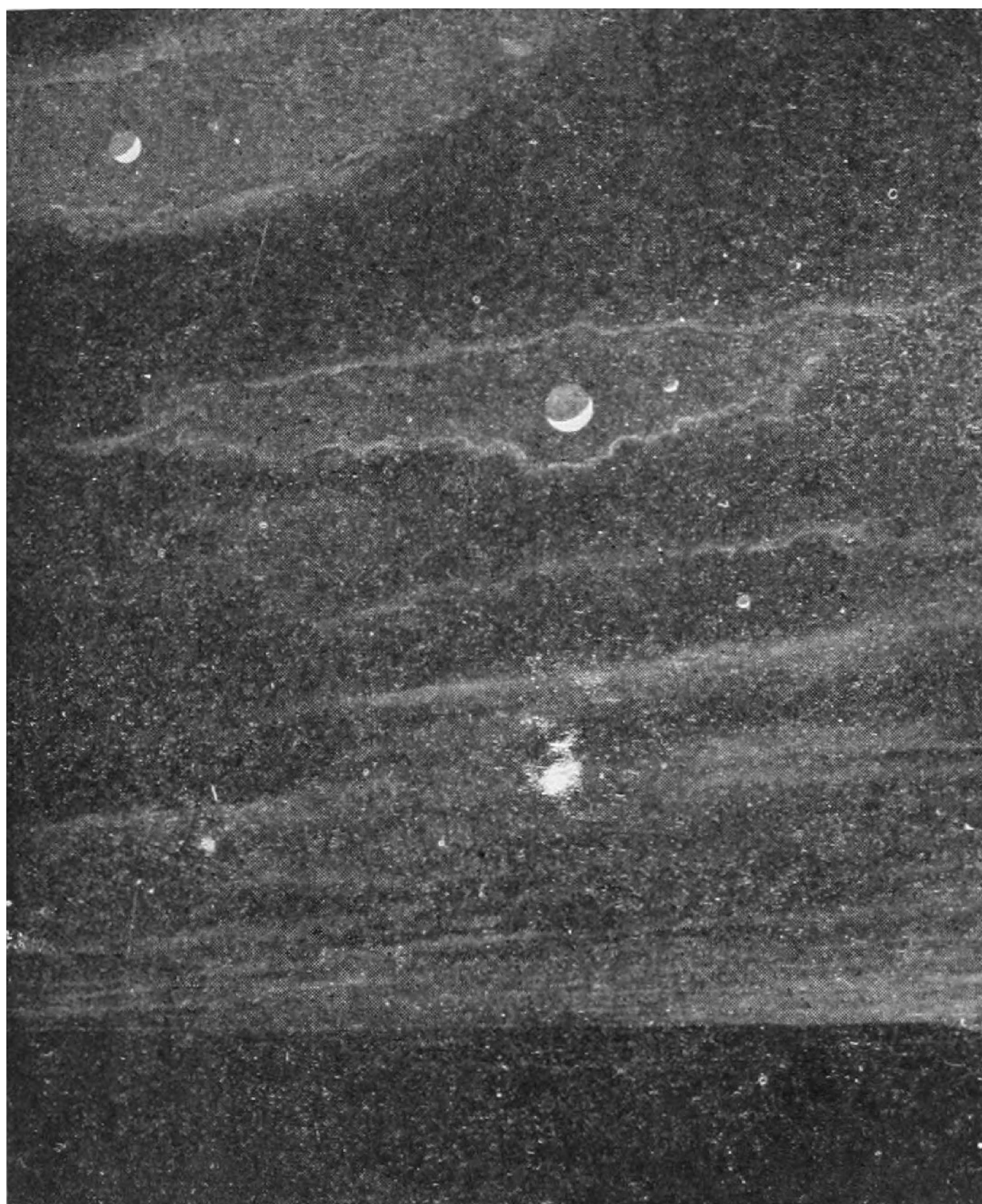


THE PROBABLE CHARACTER OF A LANDSCAPE UPON THE PLANET MARS SEEN IN THE DUSK OF EVENING.  
ITS TWO SMALL MOONS AND THE EARTH, LIKE AN EVENING STAR, SHINE IN ITS SKY



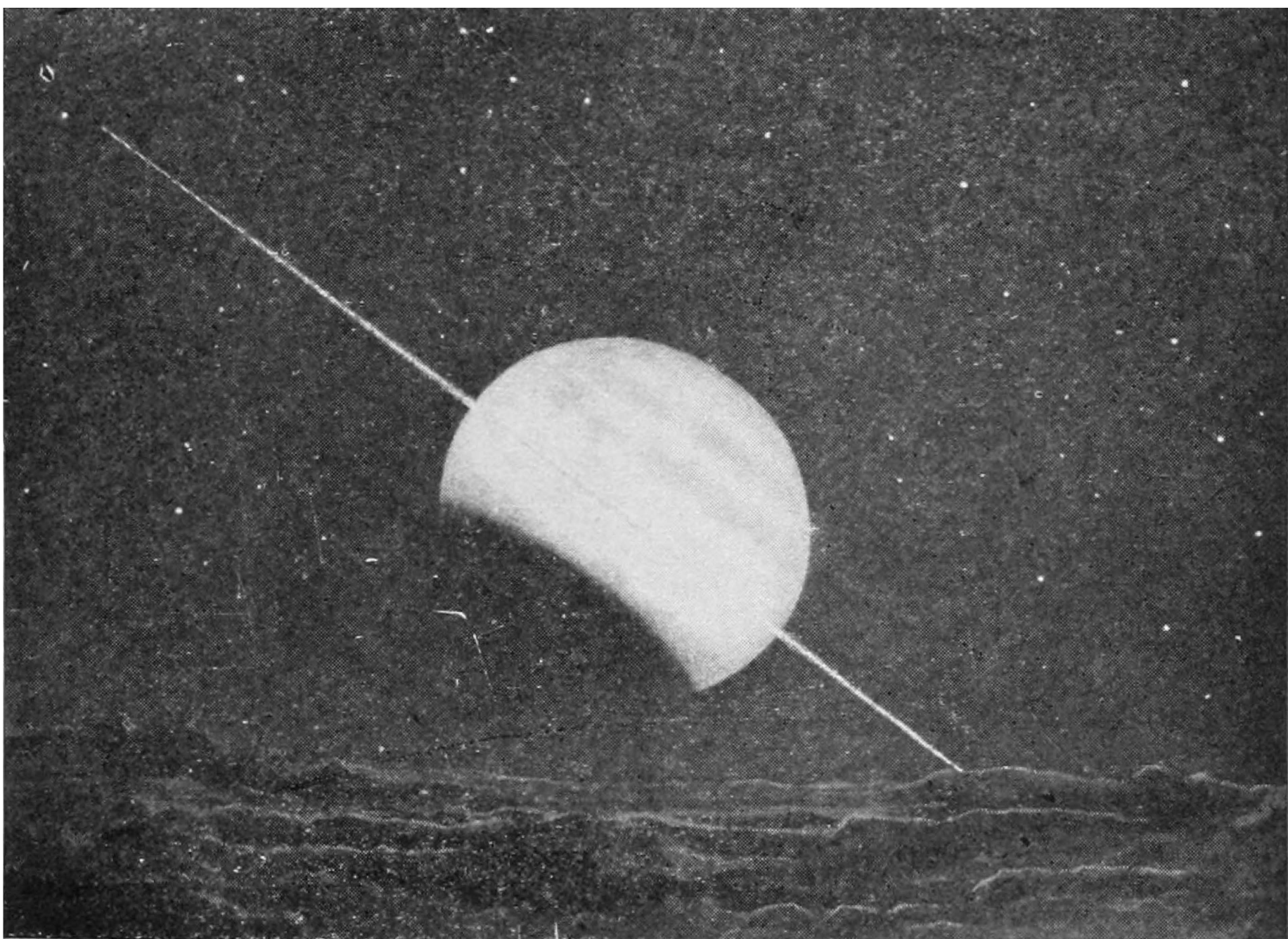


1. THE COMPARATIVE DIAMETERS OF OUR MOON  
AND THE SATELLITES OF MARS

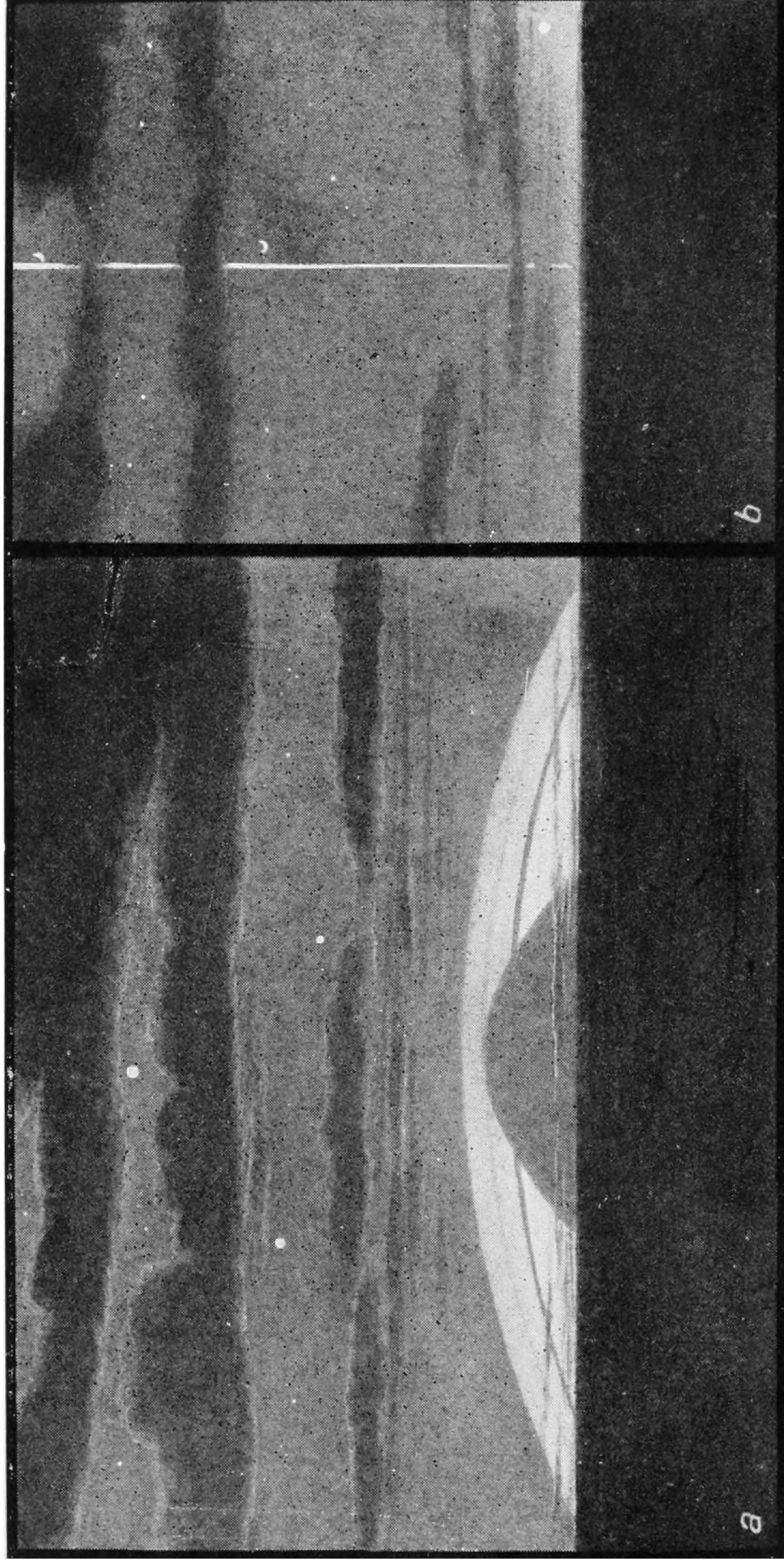


2. THE MOONS OF JUPITER





THE PLANET SATURN SEEN FROM ITS FIRST SATELLITE



HOW THE RING OF SATURN IS SEEN FROM DIFFERENT PARTS OF ITS GLOBE: (A) SEEN FROM A HIGH LATITUDE; (B) FROM THE EQUATOR