MONTHLY REPORT ON MARS.—No. 5.

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ARISTILLUS.

The atmospheric conditions in Jamaica were unfavorable during the months of February and March, owing to the successive storms and cold waves in the north, producing so-called "northers" here. These consist of cold winds which bring bad seeing. Nevertheless, at least one interesting observation was made. On the nights of February 18 and 24 the "double canal effect" was seen faintly in the canals Thoth and Nepenthes. The reader will note that the writer does not claim that these canals were really double, merely that this much-discussed appearance was visible.

The effect has been seen at one time or another by practically everyone who has studied the planet at length, under favorable atmospheric conditions. It may therefore be conceded to exist at certain times. The question which has been at issue from the first, however, is not as to the appearance itself, but rather as to the explanation of it.

Before discussing the matter at length we will first recall some of the facts hitherto published regarding it. Schiaparelli claimed that the effect was at its maximum three of our months before the summer solstice of the northern hemisphere of Mars, and again five months after it. These dates would correspond to longitudes $\odot = 50°$ and $\odot = 162°$, which it will be noticed are about one-third of a Martian year apart. The corresponding Martian dates are May 9 and August 31. The corresponding heliocentric longitudes are 138° and 250°. Consequently the planet is most favorably situated for observing the duplication at oppositions occurring near February 7 and June 1. The planet would be nearer us on the latter date.

Lowell claims, Bulletin No. 15, that only one-quarter of the canals are ever double, and that this quarter is double all the time. The canals are so indistinct at certain of the Martian seasons, however, that the duplication is invisible. It is particularly conspicuous at the seasons noted by Schiaparelli, when the canals are most clearly seen. Often one component of the double is more conspicuous than the other, therefore the canal may appear both single and double on successive evenings or on the same evening to two different observers.

This year longitude $\odot = 50°$ occurred on the terrestrial date of March 20. The planet was then rather remote, but the latter part of February was evidently a very good time to see the effect. The diameter of the planet on the two dates on which the duplication was recorded was 11″.0 and 10″.4. Especial care was taken to draw the breadth as accurately as possible on the second date, and it was found to be just one-twentieth of the diameter of the planet, 210 miles, 5°.7, or 0″.52. This was the extreme breadth, but assuming the breadth of each component equal to that of the space between them, this reduces to 140 miles, 3°.8, or 0″.34 from middle to middle. Lowell states that the breadth of the components is only one third of the intermediate space, which would make the distance between their middles 4.6° or 0″.42.

Thoth was a very conspicuous canal at the time the observations were made, one of the three most conspicuous upon the disk. My attention was drawn to it particularly because of a drawing sent to me by Professor Lowell, on which it was represented as double. In the above mentioned Bulletin he divides the double canals into two classes, those whose breadth exceed 5°.5, and those narrower. Only two specimens of the wider class were observed by him in 1903, and one of those he states was doubtful. These wide doubles he says are rare. It will be noticed that the canals observed here are but little narrower than this wider class.

Now as to the explanation. The canal may really have been double, since the observed separation is quite within the power of an 11-inch aperture. It was observed with magnifications both of 330 and 660 diameters, but the former was thought the better for the purpose, seeing 10 and 8. On the other hand, my impression recorded at the time was that the canal was not really double, but that the effect observed was due to contrast between the dark edges of the canal and the bright background on which it was situated, which made its interior appear less dark. It was far more difficult to detect than a double star of the same distance apart, because the contrast with the background was so much less, and also because the shape of the star calls one's attention to it at once.

In any case it was at practically the limit of steady vision, and anything narrower would have been seen only by glimpses, and would have appeared to me of very doubtful reality. Lowell gives the width of this same canal in his circular as 3°.0, and of some as only 2°.3, or but half as wide as our figure. Indeed he says "The doubles, like all delicate detail, appear not continuously, but by flashes of revelation according as the atmospheric waves permit of passage undisturbed." The planet was of about the same size when he observed it, but his aperture, which he varies, as usually employed is about half as large again as the writer's.

How then shall we decide whether the canal is really double, or only a contrast effect or something of that sort. Suppose that an observer should see what appeared to be two long narrow dark lines upon the moon, at a distance of 2″ apart, and should see them clearly at every lunation, he would say unhesitatingly, and perfectly properly, that the appearance was really due to two separate dark lines. Probably he would do the same if they were only 1″ apart. But how about one-half or one-quarter second? Professor Lowell says he is satisfied that they are really two distinct lines, but the writer is not quite so certain about it.

If one-quarter of the canals on Mars are really constructed as parallel pairs, it would at first seem almost certain that they must be artificial. But a little difficulty here arises. It so happens that we see the same thing upon the moon, and oddly enough, if they are real, at just about the same angular distance apart. Now we cannot believe that any structure visible upon the moon is artificial. That would seem to be really asking too much. But the lunar doubles are quite as easily seen as those on Mars, and the writer thinks that one or two of them are clearly more so. Moreover they have the great advantage that they are equally well seen every month of the year, and that lunar meteorological conditions never interfere with them.

The most conspicuous lunar double canal is connected with the crater Aristillus. Sunrise occurs on Aristillus at colongitude 1°, noon at 91°, and sunset at 181°. As soon as the shadow leaves the interior, at colongitude 27°, a dark crack is observed running along the northwestern edge of the floor. From a shaded region near this crack, and which later joins it, a broad dark stream apparently ascends the inner wall to another shaded region half way to the top. This region sends a narrower dark stream up to the crater rim. At colongitude 52° the outside of the crater, and the *mare* to the northwest of it begin to darken appreciably, much as in the case of Eratosthenes, Harvard Annals **53**, 75. By colongitude 66° part of the outer region is as dark as the stream itself, and by 103° surpasses it. It remains dark for a few days longer, but fades out and almost disappears before sunset.

In the meantime the double canal ascends the inner wall of the crater within the shaded region. The earliest drawing made of it is in colongitude 27°, and it lasts until some time after 35°. The space between the canals then fills up, and the canal itself appears single and very wide and dark, until towards colongitude 108°, or a little after full moon. It then appears double a second time until colongitude 153°, after which it is again single, but gradually fades out, and is quite invisible before sunset. The duplication is seen to best advantage at the time of its two appearances. Near its origin on the floor it seems to be

very narrow. See Figure 1. It remains so until half-way up the wall, when it broadens slightly, but still remains a close double till it reaches the crater rim. From thence down to the outer plain the components diverge and are easily separated.

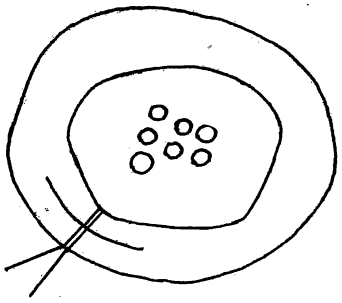

FIGURE 1.
DOUBLE CANAL IN THE LUNAR CRATER ARISTILLUS

On the inner crater wall the mean of four measures of the separation seeing 8 to 12, is 0.022 of the diameter of the crater. At mean distance the latter measures 28″, hence the mean width of the double is 0″.51. Similar doubles occur within Archimedes and Autolycus, the three doubles having nearly the same position angle. Another one occurs on the inner wall of Plato, also on the western side. One has been suspected in Werner, again on the western side, and other ones within several other craters. The doubles seem generally to be associated, as in the case of Aristillus, with areas which darken at noon and fade out before sunset. Single canals of the same general character are of much more frequent occurance, notably in the small brilliant snow craterlets of the type of Mösting A.

Of the various lunar doubles which the writer has recorded, Aristillus is the only one where the canal is continued on the outside by a diverging pair. It also appears to be slightly the widest, though there is not much choice between several of them. It seems therefore to be the best one to study. Since there are clearly two canals on the outside of the crater, the writer is inclined to believe that the double appearance on the inside also represents a real pair. To corroborate this view he has written to several of his correspondents who have adequate facilities for the study of the phenomenon, and hopes to receive answers from some of them in time to appear in his next Monthly Report.

In case their judgment agrees with his, it would seem likely that the close doubles detected in the other craters are also real. But if double canals form upon the moon, leading to regions which later darken as the sun rises higher upon them, and if the same appearance is visible

upon Mars, then it would seem likely that both cases are due to the same cause, and if one canal is really double, the other probably is so also. The lunar doubles like the Martian counterparts appear absolutely straight, uniform, and parallel, but since both are so near the limit of visibility, the writer does not feel that there is any satisfactory evidence that they are not so in fact, although there is of course no evidence that they are not.

We must note that there are three quite distinct questions connected with the double canal phenomena, which should not be confused. They are: (*a*) Do the canals sometimes appear double? (*b*) Are they really double? (*c*) Are the Martian canals artificial? Our answer to the first question depends largely on how we define the phrase "appear double." If we mean do they appear as distinctly double as a double star whose components are at a distance of 1″, the answer is certainly no. If we mean do they appear as clearly double as a star whose components are at a distance of one quarter of a second, that is a different question, and the writer would answer yes. The double effect has been seen by Schiaparelli, Perrotin, Lowell, Jarry Desloges, Douglass, Antoniadi, and a number of others. Allowing a reasonable latitude to our definition of the phrase, we may therefore answer the first question unhesitatingly in the affirmative.

As to the second question there is a difference of opinion, the first four observers replying in the affirmative, and the last two in the negative. If the writer had seen only Mars he would certainly have thrown in his lot with the last two but having seen and studied the lunar doubles, he rather favors the affirmative side, but will be glad to hear the views of some of his correspondents before expressing a definite opinion.

Unlike the first two questions, which can only be properly decided by the observers themselves, the third may be considered open to general discussion, where one man's opinion is as good as another's. If the canals should prove to be really double, and if they had been seen only on Mars, the writer would, with only a little hesitation, have declared them to be artificial. It is difficult to understand how such uniform structures could be created and maintained, without artificial aid and constant interference with the normal processes of nature. To find them on the Moon however, while it enables us to answer the second question more readily in the affirmative, makes the third much more difficult.

What we actually see on the Moon is a volcanic crack upon the crater floor, which may perhaps give out steam, and is connected by the canal with an outside area which in a few days darkens conspicuously, and fades just before sunset. Since the double canal is seen to best advant-

age about full moon, it cannot be merely a pair of straight cracks. The two canals are not over 1000 feet in breadth, and may not be over 500. They are about 2000 feet from middle to middle, and are parallel for nine miles, in which distance they ascend nearly 8000 feet over the rim of the crater. They then diverge, and descend some 3000 feet in three more miles. After that they travel eight miles more, on a nearly level plain before they are finally lost to sight. Their total length is therefore about 20 miles, the northern canal being practically straight all the way, and the other consisting of two straight sections. On the northern side of the crater there is a triangular area containing, and associated with, a number of short straight parallel dark lines, which are quite far enough apart to be seen distinctly. They are best observed soon after full moon.

An examination of the writer's photographic lunar Atlas, H. A. **51**, will show the regions of the two canals well developed at lunar noon, in plates 7C and 9C, while it has almost completely faded out towards sunset in plates 7E and 9E. The canals themselves are of course too delicate to show in the photograph.

Turning now to other matters. In our last Report it was shown that on two occasions at least, shortly after the vernal equinox of each hemisphere, a sharply bounded dark blue region suddenly developed at the northern extremity of the Syrtis major, and was connected, temporarily in each case, with the melting polar cap, by two canals. It appeared that it would be of interest to determine if there was any evidence that similar phenomena had occurred at other oppositions, at the same season of the Martian year. The available Martian literature at the writer's disposal was ransacked with the following results:—

1890. A record book of unpublished observations, made in Cambridge, showed that on August 8 a sharply defined dark blue area had developed in the Syrtis major. This had not been detected two days earlier, although seen under very favorable conditions. No canals were recorded. Interval after the vernal equinox 1.1 terrestrial months.

1892. The observations made this year are described in the last report. A sharply bounded dark blue area was formed about July 15 connected with the southern polar cap by two canals. Interval after the vernal equinox 1.8 months.

1894. The planet was not well situated to observe the phenomenon this year. If the marsh in the Syrtis was flooded, it probably occurred shortly before the telescope at Flagstaff was erected.

1896. Three drawings in the Annals Lowell Obs. **2**, Plates 21, 19, and 32 made February 19, 21, and 23, 1897 show the dark area sharply bounded, and connected with the north polar regions by two well marked canals. No statement is made regarding the color. Interval

after the vernal equinox 1.8 months. In the Memoirs B.A.A. **6**, Part 3, 91 it is stated that Molesworth describing this area says "that the northern end [of the Syrtis] was seen broadened out into an exceedingly dark diamond-shaped spot." He gives its color as a "distinct greenish blue tinge." Unfortunately the date of these two observations is not given.

1899. Annals Lowell Observatory **3** App. 22, 18, Two drawings made January 4 and 5 show the dark area sharply bounded and connected by only one canal with the north polar cap. No statement is made as to its color. Interval 2.0 months after vernal equinox. Another drawing made September 17, 1898 also shows the dark area sharply bounded, but this seems to be unusual, except immediately after the equinoxes.

1901. Annals Lowell Observatory **3** App. 51, 50. Two drawings made November 13, 1900 and January 23, 1901, 1.7 months and again 4.0 months after the equinox, show the sharply defined dark are in the Syrtis connected in the northern polar cap by two canals, in much the same manner as it appeared this last January. No statement is made regarding the color.

1903, 1905. The planet was not well situated for observation immediately after the equinox at these two oppositions.

1907. In Memoirs B.A.A. **17** Part 3, 97 it is stated that the Syrtis was very dark July 7 and 8, and again July 27, or 1.1 and 1.8 months after the equinox, being of a much lighter tint before and after these dates. Only one canal is clearly shown connecting it with the south polar cap. No statement is made regarding its color.

1909. The planet was not well situated for observation.

1911. The writer possesses no report of this opposition.

1914. The dark region was sharply defined and of a blue color on January 17, 1.0 months after the equinox. It was connected with the northern polar cap by two canals, as shown in our last Report.

While the reports of the observations made at these various oppositions do not generally give sufficient data to enable us to determine definitely whether the marsh in the Syrtis was temporarily flooded by the melting snow cap after each vernal equinox or not, yet in the seven cases which it has been possible to study, the evidence, based on the darkness and sharply defined character of the marsh, indicates that something of the sort occurred, and also that both the time required for the flooding, and the time during which the flooded condition existed were of comparatively short duration. At some oppositions it would seem probable that more than one flood occurred. Doubtless in several cases the main flood came at a time when it was not visible from either Europe or America, but only from the other side of the world. It is to

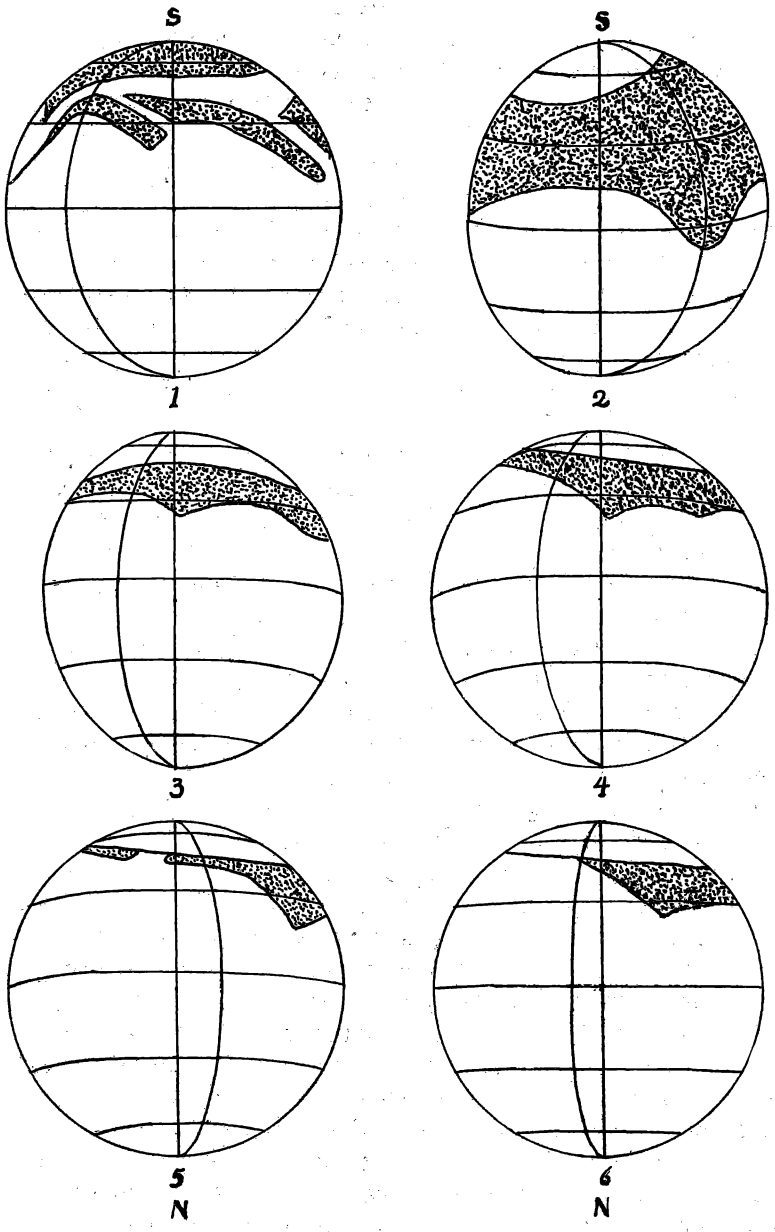

FIGURE 2.
SHOWING GRADUAL CHANGE IN LATITUDE AND LONGITUDE OF CERTAIN MARKINGS UPON MARS.

be hoped that this necessarily somewhat inadequate investigation will lead others who may have access to the original observations, to study them with the idea of throwing more light on this interesting question of a regular semi-annual flood, transmitted across the planet's surface from its melting snow areas.

Another matter brought up in our last Report has been investigated at more length since its original publication. This pertains to the gradual change in latitude of the northern boundary of the southern *maria* with the advance of the season. In the six drawings constituting Figure 2, the meridian of 140° is shown in each case as the arc of an ellipse, and the central meridian as a straight line. The equator and the parallels of 30° and 60° north and south latitude are also represented. The first drawing is taken from Schiaparelli's map in two hemispheres published in connection with our first Monthly Report. The other five are from drawings made at this station on the nights of August 6, October 12, December 19, December 25, and February 1.

The intersection of the boundary of the *maria* with the meridian of 140° on Schiaparelli's chart lies in latitude −35°. On the other figures it is successively +9°, −33°, −40°, −42° and −48°. In Lau's chart, *A.N.* 4706, it is placed in latitude −40°. On March 13 the planet was examined with the central meridian at 118° and the seeing 8, but no trace of any southern *maria* could be seen. It would seem that at that time the intersection must have advanced at least as far south as to latitude −60°. Clearly any future maps of Mars should be accompanied with the Martian date of the determination of each primary station.

It would appear that in the autumn the vegetation begins to die or turn yellow near the equator, and as winter approaches it retreats nearer and nearer to the pole,—the exact reverse of what occurs upon our earth. In Bulletin No. 12 of the Lowell Observatory it is shown that for the canals in the spring time vegetation advances from the pole to the equator, also the reverse of what happens upon the Earth. The high latitudes of Mars would therefore seem to support vegetation for a longer time than those near the equator, which also seems strange to us. On the other hand the northern polar marshes with the advance of spring retreat towards the pole, following the snow cap. The dark band surrounding the northern snow cap appears at about the end of February (Martian date), advances rapidly towards the equator for a terrestrial month, retreats as rapidly, and then in the form of a narrow dark line, save where interrupted by the marshes, retreats with the snow line.

But another curious feature is brought out by the drawings that we have not previously mentioned. Schiaparelli places Sinus Titanum

in longitude 170°, or 30° following the meridian we have represented in our drawings. In this Lau agrees with him. In the first drawing made at this station it is drawn in longitude 143°, and naturally the face of the planet was unrecognizable at the time. In the next drawing its longitude is 162°, the next 164°, then 170° and 175°. If Titanum shifts along through 30° of longitude, or even half as much, we can readily admit a deviation of 7° between Schiaparelli and Lau for the distance between Sabaeus and Margaritifer, as shown in our Report No. 3.

We must now discuss very briefly a few of the observations made here during the past few weeks. The northern snow cap has not diminished notably in size during that time. The dark line bounding it on the south has become extremely narrow. The southern cloud cap has fluctuated in size conspicuously, but has only occasionally been entirely absent. Little sunlight reaches the polar regions apparently during the few months preceding their long winter. No evidence of snow was seen near the south pole. But little cloud was visible elsewhere. The southern *maria* are still green, but are retreating southerly.

Although traces of blue are still to be seen in some of the four great polar marshes, yet they are now so remote, that no satisfactory evidence of polarization has been detected in the light reflected from their surfaces. This polarization has only been seen in the past for a few days at a time, and it probably requires a fairly arge liquid surface for its detection. The theory of the phenomenon is that light coming from the Martian sky or clouds is reflected from the surface of the water and polarized. One ray coming through a double-image prism therefore shows the bottom of the Martian pool, while the other shows the sky reflected in its surface. One image therefore appears brighter than the other. In the case of a bucket of water the difference between two rays leaving its surface at an angle of 70° is readily recognized, and at lower angles the difference is very striking. The sensitiveness is greatly increased by combining a plate of quartz with the double image prism in the usual manner.

Nilosyrtis nearly disappeared February 24, but since it was again visible at the next presentation, at the end of March, it seems likely that the effect was produced at least in part by Martian clouds. A new canal, possibly Phison was detected, originating from near the junction of Thoth and Nilosyrtis, but it did not reach the equator, and ended in the desert, unless indeed it bent around following the course of Typhon. But this is uncertain. The northern twin bays were invisible March 11. Central meridian 151°. Seeing 6. They were not seen at all at this presentation. Lunae lacus was observed for the first time March 15, and the two canals Hydraotes and Nilokeras. The last two were indistinct and some 600 miles in breadth.

The following lakes and canals were recorded:—

Feb. 16. **6** Nilosyrtis.

Feb. 18. **5** Nilosyrtis, Thoth, Phison.

Feb. 24. **4, 5** Nilosyrtis, Nepenthes, Thoth, Cerberus.

Feb. 25. **4** Thoth, Cerberus, Hephaestus, Cyclops, Eunostos Hyblaeus, Styx, Aesacus.

Mar. 15. **2** Lunae lacus, Nilokeras, Hydraotes.

TABLE OF DATA.

No.	1914	⊙	M.D.	Long.	Lat.	Sun	Diam.	Seeing
		°		°			″	
55	Feb. 15	35.9	Apr. 25	318	+1	+14	11.3	6,4
56	16	36.4	"	319	"	"		10
57	18	37.3	26	295	"	"	11.0	10
58	24	40.0	29	235	+2	+15	10.3	6
59	"	"	"	281	"	"	"	8
60	25	40.4	"	224	"	"	"	6
61	Mar. 13	47.4	May 7	118	+4	+17	8.8	8
62	15	48.3	8	75	"	+18	8.7	6

THE HUNTER.

Afar on Night's stupendous glitt'ring plains
Gleams great Orion, mighty in the chase.
With mace aloft he toward his quarry strains
And flaunts his lion's pelt in Taurus' face.

On one foot poised, with one on Rigel laid,
The eager hunter presses his advance.
His jeweled belt and shining falchion's blade
His hundred other stellar gems enhance.

Bright Bellatrix he makes his shoulder tache,
And opposite wears ruddy Betelgeuse;
O'er all his stalwart figure jewels flash,
Each royal in the splendor of its hues.

But lo! he hastes adown the distant west
To seek his prey in fields beyond our ken;
Yet all intent on his persistent quest,
When summer dies he'll mount our skies again.

ARIES.

Chicago Tribune, April 20, 1914.