

REPORT ON MARS, No. 15.

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It has occurred to the writer that there may be some persons interested in Mars who would like to make useful observations of the planet, but who do not know precisely how to begin. It is proposed therefore to devote a few pages of this report to a description of the proper use of the Ephemeris, as published in the *Nautical Almanac*. It is possible also that even some regular observers may find a suggestion here and there that may be of use to them. A very elementary knowledge of trigonometry is necessary in laying out the proper angles, and will be assumed. What is stated here applies directly to the *American Nautical Almanac*, but it applies nearly as well to the *British*, the main difference between the two being that a few of the quantities given in the former are omitted in the latter, and that the headings of some of the columns differ. We shall illustrate our remarks with a practical example, assuming the observation to be made on the evening of April 10, 1916, for an observer using Eastern Standard Time.

The *American Ephemeris* is computed for Greenwich Mean Noon, which for this observer occurred April 10 at 7 A. M., or as the astronomer records it on April 9, 19^h. It would be much more convenient for everyone if the ephemeris were computed for Greenwich Midnight, or 7 P. M., April 10, and it is hoped that this change may be made in the near future, as was done some years ago by the *British Nautical Almanac*. It is very desirable in making drawings of Mars to have a disk properly outlined on paper, the gibbous shape being correctly shown, and the positions of the poles marked, before any attempt at sketching the details is made.

We shall assume the scale of the drawing to be three millimeters or one-eighth of an inch to 1". It is unfortunate as shown in our Report No. 10, that the angular diameter of Mars as given in the Ephemeris is appreciably too large. We understand it will be changed before long, and we hope back to the correct value until recently given in the *British Nautical Almanac*. We shall assume that our drawing will

be made at about seven o'clock in the evening. This will be 12^h after Greenwich Noon. The diameter given for April 10 is 10''.10 and for April 12, 9''.93. Interpolating for 12^h gives us the diameter 10''.06. To correct the error in the Ephemeris, we divide by 13.6 and subtract the quotient from 10''.06, which gives us the true diameter of Mors at that time as 9''.32. We accordingly draw one or more circles having diameters of three times this, or 28.0 millimeters.

On account of cloudy weather the drawing may not be made on the date for which the outline has been drawn, but the changes occurring in a day or two are of little moment. For this reason in drawing the preliminary outline it is not really necessary to interpolate, although this is done in the description in order that it should be theoretically correct. In the computation of all quantities determined after the drawing is completed however interpolation should be used.

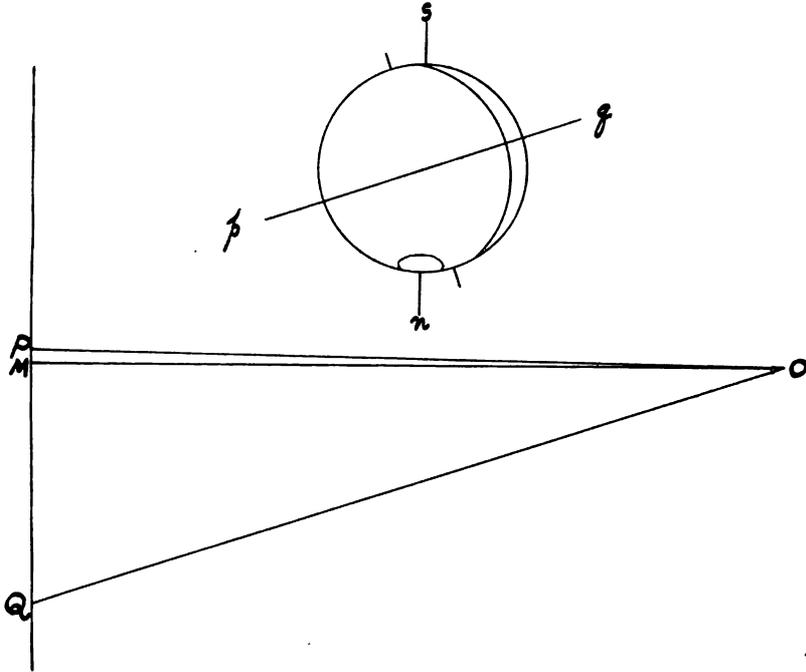


FIGURE 1.

It is the custom of the writer to enter all his drawings on the right hand page of a record book, which is ruled in horizontal lines, with a vertical line at the left hand side. The drawing is centered on one of the horizontal lines and the circle drawn. On one of the lines beneath it, we lay off a distance of 100 millimeters, from the vertical line to the point *O*, Figure 1. Turning to the ephemeris under the column headed *P*, we obtain by interpolation for our date, the

angle $359^{\circ}.0$. Under column Q we obtain $107^{\circ}.7$, subtracting 90° gives us $17^{\circ}.7$. Laying off the natural tangents of those angles on the vertical line, we obtain $+1.7$ mm and -31.9 mm. The directions are determined by the description given in the Almanac. Two long lines s and n are drawn perpendicular to OP , and two short lines perpendicular to OQ . These lines if prolonged would pass through the center of the circle.

Turning to the ephemeris under q we obtain the angle $0''.86$ which is so small that we need not trouble to correct it for the error of the angular diameter. Multiplying by 3 we lay off for the phase the distance 2.58 mm on the line pq drawn parallel to OQ . If we take a radius slightly larger than that of the circle, in this case 15.0 mm, and draw an arc through this point, and centered on the line pq , we shall obtain a close approximation to the arc of an ellipse. The length of this radius is most simply obtained by trial. The phase drawing is now complete, but when a series of drawings are being made, it is a good plan to copy in the snow cap from one of the previous drawings before beginning to work. This saves time at the telescope, and if it is incorrect, it is a simple matter to correct it. The method employed in making the drawing is described in full in Report No. 9, and need not therefore be repeated here. At the top of the page we record the date, and beneath the figure the times of beginning and ending the drawing of the outlines, also the time required for the shading, the magnification, quality of the seeing, and also the aperture, when a change from that usually employed occurs. These observed data we record in pencil, and the computed results in ink.

To the mean of the times given for the drawing of the outlines we add 5^{h} to reduce to Greenwich Time, and multiply by $r = 14^{\circ}.62$, the mean rotation of Mars in one hour.

TABLE I.
MULTIPLICATION TABLE FOR r .

1	14.62°	4	58.48°	7	102.34°
2	29.24	5	73.10	8	116.96
3	43.86	6	88.72	9	131.58

Table I will be found useful when much multiplication is involved. Adding this result to $158^{\circ}.11$ given in the Ephemeris under Central Meridian, gives us the central meridian of the drawing. The latitude of the central point, $+15^{\circ}.8$, is taken from column $D\oplus$. The inclination of the pole towards the Sun, $+23^{\circ}.5$, is taken from column $D\odot$, and the longitude of the Sun as seen from Mars, $78^{\circ}.6$, is given in the column $\odot \delta$. The three corresponding columns in the British Nautical

Almanac are headed B, *B*, and \odot . Taking the last number, and turning to Report No. 10, Table I, column 2, we find in the next column the Martian Date June 2.

These results give all the facts that it is necessary to record regarding any drawing. We may however want to know at what time we should make a drawing in order that a certain longitude should be on the central meridian. Drawings are made here in every 30° of longitude, beginning at 0° . Let us suppose we wished to know when longitude 330° would be central. We look out 330° in Table II and find against it $22^h 34^m.2$.

TABLE II.

TIMES OF TRANSIT FOR SELECTED MERIDIANS.

Merid.	Hour		Merid.	Hour		Merid.	Hour	
$^\circ$	h	m	$^\circ$	h	m	$^\circ$	h	m
30	2	03.1	150	10	15.6	270	18	28.0
60	4	06.2	180	12	18.7	300	20	31.1
90	6	09.4	210	14	21.8	330	22	34.2
120	8	12.5	240	16	24.9	360	24	37.4

Turning to the Ephemeris, in the last column under Mean Time of Transit of Zero Meridian, we find for April 10, $13^h 49^m.0$. If we should add this to the number taken from our table, the result would be greater than 24^h . We must therefore go back to the previous date. This gives us $13^h 10^m.8$. Adding the numbers now gives us $35^h 45^m.0$ on April 9, or April 10, $11^h 45^m.0$ G.M.T. Subtracting 5^h to correct to Eastern Standard Time gives us $6^h 45^m.0$ as the required result.

In the above computations the rate of rotation $14^\circ.62$ has been taken as a constant. This is not strictly true, but its limiting values in any case likely to occur in practice may be taken as $14^\circ.60$ and $14^\circ.64$. This would give a maximum error of $0^\circ.5$ for the longitude of a drawing, and of 2^m in the time of transit. The maximum value $14^\circ.64$ is only reached at aphelion oppositions, as we then pass Mars more rapidly than we do at perihelion, when it is nearer to us. This at first seems strange, but is accounted for if we recollect that at perihelion Mars is moving more nearly at the same speed as the Earth, so that we stay with it longer. The minimum value $14^\circ.60$ is attained when the planet is remote from us, and when very remote and at too great a distance to observe, a still smaller value is reached.

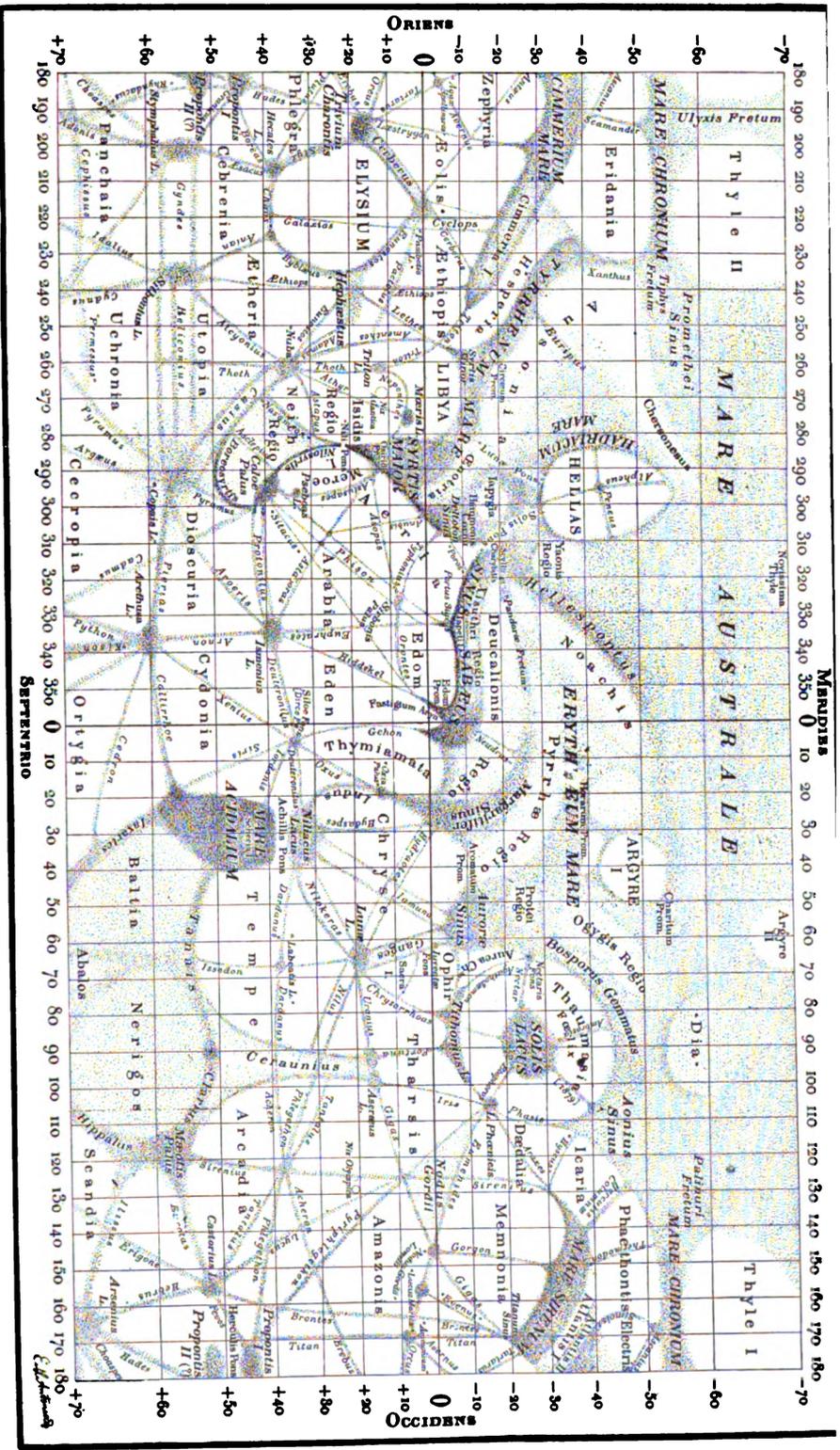
It may be of some interest to the amateur to know what can be seen on Mars with a small telescope. With our 3-inch finder, and a power of 180 on February 27, seeing 5, the Acidalium marsh and the southern maria were both conspicuous. They were also visible with a power of 90. The northern polar cap could be seen with more difficulty. On February 3 the Syrtis and the canals Thoth and Nilosyrtis were clearly

seen. By April all these features will be more difficult, and it is probable that the polar cap will be too small to be visible. We should look at 9^h Eastern Standard Time, or 8^h Central, on or about April 7 for Acidalium, and about April 17 for the Syrtis and the canals. In Report No. 8, Figures 2 and 9 will give an idea of the appearance of the former region, and Figures 22 and 23 of the latter.

We are happy to be able to refer our readers in the future to the excellent map of Flammarion and Antoniadi, published herewith, (Plates XI and XII) which gives many features not contained in that of Schiaparelli, is on a much more convenient projection, and has the great advantage over many maps that have been published of the planet, that it is exceedingly clear, in spite of the fact that the canals are very numerous in certain regions. The type is everywhere sufficiently large to be read, yet is nowhere so obtrusive as to hide the topographical features.

As was shown in our Report No. 9, for all solar longitudes \odot exceeding $34^{\circ}.1$, which was passed January 2, 1916, the planet is seen to better advantage at the present opposition than at the last one. During the past winter we have had fewer favorable nights than usual in Jamaica, and these were mostly occupied in making drawings of the planet, a few topographical positions however have been determined. The shifting to the west, that is to higher longitudes, of the Twin Polar Bays has been confirmed. In Report No. 14 a measure is given, made on December 8 of the south preceding end of Castorius, the preceding of the two bays. Its longitude was $135^{\circ}.6$. Two days later we found it $137^{\circ}.5$. Mean $136^{\circ}.6 \pm 1^{\circ}.0$. On January 15 it was $151^{\circ}.1$, and on February 19 practically the same, $151^{\circ}.8$. Mean $151^{\circ}.4 \pm 0^{\circ}.4$. Shift $14^{\circ}.8$. The longitude according to the map is 155° . There is very little water in it now as compared to the previous opposition. It is faint and difficult to see, much more so than last December, and presumably it has dried up. Therefore its advance has practically ceased. In a report just received from Professor Lau in which he writes of a drawing recently sent me, he says it shows Charontis, but that the "details (Phlegra, Propontis) are evidently strongly displaced." Propontis is the companion twin bay.

The position of the southernmost point of Acidalium, known also as Niliacus, was determined February 27, 28, and March 1. Longitudes $33^{\circ}.9$, $37^{\circ}.3$, $36^{\circ}.9$, mean $36^{\circ}.0 \pm 1^{\circ}.4$. Latitudes $+ 26^{\circ}.1$, $+ 26^{\circ}.2$, $+ 23^{\circ}.2$, mean $26^{\circ}.5 \pm 1^{\circ}.1$. Its position according to the map is in longitude 30° , latitude $+ 28^{\circ}$. The position of Nodus Gordii was determined November 4. It was found to be located in longitude 131° , latitude $+ 25^{\circ}$. Report No. 13. On account of its unusual northern latitude however, it was not recognized at that time. Its position was again determined January 16, longitude $123^{\circ}.2$, latitude



GENERAL CHART OF THE PLANET MARS BY FLAMMARION AND ANTONIADI
From "La Planète Mars" Tome II.

+18°. According to the map its mean longitude is 126°, and its latitude +9°. We are very certain of the accuracy of our result in January, because owing to the inclination of the planet's axis, the point measured lay in the exact center of the disk. This seems to be a clear case of shift in latitude. By the time it was due to be seen in February, it had completely faded out. In the light of this shifting of details, it is now seen that the second drawing in Figure 2 of Report No. 5 refers to the Nodus Gordii, and not to Sirenum. The position there determined was in longitude 143°, latitude +9°. This is not far from Lowell's position as given on the map, 146° and +1°.

The longitude of Thoth in latitude +30° was determined February 2 as 261°.2 and February 3 as 256°.7. Mean 259°.0 ± 2°.2. This seems rather a large deviation, 80 miles, and the measure should be repeated. According to the map the longitude is 262°. In this connection it may be mentioned that this canal is really Thoth, and not Amenthes as has been suggested by some. Amenthes is connected with Nilosyrtris by the Tyrrhenum Mare in latitude -10°. Thoth is connected with it by Nepenthes in latitude +5°. The latitude of the connecting canal was measured on a drawing made February 2, ω 270°.8. Where the canal crossed the central meridian its latitude was +6°.4. It is therefore Nepenthes, and the canal in question Thoth.

Three determinations have been made of the position of Titanum. December 8 its longitude was 156°.2, January 15, 155°.4, and February 19, 157°.7. Mean 156°.4 ± 0°.8. According to the map it is 170°, a difference of 13°.6. This is equivalent to 500 miles! The latitudes on these three dates were -22°.9, -18°.7, and -22°.5. Mean -21°.4 ± 1°.8. According to the map its latitude is -20°. Difference 50 miles. An examination of the drawings confirms this shift, and makes it clear that Titanum has certainly moved away from Elysium. On our drawings of February 7, 9, and 12 it was also clear that the large bay similar to Titanum which was visible at the last opposition, had reappeared at the mouth of Laestrigon. In Report No. 5 we found evidence of a considerable shift in the longitude of Titanum, ranging from 162° early in the season, to 175° towards the end. Titanum was one of the points suggested for general observation this year in Report No. 13, and it is hoped that it may have been located by some other observer.

Certain of the more accessible Associates have been notified by mail of these observations, with the request that they be repeated. Their main importance lies in the fact that if the more conspicuous features of the planet shift about over its surface indiscriminately, no determination of the period of rotation based on observations of a single feature, continued through the period of the few years of any one

man's observing life should have much weight, but for the present we must still depend on a comparison of our results with the earliest recognizable drawings of the planet.

Another point of importance is that if the canals shift laterally through several hundred miles, it is useless to make maps covered with scores of canals located only a few miles apart, and only a few of which are seen at any one time. It would obviously be idle to give the Syrtis canal one name on Dr. Lowell's map, to give it another on that of Mr. Lau, and to give it still a third in the present investigation. About 800 canals have now been named. It is better to confine ourselves to perhaps a hundred names, such as are shown on the present map, rather than burdening our memories with the names and locations of 700 minor canals, which would be of no particular importance, even supposing that they had a separate individual existence. As an example of what is proposed, it may be mentioned that on February 12 a new canal appeared joining Cerberus, and lying between Antaeus and Tartarus, neither of which was then visible. Instead of giving it a new name, it is proposed in such a case to designate it simply as [Tartarus-Antaeus]. Should all three canals appear later at once, which is very unlikely, it might then be time to change the designation of the present one.

A few exceptions to this rule may be necessary. Thus it is clear that the little canal recorded in 1913-14 joining Juventae to Aurorae was not identical with Ganges, and might very well appear at the same time with it. In his map of 1896 Lowell shows two small canals Baetis and Hebe connecting with Juventae. In Report No. 8, Figures 6 and 8, the canal shown coincides most nearly with Baetis. This name will therefore be adopted hereafter to designate it. This is the only instance hitherto recognized where it seems necessary to go outside of the present map for a name.

On January 23, ω 27°.6, M. D. April 39, Margaritifer appeared here for the first time this opposition. It was certainly invisible December 20 and 25, M. D. April 6 and 11. It was now well developed, and quite dark. Sabaeus was also clearly seen. Its southern boundary was beginning to take form, but its western end was still quite undeveloped. The next night both were well marked, but it was only on January 30 that its whole outline was complete and strongly defined. No trace of Aryn had yet appeared, 343°.7, corresponding M. D. April 45. Neither was it seen on February 28, ω 30°.4, M. D. May 18. It was suspected however two nights later, and in a few days became clearly visible. In the light of the lateness of its appearance at the present opposition, and my inability to see it at all at the previous

one, even when carefully looked for, I cannot believe that it was visible at that time, although shown in the Martian months of March and April by several other observers.

On January 23 was also recorded the first appearance of brown supposed on the green of the southern maria, to the south of Margaritifer and Aurorae. Although this was the latter part of April on Mars, we must remember that we are now dealing with their southern hemisphere, so that it is their autumn of which we are speaking. The first greens were detected on the planet at this opposition on February 44, in this same region, Report No. 12, so that their duration was 107 days, or three and a half of our months.

In our last Report, for December, we called attention to the gradual drying up of the Syrtis marsh since its first appearance on October 23, and found that our observations were confirmed by Professor Douglass on the nights of November 28 and December 3. A report and drawing recently received from another Associate, Mr. W. F. Gale, in Australia further confirms this statement, and shows that on December 12 the northern tip of the Syrtis was appreciably *lighter* than regions further south, the darker regions lying along the western side, and extending only to latitude $+ 10^\circ$. Its color was grey, the polar sea being a light steel blue at the time. He was much impressed by a brilliant cloud immediately following the Syrtis when near the limb, and which later dissolved, exposing the intense red of the desert regions in its place. On December 26 we recorded that there was no evidence whatever of the Syrtis marsh.

Five days later, January 1, the marsh and polar sea were both conspicuous, bright blue, and equally dark. The marsh was the bluer of the two, and its eastern side was lighter and bluer than the western. No observations were possible here during this interval, and as far as heard from in response to the query in our last Report, no observations seem to have been made in the United States between December 26 and January 1. If such is the case it is regrettable, since this region could not have been well seen in Europe during this period. It was suggested in Report No. 9 that changes on Mars in the region of the Syrtis might be expected during these months, and the dates when it could be well seen were computed and indicated in Table I, in order to aid would be observers.

Although on our drawing of January 1, Casius, usually a very dark marking, must have stretched from within 15° to 35° from the central meridian, on the side of the terminator, yet it was not recorded. The whole surrounding region was extremely dark. On our next drawing January 4, $\omega 270^\circ$, Casius is shown, but it was no darker than its continuation Thoth, and it looked as if it might have been drained of its

superfluous moisture to fill the Syrtis. The next night it was much darker, and appeared to have partially recovered. In a note to the writer Mr. Lau speaks of the invisibility of Casius in a "preceding observation", made presumably in December. The maria preceding the Syrtis were now distinctly green.

When next seen, January 30, the marsh was still bluish, and this color was retained until February 4, but three days later it had disappeared. A projection of the marsh into Nepenthes was formed between January 30 and February 2, and a dark extension to the west of the northern tip, blunting it, and yet further increasing its longitude appeared February 2. A very large but much paler extension further south, and probably brownish in color reaching 1000 miles to the eastward also appeared. Its length was further increased by 500 miles the next night, and at the same time the southeastern end of the marsh retreated several hundred miles. Presumably it dried up. A special drawing was made to indicate this change, which was quite marked. This was confirmed two nights later, when the marsh appeared still smaller, but by February 9 and again February 11 was as large as ever.

On February 4, M. D. April 50, the planet was compared with the colored sketch Figure 1 shown in November number of *POPULAR ASTRONOMY*, and distributed in connection with the Index to the first ten reports. The sketch was illuminated by a 9 c. p. tungsten lamp shining through a blue medium, of such density that the snow of the planet appeared of the same tint as the white paper. The magnification employed was 660, and the aperture was reduced to five inches, so that the planet and the colored sketch appeared of the same brilliancy. It was recorded that the snow, deserts, and south polar regions were now correct, the greens, and Syrtis were of the proper darkness, and with good seeing of very nearly the right color, though possibly a trifle too green. The better the seeing, the greener they appeared.

Two nights later the maria were recorded as grey not green, and the next night as brown, like the maria south of Acidalium, seeing 9. This color we take, as above suggested to be a ripening of vegetation, analogous to the change of leaf in our fall. By February 9 the brown area had reached the junction of Laestrigon, some 3000 miles from its origin at the Syrtis, the mean rate of travel having been something like 300 miles per day. This termination of the season on Mars seems to be a very sharply marked phenomenon, which should be looked for in future years. It appears to be even more distinct than the first appearance of the greens previously noted. There seemed to be a similar brown extension starting westerly from the Syrtis, but when last seen February 11 it had not progressed very far. If really due to

a change of leaf, it would indicate that in latitudes -10° to -30° the frosts came this year between April 39 and 53, or in what would correspond with us to early November. Compare the third and fourth columns of the Calendar, Report No. 10. A similar change occurs in our northern New England States in latitude $+45^{\circ}$ about the last of September. In latitude 20° on the Earth there is of course no change of leaf.

The south polar regions throughout the whole of this period appeared of a greenish yellow, but it is believed that yellow was more nearly its true color, and that the green was mainly a contrast effect. The clouds frequently seen in Elysium following Charontis, Styx, and Cerberus, and also those seen following Thoth and Nilosyrtris, indicate to us that these canals are all of the same nature as Acidalium, which is always followed by a cloud. In other words they seem all to be of a marshy character, rather than canals due to vegetation. Indeed on one occasion it was thought that faint traces of polarization were detected in Nilosyrtris. These clouds sometimes persist all the way across the face of the planet, but usually they disappear or are very faint after noon.

On February 7, $\omega 232^{\circ}$, there was a bright cloud filling the space between Thoth and Nilosyrtris, but two hours later it had vanished and the intervening space was unusually dark, brightness 5, giving the impression of moistened ground, as if there had been rain. Irrespective of the latitude, -20° , thawing does not seem likely under the conditions observed, while rain seems a possible explanation. These cloud changes sometimes take place with great rapidity. Thus on February 12, $\omega 172^{\circ}$, there was a large cloud on the limb following Nilosyrtris, reaching as far as the southern maria, and covering 0.12 of the whole disk. Within half an hour the northern two-thirds of this cloud had entirely vanished. This cloudy region must have covered 2,000,000 square miles of surface. These clouds frequently stop at the edge of the maria.

Another comparison with the colored print was made February 25, $\omega 46^{\circ}$, M. D. May 15. The deserts of the print were now not quite red enough, and the marsh clearly not as blue as on the planet. The greens on Mars had now faded completely, and were replaced by a brownish grey tint. It may be noted here that the brown in Figure 2 is too intense and the greens, rather too blue. It is unfortunate that our forwarding agent was unable to send us a torch capable of holding a 9 c. p. lamp before the end of January, so that no satisfactory measures were possible at the beginning of the Martian season, but some made with a lamp of 2 c. p. indicate that the greens shown in the two sketches were then very nearly correct. There is some evidence that Acidalium is now drying up, and losing its blue color.

Two more reports, illustrated in colors, have been received from our Associate Mr. McEwen, extending from November 1 to December 25. His source of illumination is a lamp burning cycle lamp oil, which at 4 c. p. and at a convenient distance, renders the paper slightly brighter than the planet. Although the writer uses the white filament of a tungsten lamp, rendered still more blue by blue glass or blue gelatin film, until its color approximates that of daylight, yet both observers agree closely as to the color of the desert regions of the planet. At certain times appear rather less red to the writer, at others we exactly agree. This is rather surprising, since we should naturally suppose that a bluer illumination would require a redder pigment. It is only when we come to the greens and blues that a notable difference appears in our results. To Mr. McEwen these regions usually appear brown or greyish. He uses colored crayons in preference to water colors, as the writer does in part, Report No. 9, and the tint he most frequently mentions is gold ochre. He also mentions light and brown ochre, burnt and brown yellow, raw umber, sepia, Van Dyke brown, and Venetian red.

Some of his more interesting observations follow. On November 3 Acidalium was on the central meridian, color raw umber. It was very faint, and not nearly so dark as Aurorae. This is certainly unusual, and can only be explained by heavy cloud over the marsh. He mentions particularly the bright white cloud following it. Margaritifer and Aurorae appeared as a dark band, that is to say the former had not yet developed as a bay. This is further confirmed November 10, when he records Protonilus, Ismenius, and Deuteronilus all prominent, and much darker than Sabaeus or Margaritifer, which later appeared as a faint band stretching across the southern part of the disk. A small white spot, [i.e. a cloud] was visible at the center of the disk $\lambda 354^\circ$, $\delta + 20^\circ$. November 19 Syrtis Major was very faint when nearly half way to the center, and not so dark as Nilosyrtis or Boreosyrtis. This further confirms the drying up of the Syrtis at this period, following its first inundation in October.

December 12. Hiddekel and Gehon were seen together as a very faint broad and diffused band extending from the bay of Sabaeus towards Ismenius and Dirce. This is the broad north and south band to which frequent reference was made in our earlier reports. Sabaeus bay was distinct, of triangular shape, with a sharp northern boundary. Aryn had therefore not developed by that date. The bay was less distinct an hour later, when it had passed the central meridian. The southern edge of Thymiamata, Chryse and Ophir appeared as a white line, lying in an east and west direction. Margaritifer therefore had not yet developed. We have just seen that it did not appear in Jamaica as a bay until six weeks later, January 23.

Table III contains the usual data of the month's drawings.

TABLE III.
DATA OF THE DRAWINGS.

No.	1916	☉	M. D.	Long.	Lat.	Sun	Diam.	Seeing
42	Jan. 1	35.1	Apr. 17	295	+19	+14	11.4	5, 4
43	" 4	36.4	" 20	270	"	"	11.7	5, 4
44	" 5	36.9	" 21	242	"	"	11.8	6
45	" 12	40.0	" 28	203	"	15	12.4	5
46	" 15	41.4	" 31	155	18	16	12.7	8, 10
47	" "	"	" "	180	"	"	"	8, 7
48	" 16	41.7	" 32	92	"	"	12.8	8, 9
49	" "	"	" "	117	"	"	"	8, 9
50	" 17	42.1	" 33	66	"	"	"	8, 7
51	" 23	44.8	" 39	28	"	17	13.3	6, 7
52	" 24	45.2	" "	7	"	"	13.4	7, 6
53	" 30	47.9	" 45	314	17	18	13.7	6, 7
54	" "	"	" "	344	"	"	"	9
55	" 31	48.3	" 46	297	"	"	"	6, 8
56	Feb. 2	49.2	" 48	271	"	"	13.8	8, 7
57	" 3	49.6	" 49	258	"	"	"	10
58	" 7	51.4	" 53	242	16	"	13.9	9
59	" 9	52.3	" 55	216	"	19	"	8, 6
60	" "	"	" "	310	"	"	"	4
61	" 12	53.6	May 2	179	"	"	13.8	10
62	" "	"	" "	268	"	"	"	5
63	" 19	56.6	" 9	120	15	20	13.6	8, 7
64	" "	"	" "	153	"	"	"	7, 6
65	" 24	58.8	" 14	90	"	"	13.3	6, 7
66	" "	"	" "	126	"	"	"	6, 6
67	" 26	59.7	" 16	61	"	"	13.2	7

The following canals and lakes were seen:—

- Jan. 1 **F** Nilosyrtris.
 Jan. 4 **F** Nilosyrtris, Thoth, Astusapes.
 Jan. 5 **E** Nilosyrtris, Thoth, Astusapes, Casius, Hephaestus, Eunostos, Cyclops, Cerberus, Styx, Chaos, Hyblaeus, Aesacus.
 Jan. 12 **D** Casius, Cyclops, Cerberus, Chaos.
 Jan. 15 **D** Eunostos, Cyclops, Cerberus, Chaos, [Tartarus-An taeus], Brontes, and Nodus Gordii.
 Jan. 16 **C** Brontes, Tantalus, Sirenus, Acheron, Tithonius, Eosphoros, Nectar, Ceraunius, Nilokeras, and Phoenices, Solis, Lunae.
 Jan. 17 **B** Ceraunius, Nilokeras, Ganges, Tithonius, Nectar, and Solis, Lunae.
 Jan. 23 **A** Nilokeras, Ganges, Tithonius, Nectar, Indus.
 Jan. 24 **A** Deuteronilus, Protonilus.

- Jan. 30 **FA** Protonilus, Nilosyrteis, Thoth, Casius, Indus, Oxus, Deuteronilus, Sitacus, and Ismenius, Moeris.
- Jan. 31 **F** Deuteronilus, Arnon, Protonilus, Astusapes, Nilosyrteis, Nepenthes, Thoth, Casius, and Ismenius.
- Feb. 2 **F** Protonilus, Nilosyrteis, Nepenthes, Thoth, Casius, Hephaestus, Cyclops, Eunostos, Hyblaeus.
- Feb. 7 **E** Nilosyrteis, Nepenthes, Thoth, Casius, Hephaestus, Eunostos, Cyclops, Cerberus, Hades, Styx, Aesacus, Chaos, Hyblaeus.
- Feb. 9 **EF** Nepenthes, Thoth, Casius, Hephaestus, Eunostos, Cyclops, Cerberus, Erebus, Hades, Chaos, Hyblaeus, Protonilus, Nilosyrteis.
- Feb. 12 **DE** Eunostos, Cyclops, Cerberus, Tartarus, Laestrigon, Avernus, Styx, Chaos, Hyblaeus, Hades, Erebus, Nilosyrteis, Nepenthes, Thoth, Casius.
- Feb. 19 **CD** Tantalus, Acheron, Ceraunius, Cerberus, Hades, Erebus.
- Feb. 24 **C** Acheron, Ceraunius, Nilokeras, Tithonius, Iris, Fortuna, Nectar, Ganges, Tantalus, and Solis, Tithonius.
- Feb. 26 **B** Ceraunius, Nilokeras, Tithonius, Fortuna, Nectar, Bosphorus, Ganges, and Solis, Tithonius, Lunae.

These canals except Astusapes were all broad, often several hundred miles in width, never less than one hundred. As a rule they were curved rather than straight. With the coming of March a different type of canal appeared, both narrow and straight. No duplications have hitherto occurred, but with the coming of the new type new phenomena may appear.

ARCTURUS—RISING.

Again Arcturus beams!—his gleaming light
 Burns brilliantly amidst the star-lit night,
 Like harbinger in yonder eastern sky
 He rises to proclaim that spring is nigh;
 When winter's snow still lies on hill and vale,
 And winds of March first wander down the dale,
 Ere crocus blooms or falls mild April's rain,
 Like beacon bright Arcturus beams again.

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