was our good fortune to have as our advisor Mr. Johann Oberman, Secretary to the Residente; and to him and to Mrs. Oberman we owe more perhaps than to anyone else. They were keenly interested in our progress and gave freely of their time and wise counsel. He on the day of the eclipse was one of the voluntary assistants. We shall remember always with pleasure and gratitude our stay in Benkoelen.

REPORT ON MARS, NO. 36.

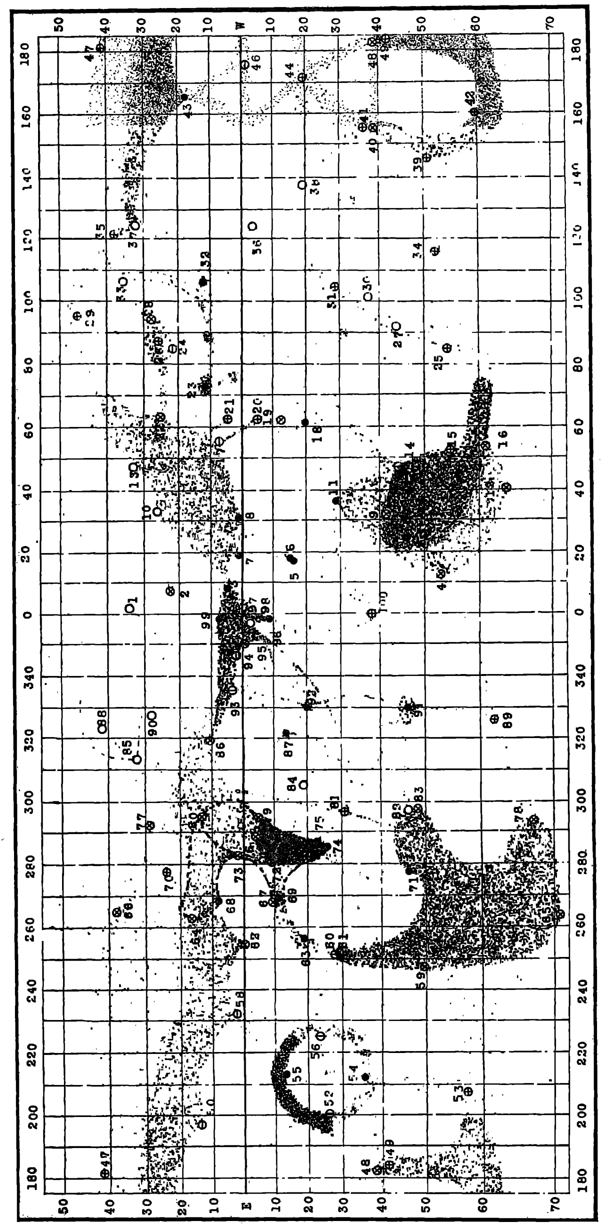
By WILLIAM H. PICKERING.

Description of the Map.

The accompanying map* is based on the survey described in Report No. 33, and serves to show the precise location of the 100 stations there recorded. This is its primary and real purpose. All of the more prominent canals visible during the years from 1913 to 1922 inclusive, however, have been entered upon it, and some also of those which were of less importance. Only those fainter canals were inserted which either were helpful in identifying the lakes, or had some other special interest of their own. Obscuring important details of the map with unimportant temporary canals is not considered desirable on a map of this character, and everything that does not aid in locating the stations is considered of distinctly secondary importance. The map is oriented with south at the top, and with east or preceding, as the term is used on Mars, indicated by an E, on the left side. The small blackened circles indicate the 24 points in class A. These may be described as being, as far as known, certainly stationary within narrow limits. The open circles containing a single horizontal line indicate the 6 points in class B, of which we may say that, with the above limitations, they are certainly stationary in latitude. The 5 circles containing a vertical line apply to class C, which are similarly stationary in longitude. The circles with a vertical cross refer to points taken from classes D, E, and 4 from F, 20 in all, which we have assumed to be stationary. The 27 circles with a diagonal cross indicate the remaining stations in classes D and E, whose motion is more or less certain. The 15 open circles refer to the remaining stations in class F, which, while an appreciable proportion of them may be stationary, were insufficiently observed to render the matter certain. The 3 stations in Olympia, not inserted on the map on account of their high latitude, complete the 100.

It is assumed that the majority of my readers are now reasonably well acquainted with the names of the more important markings upon the planet. To save confusion therefore all lettering on the map has been avoided, the numbers attached to the stations referring to Tables I and II, where the corresponding names may be found. Where names

*See page 358.



MAP OF MARS, NUMBER 3.

are given which are not found on our previous maps the initial of the authority for their usage is put in parenthesis, and in the case of Lowell the dates of his various maps are also given. The maps of 1896 and 1903 will be found in the Annals of the Lowell Observatory, Vol. 3. His map of 1909 has never been published, and our data are taken from a photograph of his globe for that apparition. The map of M. Jarry-Desloges is to be found in Volume 3 of his publications. The initials used are (A) Antoniadi, (D) Jarry-Desloges, (L) Lowell, (P) Pickering.

TABLE I.

NAMES OF THE STATIONS NUMBERED ON THE MAP.

1 Pandora S.	26 Solis c.	51 Olympia c.	76 Euxinus S. m.
2 Pandora f.	27 Ascuris	52 Elysium p.	77 Hellas N.
3 Sabaeus f.	28 Solis f.	53 Gyndes S.	78 Boreosyrtis N.f.
4 Acidalium p.	29 Thaumasia S.	54 Elysium N.	79 Euxinus S. f.
5 Margaritifer N.	30 Mandevia	55 Elysium S.	80 Euxinus S. M.
6 Oxia	31 Croesus	56 Elysium f.	81 Coloe
7 Thymiamata f.	32 Phoenicis	57 Olympia f.	82 Pseboas
8 Aromatum S. p.	33 Thaumasia f. m.	58 Cimmerium N.	83 Boreosyrtis S. f.
9 Acidalium S.	34 Arcadia N.	59 Utopia f.	84 Bonis
10 Horarum S.	35 Icaria N.	60 Thoth c.	85 Hellespontus N.
11 Niliacus S.	36 Biblis	61 Nuba S.	86 Hammonis S.
12 Acidalium N.	37 Thaumasia f. M.	62 Syrtis minor N.	87 Sirbonis
13 Nia N.	38 Bandusia	63 Triton N.	88 Noachis p.
14 Tempe p.	39 Castorius p.	64 Euxinus S.p.M.	89 Arethusa
15 Acidalium f.	40 Castorius S.	65 Boreosyrtis N.	90 Pandora p.
16 Baltia S. p.	41 Castorius c.	66 Achates S.	91 Ismenius
17 Aurorae N.	42 Arsenia N.	67 Euxinus N.p.M.	92 Juturna
18 Lunae c.	43 Titanum N.	68 Libya S.	93 Sigaeus N.
19 Lunae S.	44 Moreh	69 Nepenthes c.	94 Edom S.
20 Juventae N.	45 Olympia p.	70 Vulturnus N.	95 Edom f.
21 Juventae S.	46 Aesculapius C.	71 Neith N. f.	96 Furca N. p.
22 Nectar p.	47 Electris N.	72 Euxinus p. m.	97 Aryn S.
23 Maeisia	48 Propontis S.	73 Libya f.	98 Furca N. f.
24 Solis N.	49 Propontis c.	74 Syrtis N.	99 Furca S.
25 Ceraunius p.	50 Laestrigonum N.	75 Meroe S.	100 Siloe

On previous maps of the planet little attention has been paid to the width of the canals, and they have generally all been entered nearly alike in this respect. That they are not so in fact is undoubted. The widest streaks, if they may be called canals, lie in an east and west direction, and are extremely faint. They seem to be for the northern hemisphere what the maria are for the southern. They were visible in the earlier apparitions of the period specified, during the melting of the northern polar cap. The one crossing longitude 220° is identical with Gyndes of our standard map by Antoniadi (Report No. **15**, POPULAR ASTRONOMY 1916, **24**, 236), which we shall hereafter designate as Map Number 2. The wider one crossing longitude 110° coincides with Tantalus, Phlegethon, and Acheron, the narrower one with Clarius and Eurotas. The former ranges from 350 to 400 miles in width, the latter is about half as wide. We find all grades of width between these and the narrowest canals visible. As they become narrower they also become darker and more distinct, until they become so narrow as to be seen with difficulty. The remaining canals between longitudes 90° and

180° are with a few exceptions also faint and rather difficult, and were not visible at all during the earlier portion of the period, but have come out with the melting of the southern polar cap.

TABLE II.

ALPHABETICAL LIST OF STATIONS.

Name	No.	Cl.	Name	No.	Cl.
Achates S. (L '96)	66	D	Juturna (L '03)	92	A
Acidalium f.	15	D	Juventae N.	20	F
Acidalium N.	12	D	Juventae S.	21	F
Acidalium p.	4	D	Laestrygonum N. (P)	50	B
Acidalium S.	9	E	Libya f.	73	E
Aesculapius c. (D)	46	B	Libya S.	68	A
Arcadia N.	34	D	Lunae c.	18	A
Arethusa	89	D	Lunae S.	19	E
Aromatum S. p.	8	A	Maeisia (L '03)	23	A
Arsenia N. (P)	42	D	Mandevia (P)	30	F
Aryn S.	97	F	Margaritifer N.	5	A
Ascuris (D)	27	F	Meroe S.	75	A
Aurorae N.	17	B	Moreh (L '96)	44	F
Baltia S. p.	16	D	Nectar p.	22	D
Bandusia (L '96)	38	F	Neith N. f.	71	A
Biblis (L '96)	36	F	Nepenthes c.	69	A
Bonis (P)	84	F	Nia N. (L '09)	13	F
Boreosyrtis N.	65	D	Niliacus S.	11	A
Boreosyrtis N. f.	78	D	Noachis p.	88	F
Boreosyrtis S. f.	83	E	Nuba S.	61	E
Castorius c.	41	E	Olympia c. (A)	51	D
Castorius p.	39	D	Olympia f. (A)	57	D
Castorius S.	40	E	Olympia p. (A)	45	D
Ceraunius p.	25	D	Oxia	6	A
Cimmerium N.	58	B	Pandora f.	2	E
Coloe	81	F	Pandora p.	90	F
Croesus (P)	31	E	Pandora S.	1	F
Edom f.	95	E	Phoenicis	32	A
Edom S.	94	B	Propontis c.	49	E
Electris N.	47	D	Propontis S.	48	E
Elysium f.	56	C	Pseboas	82	F
Elysium N.	54	A	Sabaeus f.	3	A
Elysium p.	52	C	Sigeus N.	93	C
Elysium S.	55	A	Siloe	100	E
Euxinus N. p. M. (P)	67	E	Sirbonis	87	A
Euxinus p. m. (P)	72	E	Solis c.	26	D
Euxinus S. f. (P)	79	E	Solis f.	28	D
Euxinus S. M. (P)	80	E	Solis N.	24	B
Euxinus S. m. (P)	76	E	Syrtis minor N.	62	E
Euxinus S. p. M. (P)	64	E	Syrtis N.	74	A
Furca N. f. (A)	98	A	Tempe p.	14	C
Furca N. p. (A)	96	A	Thaumasia f. M.	37	F
Furca S. (A)	99	A	Thaumasia f. m.	33	F
Gyndes S.	53	D	Thaumasia S.	29	D
Hammonis S.	86	E	Thoth c.	60	C
Hellas N.	77	D	Thymiamata f.	7	A
Hellespontus N.	85	F	Titanum N.	43	A
Horarum S.	10	F	Triton N.	63	A
Icaria N.	35	D	Utopia f.	59	E
Ismenius	91	A	Vulturnus N. (D)	70	F

Some of the canals, such as Ganges and Gehon, vary greatly in width at different times. Sometimes the sides of these two, in particular, are not parallel. I have generally drawn such canals when they are at their narrowest. Between Gehon and the Syrtis is a network of very fine canals. They too are difficult, since they are never very wide. Indeed it is probable that some of them are represented as too wide on the map. Their width as shown ranges from 20 to 40 miles, and it is doubtful if they are ever wider than that. They were seen in 1918 and 1922, when the diameter of the planet ranged between 12″ and 19″, and the solar longitude ⊙ between 100° and 200°, corresponding to Martian July, August, and September. They were also seen in 1914, when the diameter was 14″.8 and ⊙ equalled 20°. Experiments with artificial disks lead us to believe that some of them may not have been more than 10 or 12 miles in width. The background on which they lie is distinctly more red than that of any other portion of the planet. Whether this fact is in any way associated with their narrowness we cannot say. The easiest canals to see lie between longitudes 180° and 280°. They are wide, and a few of them are very dark at times. Some of them sometimes disappear, but there are always a few that can be seen with a moderate sized telescope, let us say of 5 inches aperture, at the spring apparitions of the planet, if the seeing is not too bad, by anyone who possesses ordinary eyesight. I have seen several of them here with the 3-inch finder of the Harvard refractor.

It has been customary among some observers to speak of the canals as generally following great circles, and therefore laid out by the shortest possible course from point to point upon the planet. The writer on the other hand has always insisted that very few of them followed great circles, although some do appear to do so, or nearly so. Many of them are too wide and too short to enable us to judge of their straightness or curvature. The earlier cartographers represent Elysium as pentagonal. During the earlier portion of the period specified it was always circular, and much smaller than previously represented. Compare it with Map Number 2. Towards the end of the period it changed its shape rapidly, and became elliptical, and part of the time was pointed at the two ends like a broad spindle. Between longitudes 140° and 260° we place the southern maria from 200 to 400 miles farther north than they are represented on our former map by Antoniadi. Some of Schiaparelli's prominent canals like Hiddekel and Titan have either faded out entirely, or become much fainter, while new ones have appeared in other places. Practically all the canals either shift their positions, vary in width, or otherwise change in appearance. Many of the earlier lakes mapped in Arequipa in 1892, and by Lowell since then, have not appeared of late years, while we have found ourselves obliged to name several others not previously known.

The breaks in the otherwise continuous line of southern maria, called by Schiaparelli Atlantis and Hesperia, are not permanent features of the planet, nor are they often seen. They were doubtless due to cloud. A similar break in longitude 200° was noted here in 1920, ⊙ 122°.9. A marked change has been recorded in Thaumasia. Schiaparelli placed its following or western end in longitude 110°, giving it a very rounded shape like Elysium. Two of my early measures in 1913 placed it in longitude 106°.5, but latterly we find it in longitude 124°.6, a difference of some 550 miles. The later measures are certainly correct, but I have indicated the earlier ones by a dotted outline on the map. The canal Phasis with its associated mare Aonius disappeared after 1913, but reappeared faintly in 1924. We expect it to be visible again this autumn. The most conspicuously variable regions of all however are the two blue ones Acidalium and Euxinus. The former is blue most of the time, the latter occasionally so. The color is apparently due to vegetation, and when visible is striking and beautiful. Acidalium changes its size and shape so markedly that I have only attempted to indicate its average outlines on the map. For Euxinus I have indicated what may be called two average maxima, and its minimum extent, the first two by means of dotted lines. The varying changes in location of its southern border are instructive, conspicuous, and very rapid. They have been observed here between ⊙ 0° and 140°, and are associated with the melting of the northern polar cap. Now that we have at last secured a stationary set of parallels and meridians upon the planet, we should be able to study these changes to advantage. The extraordinary instance of the connection by the Pandora canal of this marking with the southern polar cap, observed at Arequipa in 1892, ⊙ 213°.9 (Report No. **4**, 8, Popular Astronomy, 1914, **22**, 223), appears to have been unique. The increase of area was then very marked. Again, in 1862 and 1864, Margaritifer, according to Lockyer, Kaiser, and Dawes, was double, but has never been seen so since. The companion which was clearly conspicuous, lay in longitude 40°, was dark, and averaged some 200 miles in width by perhaps 500 in length (Report No. **14**). All the maria along this meridian are still subject to change, as we shall show later. Unlike the earth, extensive, if only temporary, variations independent of the seasonal ones are certainly, if only occasionally, taking place on the planet.

As the truth about Mars is gradually spreading, and becoming more and more widely accepted among the more progressive and intelligent sidereal astronomers, they are now beginning to understand that the seeing is amazingly better in the south than it ever is, at any time, in the regions of our planet subject to anticyclones. Southern astronomers know by personal experience quite as well as their northern confrères that the finer markings are never visible in the north. We do not wonder that they cannot see them, nor do we expect it of them. The whole cause of the skepticism of the unbelievers, in the past, put in a nutshell, is that they absolutely refused to take our word for it, that we had any better seeing in the south than they ever did in the north. Also they confused our descriptions of better seeing with the mere fact that we saw the planets at a greater altitude than they did. Futhermore they were not willing first to come south and see for themselves, but preferred to stay in the north, and repeat over and over again that it was not so, that no such markings were visible, and that southern observers were simply drawing on their imaginations—and when they didn't say so, some of them thought it. That reputable southern astronomers should announce what were distinctly sensational discoveries, without first having assured themselves that they were true, seemed to these northern critics to be the most natural thing in the world.

A visitor after looking at Mars through the great 26-inch telescope at Washington, and expecting to see numerous fine canals, came away and remarked that all he could see there was a ball of butter with a blue fringe round it. I quite sympathized with him; that exactly describes what I have myself so often seen in New England, during anticyclone weather. In England the seeing, what there is of it, is better, and in our southern states probably better still. When we get to Arizona and Jamaica the seeing is still better. Southern observers do not draw hazy markings that they imagine they can see by glimpses, and represent them as if they were narrow, sharply defined lines, as some northern astronomers appear to think. The coarser canals are broad though seldom hazy, but the finest canals never appear that way. Either they look as Lowell expressed it, to be as sharply defined as a steel engraving, or else they are not seen at all. Those sidereal astronomers, mostly the younger men, who while wishing to pose as conservatives, yet with no planetary experience of their own whatever, rush into print to say that there are no canals and no changes, seasonal or otherwise, to be found either upon the moon or Mars, and do it in spite of the lifelong careful studies and measurements of the planetary astronomers, are not only foolish, but as far as their reputations count for anything, they utterly misrepresent the extent of their own information, or lack of it, to the public who trust to them for guidance. Northern astronomers have no idea how perfectly obvious these things are in the south. Sidereal astronomers are now learning, in some cases to their surprise, that the interpretations that Martian observers for the past thirty years have put upon their work regarding temperatures, as indicated by melting snow and vegetation, are turning out to be true, and this in spite of the past computations of the mathematicians to the contrary notwithstanding, based as they were on what were obviously false premises. But even before this was discovered, I am pleased to say, more sidereal astronomers, especially in our western states where the seeing is good, were becoming interested in Mars, and we are now getting more and better drawings of the planet, from which to make our selections for publication, than has ever before been the case.

Suggestions to Observers of the Coming Apparition.

The opposition of 1926 falls on November 4, when the diameter of the planet will reach 20″.17, and the solar longitude 313°.1, Martian Date January 28. The planet will be nearest us however 8 days earlier, on October 27, when its diameter will reach 20″.40, or very nearly the same as it was in 1922. The winter solstice, which by the system of reckoning at present in use by the *Ephemeris* occurs at ⊙ 262°.84,

PLATE XVII.

Fig. 1
'07 July 22, 110°
Douglass

Fig. 2
'24 Aug. 4, 266°
230°.7 Nov. 6

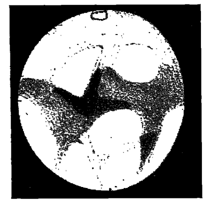


Fig. 3
'24 Oct. 19, 270°
278°.4 Dec. 25

Fig. 7
'24 Aug. 22, 61°
241°.9 Nov. 24

Fig. 8
'24 Oct. 1, 60°
267°.2 Dec. 7

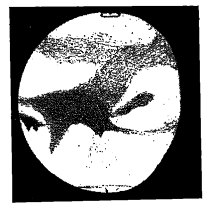


Fig. 9
'24 Nov. 8, 60°
290°.7 Dec. 44

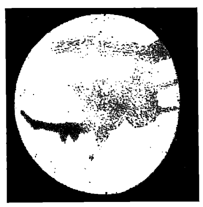


Fig. 13
'24 Oct. 5, 29°
269°.7 Dec. 11

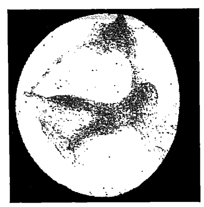


Fig. 14
'24 Dec. 13, 38°
311°.3 Jan. 23

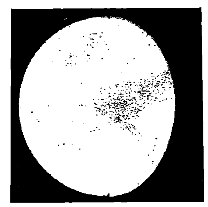


Fig. 15
'25 Jan. 23, 30°
334°.1 Feb. 7

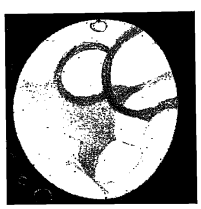


Fig. 19
'24 Oct. 12, 312°
274°.1 Dec. 18

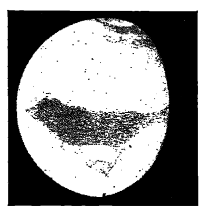


Fig. 20
'24 Dec. 23, 294°
317°.0 Jan. 33

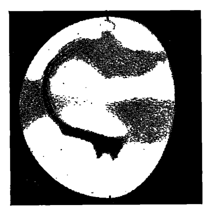


Fig. 21
'24 Nov. 10, 359°
291°.9 Dec. 46

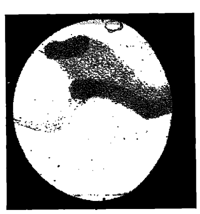


Fig. 25
'24 Dec. 5, 149°
306°.7 Jan. 16

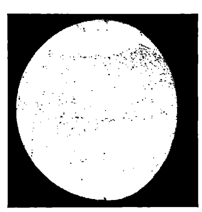


Fig. 26
'25 Jan. 8, 150°
325°.9 Jan. 49

Fig. 27
'13 Oct. 12, 159°
334°.6 Feb. 8

Drawings of Mars Forecasting What May be Seen in 1926.

PLATE XVIII.

Fig. 4
'24 Dec. 27, 269°
319°.2 Jan. 37

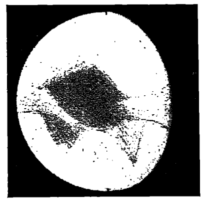


Fig. 5
'25 Feb. 1. 274°
338°.9 Feb. 16

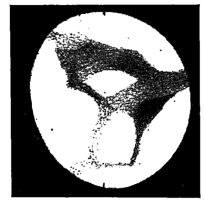


Fig. 6
'13 Sept. 30, 258°
328°.2 Jan. 53

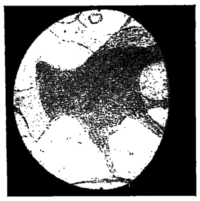


Fig. 10
'24 Dec. 11, 60°
310°.2 Jan. 22

Fig. 11
'25 Jan. 19. 60°
331°.9 Feb. 3

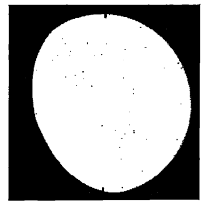


Fig. 12
'13 Sept. 17, 51°
320°.9 Jan. 40

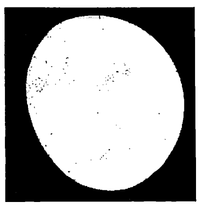


Fig. 16
'13 Sept. 17, 36°
320°.9 Jan. 40

Fig. 17
24 Sept. 22. 118°
261°.5 Nov. 54

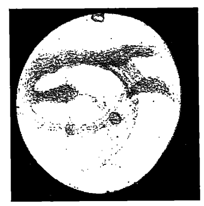


Fig. 18
'24 Oct. 29, 115°
284°.6 Dec. 35

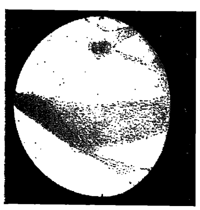


Fig. 22
'24 Dec. 21, 1°
315°.9 Jan. 31

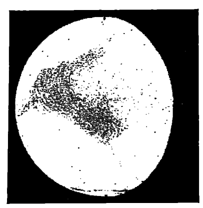


Fig. 23
'25 Jan. 23 0°
334°.1 Feb. 7

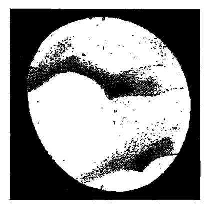


Fig. 24
'13 Oct. 30, 344°
344°.1 Feb. 27

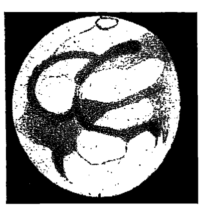


Fig. 28
'24 Oct. 12, 330°
274°.1 Dec. 18

Fig. 29
'24 Dec. 19, 331°
314°.8 Jan. 29

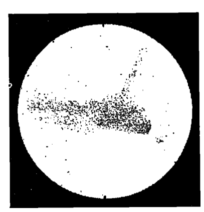


Fig. 30
'25 Jan. 27, 324°
336°.2 Feb. 11

Drawings of Mars Forecasting What May be Seen in 1926.

corresponding to Martian December 1, falls on terrestrial August 13. The vernal equinox occurs at ⊙ 352°.84, corresponding to Martian February 43, and falls on January 17, 1927. The planet will therefore be nearest to us during the summer of its southern hemisphere. This hemisphere will be turned towards us throughout the apparition, the maximum inclination of its pole being 23°.98 according to the *Ephemeris,* and occurring upon August 24. We shall therefore see the southern polar regions in this respect to the same advantage at this apparition as we did at the last one, except that the plane will be somewhat more distant. On and after September 11, when it is in ⊙ 280°.9, diameter 15″.8, it will present a larger disk than it did in 1924 at the same Martian season. It will then rise for northern observers at between nine and ten o'clock in the evening, and be in δ +14°.2. It will remain in nearly this same declination throughout the year.

A detailed statement of what is believed to be the best and most useful method of making observations of Mars, and also of the use of the *Ephemeris,* is given in Report No. **27**, published in the June-July number of POPULAR ASTRONOMY for 1924. The only important addition that it is now necessary to make, becomes necessary on account of the change adopted in the *Ephemeris* from Greenwich Mean to Greenwich Civil Time, or Universal Time, as it is now proposed to call it. Considering for example that portion of America using astronomical Eastern Standard Time, our date was formerly the same as that of Greenwich throughout the day, excepting between the hours of 7 A. M. and noon, E. S. T. For us 7 A. M. is Greenwich noon. Therefore the astronomical Greenwich day, let us say Sunday, changed its date at 7 A. M., and became Monday, while we still called it Astronomical Sunday until noon in America, although it was civil Monday for us the same as in England. This arrangement interfered little with astronomical observations, and probably few astronomers considered it at all.

Now that the change is made to Civil Time however, our dates are different between 7 P. M. and midnight E. S. T. This is the most important time of the whole day to astronomers. If we go to Sunday evening service, it is already Monday in England. Consequently if we are observing between these hours, we must remember always to take our data not from our own date, but from the date following. On the Pacific slope the change of date occurs of course between 4 P. M. and midnight. These changes are obvious if we prefer to use 24 hour time in our observations to the ordinary civil time. Probably most amateurs however will prefer to continue to use the latter. Practically for Martian observations we may remember that Greenwich midnight, 0^h Universal Time, for which the lunar and planetary ephemerides are computed, is still 7 P. M. E. S. T., but in using the *Ephemeris* we must also remember that until our date changes at midnight, we must add one day to the date there given. The rule for computing the private ephemeris given in the above mentioned Report still applies. In computing the longitude of the central meridian of a drawing, if we wish to obtain a more accurate result than that given by Table III, we may take the difference in the time of transit of the zero meridian from the *Ephemeris* for two successive dates for the period concerned, which will in general be about $24^h\,40^m$, and reduce the minutes to decimals of an hour. Divide 360° by this quantity, and then construct a multiplication table like Table III, substituting this result for the first figure in the second column.

Now with regard to the drawings themselves, it is particularly requested that they should be made at such times, computed beforehand, that the central meridians shall closely coincide with the six longitudes 0°, 60°, 120°, 180°, 240°, and 300°. When they do not, certain areas of the planet are left but poorly represented, the observer records fewer canals, and his drawings are not readily comparable with those made by observers who are more careful in such matters. A few remarks may also be made here regarding the drawings sent in for publication. If we refer to those shown in Report No. **35**, we shall find a great difference between them, as regards their artistic appearance. From that point of view alone some of them are rather poor specimens. While artistic appearance is not the most important point by any means, it should nevertheless be considered. It is our continued experience that a pencil sketch is far preferable to one in india ink, and far easier to make acceptable. It is moreover so easily altered that it is generally much more accurate. It should be drawn so as to give slightly stronger contrasts than are wanted in the final result. Our reproductions are all of 1.75 inches diameter. Anyone who sends in a sketch whose diameter is less than 2.5 inches must have considerable confidence in his own artistic ability. All drawings should have the same diameter, and 3 inches is recommended when considerable detail is shown. Very short dark lines, as in the accompanying sketches, should indicate the location of the two poles. This is particularly important if the drawings are accurately oriented by means of a position circle. Colored sketches are interesting to study, but should never be sent for reproduction. The sketch should be made on white paper, and should preferably have a blackened background. This is best done by enclosing the drawing in a square, and filling in the space between it and the square with india ink. When the planet is markedly gibbous, the ellipse can be drawn chiefly with dividers and finished with draftsmen's curves, as explained in Report No. **27**. Another way of furnishing a black background is to cut out the drawing carefully, and paste it on a piece of black paper. This is simpler, but it usually leaves the limb of the planet rather rough.

For reasons which will appear later in this Report, it is hoped that observers will not only send in a complete set of six drawings made if possible before opposition, but also as many as they can, made afterwards, particularly of those showing broad conspicuous northern canals and bands. Anyone, whether a member of the International Society or not, may send drawings, but it is requested that they also furnish at the same time as far as possible, all the necessary data to fill out a descriptive table like Table I in Report No. **34**, particularly columns 3, 4, 5, 6, and 8. Since owing to the time consumed in identification of all the canals and lakes on all the drawings, a considerable interval must necessarily elapse after the last drawing is received before the Report is ready for publication, and a further interval before it can be printed and published, it is earnestly requested that all the observers send in their drawings at the earliest moment possible. We shall endeavor to publish our final reports on this year's observations some time in 1927.

A Forecast of What We May Expect to See in 1926.

It is believed that the coming apparition, like that of 1924, will prove to be an unusually interesting one, but not for the same reasons. It is thought that those who expect to see many conspicuous canals, because of the proximity and northern declination of the planet, will be disappointed. It is believed that during November, December, and January, when the planet will be near us, and can be conveniently observed, comparatively few canals will be seen. Probably the largest number will be recorded in September and October, in the late evening and early morning hours.

Twice in every Martian year the water from the melting polar cap crosses the planet from pole to pole. Heretofore when this has occurred, and the planet's atmosphere has been filled with clouds and mist, the planetary astronomers have always been taken by surprise, and some have even attempted to explain the appearance as due to clouds of dust. The transit from north to south occurs when the planet is near its extreme southern declination. Knowing that for this reason few northern astronomers would be able to secure satisfactory observations, I particularly requested observations of a few hours duration from those located to the south of Jamaica. As we have already seen in a former report no one responded. I secured observations of some of the changes visible in my longitude. A few of these have already been shown in the two sets of Jamaica drawings published in Report No. **29**. It is hoped to exhibit some of the others in a future report. The next opportunity to repeat these observations will occur in 1937.

However, the water crosses in the opposite direction, from south to north, when the planet is to the north of the equator, and this event will occur this year. We have plenty of northern observers interested in Mars, and it is therefore hoped that a considerable number of observations will be secured in different terrestrial longitudes. The phenomena observed will certainly be different from those recorded when the water is flowing in the opposite direction, and when 1937 arrives it is hoped that it will be possible to make a satisfactory comparison of the two results. In 1922 the Martian cloudy season was at its height in $\odot$ 150°, corresponding to the latter half of the Martian August. This period fell midway between two oppositions, and so was not seen to the best advantage at either of them. This year the most marked period is expected at about $\odot$ 325°, towards the end of our November, and corresponding to the latter half of the Martian January, five months later in their year, but owing to the eccentricity of the Martian orbit, later by 175°. This year it is believed that whatever changes may occur will be better seen than in 1922.

The southern snow cap is expected to disappear as snow about the middle of our August. It will then change its color, but remain as a small yellowish cloud until near the time of opposition, when a considerable accession to its size will occur. This will take the form of an extensive bank of cloud, at first following the two limbs of the planet, but changing its size, shape, and position angle conspicuously from night to night. Later it will cross the central meridian in lower latitudes, concealing much of the detail in the southern hemisphere. This moisture is precipitated from the extensive atmosphere of the planet by the advancing chill of the coming autumn. The southern summer solstice will have already passed nearly three terrestrial months before the clouds form, and on an oceanless planet the winter's cold cannot be long delayed. As the moisture begins to condense and deposit as snow near the northern pole, very shortly after opposition this year, strong winds from the south will arise, and begin carrying the balance of it across the equatorial regions, where it will dissolve and reappear in part as haze, prior to reappearing as clouds in the north.

In crossing the northern deserts from the maria, the moisture takes the form of broad meridional bands, first described and illustrated in Report No. **11**, and later in **12**, **13**, **15**, and **18**. The width of two of these bands illustrated in Report No. **11** exceeded 1000 miles, but usually they are narrower. They generally start from the region between the Furca and Aurorae connecting with Acidalium. The next most important region is between the Syrtis and Boreosyrtis. Finally for a brief period towards the end of the Martian March, after the northern cap had begun to melt, a short sharply curved band extended in 1915 from Cerberus to Propontis and Castorius. The direction of the curvature of this band, combined with the direction of the rotation of the planet, indicated that the moisture was then travelling southward, not northward. This conclusion is based on our belief that these bands are due to a darkening of the dry surface of the deserts by a precipitation of rain. The rain is believed to fall at night, and the curvature of the band in this case indicates the direction of motion of the clouds. These bands occur mainly in the northern hemisphere of the planet, and only during their late winter and early spring, when the northern cap is forming, and shortly after it has begun to melt, that is to say only when the atmosphere of this region is charged with moisture.

When this moisture again returns southerly, it does so from the same three dark areas or marshes,—Acidalium, Boreosyrtis, and Propontis, by way of the fairly permanent canals Acidalium-Nilokeras-Jamuna, Casius-Nilosyrtis, and Erebus-Hades-Cerberus. These three systems of canals are all concave towards the west, as they should be. The only prominent canals on the planet that may be said to be concave towards the east form the system Eunostos-Hyblaeus, and that is clearly merely a fainter continuation of the Erebus-Hades-Cerberus system further confirming the theory. The theoretical forms of these great canals are discussed in full in Report No. **19**, the discussion being based on Ferrel's theory of the winds. On account of the continental character of the whole surface of Mars, this theory applies much more satisfactorily to that planet than it does to the earth. The very shape of these canals proves that the moisture is carried through the atmosphere, and not across the surface of the ground in conduits or ditches. The only canals on Mars that are long, straight, and meridional, are very few and both faint and temporary, and apparently not at all adapted to compete with the free atmospheric circulation of the planet.

In the southern hemisphere when the moisture is travelling towards the pole, no such bands exist, unless we consider them to be represented by Hellespontus and Bosporus of Antoniadi's map. This is because the maria are in contact with the polar cap, and no deserts intervene. When the water returns northerly, however, in Martian October and November, we have a dark strongly marked canal, smoothly curved, and again concave as it should be towards the west. In 1924 this coincided approximately with Hellespontus. It is shown in Report No. **34**, Figures 1 to 4 and 21 to 24. The velocity of the wind in it, as computed from its curvature, came out 109 miles per hour, thus coinciding closely with the velocities computed for the majority of the similarly situated northern canals, in Report No. **19**.

In studying the meridional bands this year especial attention should be paid to determining if they are in any way associated with any visible clouds, and if they are wider in the morning or in the afternoon. Their changes may be rapid, and it is thought that any alterations in their shape or width may be advantageously confirmed by a comparison with the drawings of other observers in different terrestrial longitudes. Such drawings of distinctly marked features, even if made with only comparatively small apertures, may therefore be very useful. These bands are most noticeable in Martian February, March, and early April. Consequently we should not expect to see them this year before the end of our November, and they will become more conspicuous in December and January.

At the northern pole, following the northern summer solstice, the clouds condense as separate masses like our cyclonic storms, as recorded and illustrated in Report No. **23**, but in the south, following the southern summer solstice, they seem to be larger and more nearly continuous. It is clear that these clouds, which will soon after form all over the surface of the planet, may distort and for a time almost completely obscure the characteristic surface features. The study of their motions should be a matter of especial interest to those astronomers who are meteorologically inclined, but of even more interest to the average planetary astronomer will be the changes actually and conspicuously produced in the characteristic general features of the planet. The clouds themselves will not differ greatly in color from the deserts, and it is quite possible that the distinction between them and the deserts will be studied to the best advantage by means of photography, on slow plates sensitive to blue light. Something may perhaps be done visually by using very light blue glass. In 1925 a general haze overspread the planet at ☉ 309°.0, M. D. January 20, corresponding this year to terrestrial October 28. It did not clear away until after we had ceased to observe, and it caused all the darker maria to appear comparatively faint. Apparent surface changes, which will not in fact be real, will be produced by clouds overspreading the darker markings on the planet and thus reducing their dimensions in certain directions. On the other hand, a temporary increase in the usual dimensions of the darker areas, such as the production of a dark band or of a broad darkened area, can only be due to a real surface change.

A spectroscopic study of the Martian atmosphere was made in 1924 at a time when it contained the minimum amount of moisture, as is shown in Report No. **31**. A study of it throughout this apparition when it will contain the maximum amount should also be of interest. A letter has recently been received from Professor Very regarding the amount of oxygen in the atmosphere of Mars. It will be remembered that the Mount Wilson observers found that there was about 15 percent as much as there is in the atmosphere of the earth. Professor Very refers to his own measures, and to the *Astr. Nach.* 4762, October, 1914, and says, "You may say that Martian oxygen cannot be less than 33 percent, nor more than 50 percent of ours." If his results are correct, it would seem to be entirely possible, as indicated in Report No. **31**, that animals constituted much like ourselves could breathe on Mars. It is certainly satisfactory that two entirely independent investigations of this very interesting matter should lead to similar results.

It is a curious fact that among all the more prominent canals on Mars, none happen to be laid out either in rectangles or rhombuses. Hexagons also are unknown, but regular pentagons have appeared for brief intervals in different places at each of the three nearer approaches of the planet since 1892, when the first one was recorded in latitude 20° N, longitude 125°, with the Harvard refractor at Arequipa. In a note published in the *Scientific American* for January, 1926, attention is called to this marking, and also to the much more complicated five-pointed star recorded by Trumpler in 1924, and shown, unfortunately very faintly, in his drawing in Report No. **34**, Figure 4. It is shown much more clearly in the *Pub. Astr. Soc. Pac.,* 1924, **36**, 266, Figure 6, and also appears on the map accompanying this report. It lies to the north of Sabaeus, and the canals Typhonius, Orontes, Phison, Euphrates, Hiddekel, and Protonilus are some of the important ones composing it. Attention was also called, as a curiosity, to a very faint rhombus seen by M. Jarry-Desloges in 1909, but apparently pentagons were omitted that year.

If there was one there, it certainly was not discovered, but a letter has just been received from Professor Douglass, in which he says, "Your geometric designs from the *Scientific American* incite me to send you a tracing of a view in 1907 which literally startled me. I have not seen anything like it since. I thought at the time it looked more like 'intention' than anything I had ever seen." It was drawn with the 16-inch refractor on Mt. Lowe, California, July 22, and also on July 25. Its center appears to have been located in nearly the same longitude as that of the pentagon in 1892, but about 20° farther south, near the equator. The diameter of the star (Figure 1, Plate XVII) is about 1100 miles. These figures are too delicate to be seen except under the most favorable atmospheric conditions, and with excellent instrumental equipment. Judging by the past we should not expect another one before 1939, but since the planet will be so near us this year, it may be well to keep the matter in mind, and should a pentagon or a five-pointed star appear near the center of the disk, to locate it as accurately as possible, and draw it most carefully.

Description of the Figures.

In Plates XVII and XVIII we have shown the character of the changes that it is believed will be observed this year. Under each figure after the first, is given the date on which the drawing was made, followed by the longitude ω of its central meridian. Below that is given the solar longitude $\odot$, and the corresponding Martian date. All the drawings with approximately the same central meridian have been placed in the same horizontal line, but as the number of these drawings varies from 2 to 6, it has not been found possible to arrange them in the consecutive order of these approximate longitudes. In order to partially remedy this difficulty, as well as to give more complete information with regard to the drawings, Table III has been prepared. The first column gives the number of the figure, the second the approximate longitude of the central meridian of the series of figures illustrating the change described. The third gives the terrestrial dates in 1926 when Mars will reach the solar longitude given under each figure of the set. The fourth gives the latitude of the center of the disc of the planet, the fifth its diameter, and the sixth the quality of the seeing.

When the planet presents approximately the central longitude indicated in the second column, we shall expect to find that it will exhibit the appearance of the figure corresponding to the nearest date given in the Table. We say "shall expect to find" because we have already pointed out in Report No. **34**, and elsewhere, that the climate of Mars is in a sense far more uncertain than our own, even after allowing for its longer year. Thus the date when an expected phenomenon may occur, such as the melting of the snow cap, or the annual change in some conspicuous feature, may occur in some years many weeks later than it does in others. It is hopeless therefore to expect to give precise dates for these events in advance. Some of the changes shown in these figures are due simply to clouds, and obviously these are not likely to be exactly repeated. The general character of the changes however, at about the time of these terrestrial dates, should be those indicated, and it is very certain that while these changes are transpiring, there will be no display of canals and lakes such as was seen in 1924. In November after the opposition, Mars will have reached a portion of its orbit in which we were able to observe it to advantage in 1913. We have therefore included some of our drawings made in that year for comparison with those made at a similar season in 1924 and 1925. The diameter of the planet in this latter year was small, ranging in these drawings from 8″.0 to 6″.5, but it is believed that all the details that we were able to draw were really there. The disk will be much larger this year at that season.

TABLE III.

Description of the Figures.

Fig.	C.M.	1926	Lat.	D.	S.
1	110		Douglass		
2	270	June 23	—17	23″.7	10
3	270	Sept. 7	—20	16.3	10
4	270	Nov. 15	—15	8.5	7
5	270	Dec. 21	—22	6.5	7
6	270	Dec. 1	+ 5	8.4	9
7	60	July 11	—16	25.1	10, 12
8	60	Aug. 20	—18	19.6	9
9	60	Sept. 27	—22	13.2	7
10	60	Oct. 30	—25	9.7	6, 7
11	60	Dec. 8	—24	7.1	8, 7
12	60	Nov. 18	+ 3	7.8	—
13	30	Aug. 24	—18	18.8	10
14	30	Nov. 1	—25	9.5	6, 7
15	30	Dec. 12	—23	6.9	9
16	30	Nov. 18	+ 3	7″.8	8
17	120	Aug. 11	—17	21.4	10, 11
18	120	Sept. 17	—21	14.6	8
19	300	Aug. 31	—19	17.5	11
20	300	Nov. 11	—25	8.7	7
21	0	Sept. 29	—23	12.9	8
22	0	Nov. 9	—25	8.9	8
23	0	Dec. 12	—23	6.9	9, 8
24	0	Dec. 31	+ 9	10.3	9
25	150	Oct. 24	—25	10.2	7, 6
26	150	Nov. 27	—24	7.7	6, 7
27	150	Dec. 13	+ 7	9.1	9
28	330	Dec. 4	—19	17.5	10, 9
29	330	Nov. 7	—25	9.0	8
30	330	Dec. 16	—23	6.7	10

Turning now to the drawings themselves, Figure 2 represents the normal general detail of the planet in approximate longitude 270°, and was drawn on August 4, 1924, when it was well seen. Its most interesting peculiarity is that it shows a slight darkening of the region of Libya just preceding it. This region is usually as bright as any of the deserts, but in 1922 it and Aethiopis gradually darkened, and by ⊙ 190°.1, M. D. September 53, were as dark as some of the maria. A general darkening was therefore predicted for this region, as far as Elysium for 1924, at some time between June and October (Report No. **27**). Neither in May, June, nor July was any darkening worth mentioning detected here, but in August, as we see, a slight darkening occurred in Libya at ⊙ 230°.7. In September the darkening persisted, but in October, as shown in Figure 3, Libya had again faded out, but Aethiopis was now very dark, and formed a large dark bay projecting towards the north from Cimmerium. This is really an extension of what was named by Schiaparelli Syrtis minor. It was now more prominent than the Syrtis itself, and appeared to be associated with a conspicuous dark area lying between the two, whose beginnings are shown in Figure 2. The diameter of the planet when this figure was drawn was still 16″.3, so that the other changes which the reader will note for himself, such as the development of the very dark southward pointing canal, are without doubt genuine, and not due merely to the increased distance of the planet.

On account of unfavorable weather no drawings of this region were secured in November, but fortunately it was clear in Japan when this longitude became visible there, and both Messrs. Schofield and Nakamura show on their drawings a very marked darkening of Libya, although that of Aethiopis appears to be less pronounced. Schofield in a letter calls especial attention to it. Figure 4 was made in the following December. The planet's diameter was now reduced to 8″.5, which while it may account for the loss of some of the detail, cannot possibly account for the loss of the Syrtis, which was evidently concealed by a cloud. Syrtis minor is still visible, although shortened, together with a wide meridional band extending southerly from it. Figure 5 is the last drawing that we made before the telescope was taken down and returned to Harvard. The planet's diameter was still as great as 6″.5, and it will be noticed that the Syrtis has reappeared. A large dark region has developed just south of the maria, somewhat resembling that shown in Figure 2, but rather more prominent. Dr. Ellison fortunately was able to observe the planet three weeks later than we, and in commenting on the faintness of the markings, following the disappearance of the snow, remarks that on the last day that he saw it, February 21, although the definition was fairly good, yet the Syrtis and Hellespontus "were just barely visible." The diameter was 5″.8. Although Figure 6 comes between Figures 4 and 5 in the planet's year, as shown by its value of ⊙ 328°.2, it has been placed last, because it was drawn at a different apparition—that of 1913-14. It will be seen at once that it resembles Figure 2 more than either of the others does because Syrtis minor did not develop prominently in 1913, and the region immediately south of Amenthes-Thoth was not so dark.

This exemplifies our earlier statement that we cannot tell beforehand precisely how Mars will appear at any apparition when the moisture is shifting rapidly from one pole to the other. Consequently drawings that will be made in all terrestrial longitudes in 1926, even if secured with telescopes of rather small aperture will be of value, and need not necessarily confirm one another in all respects. Since Libya and Aethiopis lie along the equator the seasons need not affect them greatly, but the darkening of their soil can, as we see it, be due to only one of two causes, either to vegetation, or to the precipitation of moisture in the form of rain. Since they are never green like the maria, and the darkening occurs at such irregular intervals, having been very dark in 1922 at M. D. September 53, while in 1924 no darkening was detected before M. D. November 6, nine weeks later, and then it was only slight, it seems very unlikely that it could have been due to vegetation. Libya faded out by M. D. December 25, but darkened again as seen in Japan on December 39. Whether this temporary lightening was due to a drying of the soil, or to a covering by cloud, we may perhaps determine this year. At all events weather conditions on Mars are likely to be unusually instructive at the coming apparition.

Figures 7 to 12 all have the same central meridian, approximately 60°. In the first the dark area reaches to the southern pole, and Aurorae at the center shows only the faintest markings to the north of it. In Figure 8 notable changes have occurred. In Figure 9 the canals Ganges and Nilokeras have materially developed, Margaritifer has widened, while the southern maria are fading out in spots. In Figure 10 this fading is confirmed, and Nilokeras has disappeared. The eastern end of Thaumasia has darkened. In Figure 11 clouds have developed further in the southern hemisphere, and Thaumasia has completely disappeared. These figures illustrate what was meant when we referred earlier to this longitude as one in which notable surface changes occurred. In Figure 12, drawn in 1913, and lying in ⊙ between Figures 10 and 11, Ganges has acquired a very considerable width, and has now taken on the characteristic form of a meridional band.

Figure 13 shows the customary appearance of the planet in longitude 30°. In Figure 14 a projection from Furca and Margaritifer combined extends northerly. The triangular projection from Aurorae shown near the center of Figure 10 can be detected on the right, while a pronounced canal appearing as a broadened area in Figure 13 leads towards it from the southern cloud cap. This canal and another one are shown in Figure 15, the projection from Furca has largely faded out, while that from Aurorae appears to have moved eastward. In Figure 16, drawn in 1913, the meridional canal from Aurorae, is shown to somewhat better advantage. It lies in a different direction, and has widened towards the north. Figure 17, in approximate longitude 120°, shows the Thaumasia region differing but little in appearance from our sketches of the previous month. In Figure 18 however, drawn only five weeks later, we see plainly the effect of the advancing moisture in the very marked widening of all the canals.

In Figures 19 and 20, both drawn near longitude 300°, the most striking changes consist in the elimination of all the southern detail by dense cloud masses, the apparent broadening of the Syrtis caused by the darkening of the two deep notches on either side of it, and finally the light cloud which has formed partially concealing it. The next night after Figure 20 was drawn, this cloud had moved northerly, and the tip of the Syrtis was completely hidden, as we see was the case in Figure 4, drawn four nights later. Figure 21 near longitude 0°, drawn on November 10, shows the characteristic appearance of this region, and may be compared with Figure 13 drawn a month earlier, but we should hardly recognize it in our drawing of December 21, Figure 22. The prominent canal in the south has also shifted. In these two figures both the latitude and the longitude of the center of the disk are practically identical. The mare has now completely enveloped the Furca, while Margaritifer has disappeared. A nameless, strongly marked canal, extending northwesterly from the Furca has developed, also a large pronounced lake on the canal extending from the southern polar regions to the eastern end of Sabaeus. Figure 23, drawn a month later, shows much the same markings as Figure 22, save that the lake has disappeared. Figure 24 on the other hand, drawn in 1913, shows the Furca clearly marked, much as in Figure 21, and very dark, with a dark northern mare also conspicuous, and the two joined by an unusually broad meridional band, resembling a terrestrial shower of rain seen in perspective. This last drawing was made three weeks later than its predecessor in the Martian year, and it is possible that the region was then in the process of recovering its usual appearance after the worst of the rainy season was over.

In the next set of figures No. 25 shows a characteristic view of Sirenum, with Thaumasia on the left. Solis does not show, perhaps being concealed by limb clouds. A month later, in Figure 26, we should not recognize the region, although the latitude and longitude of the center are the same. In 1913 still later in the season, Figure 27, only the bay of the Sirens can be certainly identified. The two dark regions to the north are apparently Lunae near the terminator, and Propontis near the limb. The change in the latitude of the center (see Table III), produces a marked effect in this Figure. In our final set, Figure 28 is a drawing made on Ocotber 12 of a very characteristic appearance of longitude 330°, as seen during the apparition of 1924. Figure 29 shows this same longitude two months later in December. The great canal connecting the polar regions with Sabaeus has shifted to the right, that is towards the west, in the latter figure, as we saw that it had done in Figure 22, and the large dark marking on it is clearly the prominent lake shown there, and also in Figure 14. The canal towards the limb preceding it is correctly placed according to Figure 28, and Sabaeus also shows, although without detail, but the Syrtis is completely concealed by cloud. It is difficult to realize that the two drawings are of the same objects. In our last figure, drawn six weeks later than Figure 29, the Syrtis has again appeared, although faintly, and the resemblance to Figure 28 is restored, excepting that the Syrtis is broader, and the great canal above mentioned has continued to travel westerly, as indicated by the position of the planet's central meridian.

In this Report we have endeavored to show how the main canals develop and shift, and how the water is transported semi-annually through the planet's atmosphere from pole to pole. In other words to give the explanation of why these canals exist on what we should consider to be a desert planet. They appear to be strictly natural objects, due to atmospheric causes, following and exemplifying Ferrel's theory of the winds. It is believed that they would be seen on Mars even if no life existed there whatever. That they depend on the semi-annual transfer of water from pole to pole is obvious. That the Martian vegetation also depends on this transfer is certain, and it is pretty clear that these great canals indicate the routes by which the water, carried through the atmosphere, reaches the more important areas of vegetation. That