REPORT ON MARS, NO. 42.

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The expected changes on Mars have been so marked and so rapid during the past month, that it has been thought best to describe them at once for the benefit of other observers, although it involves a regrettable delay in the publication of several sets of drawings which were sent to me of the apparition of 1926. It is expected that these changes, which always occur at this Martian season, will continue through November, and perhaps into December. This may involve further delay, but it is clearly important that the remaining drawings of 1926 should appear at the earliest possible moment. It will be recalled that the instrument now employed here is our 12.5-inch reflector, which we always diaphragm down to 10 inches, thereby materially improving its definition. We also always use an electric fan as described in Report No. **41**, POPULAR ASTRONOMY, 1928, **36**, 451. This drives out the warm air at the lower end of the telescope as well as the cold air at the top. The improvement in definition in our case is marked. Many nights when the seeing is only moderate we see as much now as we did formerly with our 11-inch Clark refractor, but with the seeing at its best, the difference between the two instruments is very noticeable, and of course the finest detail detected is always the most interesting. It is believed that the fan could also be used profitably with large refractors of long focus, in case the air at the two ends of the tube is found to be of different temperatures. These instruments might then prove themselves to be distinctly superior for planetary work to those of moderate size. Thus in 1924 a fan, by enforcing a uniform temperature throughout the tube, might have put the Lick telescope far ahead of our 11-inch.

We always use a position circle, which consists of a micrometer which carries a negative eyepiece. The eyepiece gives a magnification of 340, and is fitted with a very fine web. This latter is appreciably finer than those I have seen in the temperate zone, indeed when illumined by sunlight it is only just visible to the naked eye. A negative eyepice for plantary work is distinctly better than a positive one, chiefly because with high powers the little irregularities on the surface of the field lens of the latter interfere with the finer detail of the image. A low power of 240 we find occasionally useful to bring out slight contrasts, such as those between clouds and deserts, which are not easily visible with the higher magnification. It is of no use to attempt to orient one's drawings of Mars by the phase, even when the latter is large,—hence the position circle. If one does not have one, we may orient approximately by the northern polar cap, which will be visible from now on for several years to come. Its southern border is at present, owing to melting during the Martian day, at a position angle of from 95° to 100° with

the planet's central meridian. It is white and due to snow. The large yellow southern cap is due to clouds, and its position angle is unreliable, owing to constant variations.

Our observations began this year on the night of Friday, Saturday, October 5,6. The central meridian in our drawings ω ranged from 8°.8 to 16°.1, the solar longitude $\odot$ was 321°.5, the equivalent Martian Date January 41, the diameter d 10″.4, the latitude of the center +2°.4, and the seeing 4, later 6. The Martian atmosphere was full of cloud, hiding much of the maria. These latter seen through Martian mists were extremely faint, and their outlines indistinct. The northern cap was only just visible. Acidalium could not be seen, though carefully looked for. Ganges and Nilokeras leading to it were faint.

October 8, 9, ω 293°.8, $\odot$ 323°.4, d 10″.6. Martian haze had cleared, and the northern cap, though fully 1500 miles in length, allowing for phase, yet on account of the position of the polar axis was extremely narrow, not over 0″.5. The Syrtis was conspicuous, but ill-defined to the north and on the preceding side towards Libya, which was slightly darkened.

October 10, 11, ω 275°.6, $\odot$ 324°.4, d 10″.7. Heavy precipitation has occurred, darkening Libya and Isidis, so that they are only just distinguishable from the Syrtis. This is presumably from the clouds that we saw preceding the latter. Protonilus is visible though very faint.

October 14, 15, ω 245°.3 to 267°.3, $\odot$ 326°.6, d 11″.0. Isidis has lightened, but as the day progressed, darkened again to equality with Libya. This may have been due to the evaporation of low-lying mists. Both are somewhat lighter than before. Both edges of the Syrtis are dark, like two canals, with Euxinus strikingly so. The lightness of the interior may have been due to cloud, or the edges of the Syrtis may really have been serving as canals. The huge southern cloud cap is characteristic of the month of January in the Martian year, and was recorded in 1925 and in 1926, 27. It advanced 20° towards the north, south of Hammonis, or nearly 800 miles, between October 10 and 14, the Martian hour of the day, which was about noon, being practically the same on the drawings compared. This was unusual and local. It is at the rate of 8 miles per hour, a plausible rate, if there was no condensation or evaporation, for this planetary wind. A straight broad canal joins the northern part of Euxinus to Triton Lake, dividing the Isidis region in halves. This is identical with one recorded by Professor Douglass and myself in Arequipa in 1892. It leaves Euxinus in latitude +27°, and appears to coincide with Lowell's unnamed canals 659 and 660, which, however, he placed about 250 miles farther south. He considered them to be *novas,* by which he said he meant a canal "which has had no previous existence." He gives an interesting account of them in *Lowell Bulletin,* No. 45. In the light of our observations, it or they, if there are really two of them, are properly speaking seasonal canals of short duration. Hephaestus and Eunostos-Cyclops were fairly narrow.

The northern hemisphere is now turned slightly towards us some 2° to 5°. This only occurs once in 15 to 17 years in the northern midwinter, and so gives us an opportunity to study the northern snow cap during its formative period. The melting of the caps on the other hand is always well seen, as they are then turned towards us when the planet is near opposition. Mars is now having its maximum warmth at the southern pole and its maximum cold at the northern one, and we can watch the water distilling from the southern hemisphere and beginning to condense and freeze at the northern cap. The latter began this year to increase perceptibly in size after this date.

The statement is made in a very excellent astronomical text book, that "at the Martian solstices the cap in the winter hemisphere is very large, often extending halfway from the pole to the equator." This statement was clearly made not as the result of anybody's careful investigation of the matter, but simply because it seemed plausible, and ought to be the case anyway. The only trouble with it is that it is quite untrue. We may say at once that such a statement would require a considerable number of observations to substantiate it, and would better not have been stated in such a positive manner unless it could be proved. Doubtless the temperature at the winter pole of the planet is low enough to freeze water, but the difficulty apparently is that there is very little if any water there to freeze. The water does not begin to arrive in quantities from the other pole until several weeks later. We can never see either pole at its winter solstice because the sun does not illumine the planet at that time beyond latitude 66°. Probably if there were a snow-cap, and it extended as far as latitude 60°, we should see it. In Table I we give the record of two drawings in each of the four years that have a bearing on this question as far as the northern polar cap is concerned. The northern winter solstice occurs in ⊙ 270° on M. D. December 12. The last column of the table gives the central latitude as seen from the sun.

TABLE I.

THE NORTHERN POLAR REGIONS OF MARS.

Date	ω	⊙	M.D.	d	De	Ds
1913 July 27	180°	290°.6	Dec. 44	6″.2	—10°.0	—22°.3
Aug. 6	92	296.6	Dec. 54	6.5	— 7.5	—21.3
1924 Oct. 5	0	269.7	Dec. 11	18.8	—18.2	—24.0
12	330	274.1	Dec. 18	17.5	—19.0	—23.9
1926 Aug. 18, 19	261	266.6	Dec. 6	13.2	—15.3	—24.0
27, 28	230	272.5	Dec. 16	14.2	—14.1	—24.0
1928 Oct. 5, 6	9	321.5	Jan. 41	10.4	+ 2.4	—14.6
8, 9	294	323.4	Jan. 44	10.6	+ 2.8	—14.1

In 1913 and 1928 the drawings described are the earliest ones that we have. The only ones that show any trace of a snow cap at all are the third, and the last two. The case of the third is a curious one. The last previous reference to a cap is on September 22. On that date and on October 1 one is shown having a visible diameter of 30°. On October 3 it suddenly grew quite large, reaching latitude +60°. Two days later,

at the time of the solstice, it was so small as to be described as "practically invisible." It would appear to have consisted either of cloud or of a thin layer of hoarfrost. It was glimpsed two or three times again when very small but was not steadily visible until November 8, ⊙ 290°.7, after which it rapidly increased in size. On October 5, 6 of the present year it appeared probably as a great mass of cloud, but in the last observation recorded in the table it was undoubtedly snow, reaching apparently to latitude +70°. Since then it has been rapidly increasing in size, but it is thought will not much surpass its present dimensions. It now, November 8, M. D. February 17, reaches latitude +50°, and is expected to remain near that figure until the equinox, which occurs on Martian March 1. We thus see that the Martian polar caps behave much like the terrestrial ones. In the light of these observations a further statement in the text book that "the northern one (cap) never quite vanishes" would seem to require modification.

October 16, 17, ω 207°.5, ⊙ 327°.7, *d* 11″.2. A faint, indistinct shading 1000 miles in diameter was seen in the place of Charontis. This was confirmed six months later, when it appeared a little darker, and a faint broad hazy canal, Tartarus, connected it with Titanum. The seeing on this latter night was 10, the best yet, and a slight darkening was for the first time detected bounding the northern cap, which had increased materially in size, being now estimated at 2000 miles in diameter. No visible clouds have been detected in its vicinity. The increase might therefore be attributed either to frost, to snow deposited from clouds formed at night, or from invisible daylight clouds. The yellow south polar cap was now clearly brighter than the deserts, indicating that it had risen higher in the dense Martian atmosphere. On only one previous occasion had it been recorded as brighter.

October 27, 28, ω 117°.9, ⊙ 333°.6, M. D. February 6, *d* 12″.2. A very faint rounded dark area 1500 miles in diameter is central over Lowell's Nodus Gordii. The following night the north preceding portion of this had darkened, and was connected with the northern cap by a faint band from 500 to 1000 miles wide, still more faintly seen the previous night. The inclination of this band to the meridian indicated that the clouds which had presumably deposited the moisture were travelling northerly. On both these nights the southern cloud cap had diminished in a striking manner.

October 29, 30, ω 92°.1, ⊙ 334°.7, *d* 12″.4. The southern cap has increased notably in size, and the dark border of the northern one is quite pronounced, implying that the seasonal melting, begun at about ⊙ 33°, is now well under way. Solis is near the central meridian, dark and elongated, in a more or less meridional direction. A similar but much smaller spot is now seen at the preceding end of Sirenum. This was not detected two days earlier when it should have been located on the central meridian, seeing 9. It was confirmed four days later.

November 1, 2, ω 67°.2, ⊙336°.3, *d* 12″.7, Martian Date February 11.

Striking detail appeared tonight. Aurorae, Lunae, and Solis appeared as three dark spots, the first two quite round, and each about 500 miles in diameter. Chrysorrhoas was clearly seen, Ganges was tremendous, dark, and 500 miles in width, while a somewhat lighter canal 400 miles wide joined Aurorae and Solis, thus completing the triangle. All three canals were convex outward. Nilokeras was also strongly marked, leading to a large darkened area near Acidalium. The southern cloud cap had again increased markedly, extending on the sunrise limb to 15° north of the equator, but reaching to only —60° on the side of the terminator. Two position angles were taken of Solis when near the central meridian, giving it an inclination 37° ± 3°. This was surprising, because in 1926 all the better drawings showed it as elongated in a meridional direction, when not circular. It therefore became important to check this result.

November 2, 3, ω 92°.4 and 100°.5, $\odot$ 336°.8, d 12″.8. The first series of six measures was taken with Solis on the central meridian, and gave an inclination of 37° ± 4°. The second set of four measures taken half an hour later gave an inclination of 40° ± 2°. The two sets therefore confirmed that of the previous night, and show that Solis is now elongated in general along the course of Eosphoros. The length of the darkened area at present is about 1000 miles, and its width half as great. It would therefore stretch one-third way across the American continent. Such a change as this since 1926 can obviously only be due to vegetation, but even then it certainly cannot be laid to accidental natural causes. These might have scattered it in various directions, but could hardly have kept it together, and swung it or built it out at an angle of 40°. It would certainly seem to imply purposeful and intelligent control, and furthermore an intelligence and efficiency not to be expected in the lower animals, but quite comparable to our own. I see no reason to despise the Martians as "only lower forms of life."

November 3, 4, ω 31°.3, $\odot$ 337°.4, d 12″.9. The expected green in the maria appeared for the first time. It was still faint, but undoubted, and in a few weeks will be distinctly more intense. All the region between longitude 15° and the terminator was covered with thin mist, through which the outlines of the maria could only faintly be seen. The greens are most marked in the Martian months of February, March, April, July, and November. Since the maria lie mainly in the southern hemisphere, this means that the greens appear chiefly in the early autumn and also in midwinter and the late spring of that region. The second period certainly sounds paradoxical, until we recall that the maria lie mainly in the torrid zone, where the fluctuations of temperature from day to day are very slight, and as we have shown in former Reports are not likely even at night to fall much lower than is the case on the earth. On a planet whose temperature is as uniform as it is on Mars, it must be further noted that it is presumably not a question of temperature at all, but a question of water, and it so happens that the first and last periods