MONTHLY REPORT ON MARS.—No. 3.

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During the past month the meteorological phenomena exhibited by the planet have been less striking than heretofore. It therefore seems a suitable occasion to review what has been already observed, before proceeding to the study of the advance of vegetation, which will next occupy our attention. In our last report it was noted that we had opened correspondence with a number of observers scattered in different longitudes around the world, not only to secure information about surface details which had passed beyond our range of observation, but also for the mutual confirmation of observations and measurements. For this latter purpose we are now able to present some results kindly furnished by one of our nearer correspondents, Professor Douglass.

In Table I are given the measurements of the latitude of the southern boundary of the northern polar cap on various dates, as measured at the Harvard Station in Jamaica, and at Tucson, Arizona. The measurments were all made from drawings, and when the phase was noticeable, the outline of the snow was prolonged beyond the terminator to the dark limb. When several drawings were made the mean is taken. This method is practicable in the case of the northern polar cap, because it is concentric with the Martian pole. The Harvard drawings were all made with an 11-inch aperture and a magnification of 660, those at Tucson with an aperture of eight inches, and a magnification of 220 to 340, according to the quality of the seeing. Occasionally a magnification of 420 was employed. The drawings at the latter station were all made by Professor Douglass, but were measured and computed by his assistant Mr. Getsinger.

From a general plot of the observations it has been concluded that the polar cap increased in size at an average rate of 1° every five days until October. It then increased at a diminishing rate until November 2, corresponding to the equivalent date of March 5 of the terrestrial year, and reaching a mean latitude at that time of perhaps 57°. It then receded according to the same law, and at the same rate. During the advance, and for a large part of the recession, until towards the end of December, the fluctuations in size were quite marked, the lowest latitude reached as shown by the table, being 42°. After that the snow storms ceased, and clear weather generally prevailed in the northern hemisphere during the day time.

TABLE I.

LATITUDE OF THE SNOW CAP.

JAMAICA.

1913-4	Lat.	1913-4	Lat.	1913-4	Lat.	1913-4	Lat.
	°		°		°		°
Aug. 14	72	Nov. 28	61	Dec. 15	67	Dec. 31	65
Sept. 2	65	" 30	56	16	68	Jan. 4	66
" 30	67	Dec. 1	58	17	67	5	67
Oct. 12	58	2	60	18	66	6	56
19	61	3	62	19	64	10	61
30	52	4	59	22	65	15	73
Nov. 1	42	8	55	23	66	17	70
7	59	10	58	25	60	18	70
17	60	12	62	29	69	20	70
26	67	13	64	30	62	21	68

TUCSON.

	°		°		°		°
Dec. 22	66	Dec. 28	64	Jan. 3	62	Jan. 9	66
23	64	29	63	4	62	11	68
24	63	30	61	5	63	12	67
25	64	31	62	6	68	13	68
26	66	Jan. 1	64	7	65	14	68
27	67	2	66	8	69	15	66

The early observations were made in the latter part of the night, when the planet was quite remote, and are rather few in number. Indeed this portion of the investigation could have been conducted to better advantage two years ago, at the preceding opposition, had we been located here at that time. After November 26 more frequent observations were made, and these are further enforced a month later

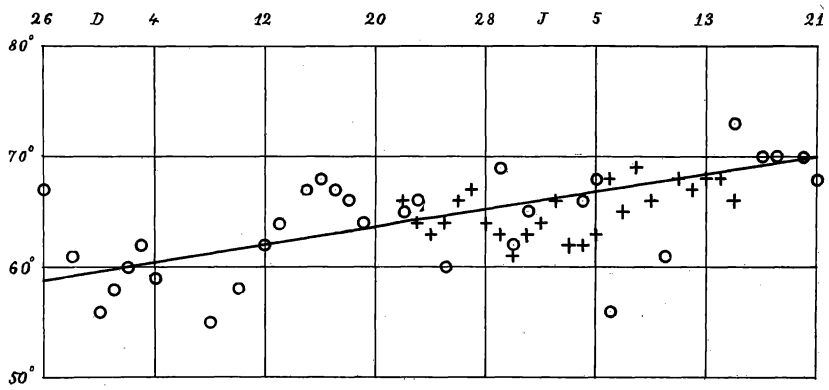

FIGURE 1, SHOWING THE VARIATION IN LATITUDE OF THE SOUTHERN BOUNDARY OF THE NORTHERN POLAR CAP OF MARS.

by those of Professor Douglass. These later observations are plotted in the curve Figure 1, those made in Jamaica as circles, and those at Tucson as crosses. The writer suspects that the smoothness of the fluctuations in the early part of the curve is in part due to accident,

since measurements made from mere drawings should hardly yield as accurate a result as the curve would seem to imply. Greater accuracy than later might however be expected, since the snow cap was wider.

It is not thought that the great extension of the snow cap noted at Jamaica on January 6 is due entirely to error. The definition was fair seeing 8, and the snow cap well seen. At Tucson the magnification employed on that and the two preceding evenings was 220, so that the planet appeared but one-third the size that it did in Jamaica. Indeed in the case of five out of the seven chief deviations noted between Jamaica and Tucson, a magnification of only 220, was used at Tucson, while in most of the accordant observations a higher power was used.

With two independent observers it is possible to obtain some idea of accuracy and reliability of the results. It was found that upon ten nights, observations had been secured at both stations. These are recorded in Table II, in which J stands for the observations made at Jamaica, and T for those made at Tucson.

TABLE II.

COMPARISON OF RESULTS.

1913-4	J	T	J—T	1913-4	J	T	J—T
	°	°			°	°	
Dec. 22	65	66	—1	Dec. 31	65	63	+2
23	66	64	+2	Jan. 4	66	62	+4
25	60	64	—4	5	68	63	+5
29	69	63	+6	6	56	68	—12
30	62	61	+1	15	73	66	+7

It is found from the last column that the Jamaica observations place the snow line just 1°, or rather less than 40 miles, north of the position determined at Tucson. A difference in this direction would naturally be expected from the larger aperture and higher magnification employed in Jamaica. That the difference should be so small is very satisfactory. The average deviation of the two observers from their mean is 2°.2 or 85 miles. This amounts to 1/50 the diameter of the planet, or 0″.3, which again is satisfactory, and quite as close as could be expected from measures of drawings. While some of this deviation is undoubtedly due to the irregularity of the shape of the polar cap, and to the fact that the observations were not made when the same meridian was central, yet it is thought that this source of deviation is comparatively insignificant, and that the chief cause of the difference between the results, after the accidental errors made by the observers is eliminated, is uncertainty of the exact extent of the snow, due to haze and cloud in the Martian atmosphere, near the limb and terminator of the planet. This would of course also affect micrometer observations, and cannot be avoided.

The dark band surrounding the polar cap, and produced by the melting of the snow, reached its maximum breadth of 25° in latitude during the first half of November, immediately after the polar cap had reached its maximum extension. Unlike the polar cap, however, it was eccentric with regard to the pole, its maximum breadth lying between longitudes 45° and 135°. It there closely resembled the southern *maria*, but differed from them in having only a brief existence. Its color was recorded as grey, not green. The appearance is believed to be due to moist ground rather than to vegetation; indeed, if our interpretation of the phenomena presented during a large part of these observations is correct, Mars might properly be described as the marshy planet. At present all of the polar marshes, with the exception of the Acidalium, are becoming lighter colored and are apparently gradually drying up.

The southern pole of the planet was heavily clouded throughout December, the cap being less brilliant, but much larger, and consequently more conspicuous than that at the north. The northern polar cap was due to snow. The cloud sometimes reached beyond the equator on the sunrise limb, but was very variable in extent, differing in that respect markedly from the northern snow cap. Except in high latitudes the Martian sunsets were clear. The polar clouds cleared for a time early in January, but were again conspicuous after the middle of the month. Clouds often gather on the northern boundaries of the dark regions of the planet. This was noticed on December 18 and 19, where even as small an area as Cerberus had a cloud on its northern edge. These clouds are often in continuous connection with the sunrise limb, and are evidently formed at night. They usually disappear by the afternoon. Clouds also often follow the polar marshes, but do not precede them, except in the case of the twin bays mentioned in the last report in longitudes 160° and 185°. In this case a cloud formed between them three days after they first appeared, and immediately covered and partially obscured the following one. The Acidalium Mare was frequently followed by a cloud, which on December 31 even reached the central meridian. These clouds serve very well to illustrate the fact that, as in the case of the earth, a considerable amount of moisture is transported often in visible form through the planet's atmosphere. On the whole, except at the south pole, clouds were less frequent than during the formation of the northern polar cap, but they now seem to be increasing again.

The amount of moisture in the atmosphere of Mars depends merely on the amount of water on the planet, and on the temperature. It is quite independent of the pressure, and of the other constituents of the atmosphere, and if these are rather rare, the atmosphere of Mars may be relatively much more damp than that of the earth. The chief effect

of the lack of the other constituents would be to cause evaporation and precipitation to occur more rapidly, and to cause a greater range of temperature, which would still further accentuate this result. This probably accounts for the long spells of cloudy weather near the pole turned away from the sun, that is the south pole in the present instance.

As the moisture is being distilled from one pole over towards the other, where it is being condensed, this should cause a strong northerly component in the Martian winds, much stronger than we observe in our own planet, where a large part of our atmosphere is inert. As the north wind from the pole spreads southerly in all directions through the lower layers of the atmosphere, it falls behind the more rapidly moving surface of the planet as it gets farther south, which explains why the mists rising from the polar marshes are always found on the following side.

Turning now to the changes in the surface markings, one of the most curious and interesting was in the case of the twin bays above mentioned. When first discovered, on December 16, the following one lay nearly along the meridian, the southern point being a little in advance, to the west astronomically speaking, or to the east as we would say if it occurred upon the earth. The next day it lay more nearly in the meridian, and the next exactly so. December 19 it was crossed by a cloud, but the southern point was now clearly following the northern end, and from day to day the inclination gradually increased. When last well seen, January 21, the change in the position angle amounted to nearly 30°.

An interesting illustration occurred this past month of the mutability of even what are usually considered among the most permanent features of the planet. On November 28 a drawing was made with the central meridian in longitude 55°. The northern boundary of the southern *maria* extended across the disk in an almost straight east and west line. The region clearly visible probably extended from about 0° to 110° in longitude. Not a trace of the forked bay of Sabæus, of Auroræ sinus, or of Solis lacus was to be seen. Margaritifer sinus was indicated only by a slightly projecting nub. In our last Report we described the sudden formation of Sabæus and Margaritifer, but no trace of Solis lacus appeared, the whole region south of Tithonius being uniformly dark. Our next view of this region was on December 25 when Solis lacus was perfectly distinct. Exactly what had happened in the meantime is only known to those observers on the other side of the world, in Australia, Asia, and the related islands,—provided they were on the watch for changes of this character. It is to obtain and publish information of this sort, that our chain of correspondents around the world has been established, and it is to be hoped that some of them

will have succeeded in collecting information upon this particular point.

A sudden and very striking change occurred in Protei regio, just preceding Solis lacus, a region which, as its name implies, is given to sudden changes. On December 30 it was drawn of a nearly uniform grey tint, but it was recorded that there was a lighter region in its interior, which is represented as a faint hazy marking lying in an east and west direction. The seeing was recorded as 12, which is as perfect as an 11-inch telescope is capable of detecting. The next night the interior contained two large lakes 200 and 300 miles in diameter, although not quite circular in form, and four well marked canals! Seeing 10, which is perfect for a 5-inch objective. The most plausible explanation of this change is that the effect was produced by the clearing away of a belt of cloud. Indeed this region seems now to have clouded up again.

The general character of these changes is a fading out of portions of the uniform grey surface, and the leaving of other portions in the form of canals, lakes, etc. In other portions of the planet however we find the dark regions advancing into the desert, showing that the desert so-called is not a desert all the time. Thus in December when Sinus Titanum and Sinus Sabæus both developed so markedly, it was not due to a retreat of the general coast line, but to an advance northerly of these two bays. Sinus Titanum is not marked on Schiaparelli's map of 1888, although the name was given by him. It is the northern point of the Mare Sirenum, and is one of the most important and clearly marked points upon the planet.

The so-called coast line or, more strictly speaking, boundary between the desert and the fertile region to the south of it, does shift in latitude in a very marked manner at times, especially at the promontories, that is the portions where it reaches farthest south. This has been very marked this year in the region preceding Sirenum. At present the whole of Libya is darkened, so that the Syrtis minor, which name Schiaparelli later changed to Syrtis parva, and which he represents as extending northerly to latitude $-10°$, now apparently extends to latitude $+10°$, a difference of some 800 miles. This darkening of Libya was one of the first changes noticed on the planet, and some of us may remember the mild consternation and deprecation expressed in astronomical circles some twenty-five years ago, when it was announced from Nice, by Perrotin, that the whole of Libya, a region larger than France, had been flooded!

Several of the smaller lakes and canals have now begun to appear in the desert regions. On January 8 it is recorded "there is a small, faint, ill-defined shading at A." "A" proves to be a point coinciding with Lowell's Sirbonis lacus, and is situated to the north of Sabaeus. Two

nights later three canals were drawn through this point, but they were described as on the "limit of visibility" and "only suspected". January 12 all were clearer, and they are recorded as "probably all genuine". The seeing was 8. This was our last observation of them, and it will be interesting to see how clearly they have developed when we see them at the next presentation in February. Although Sabaeus itself is now well developed. the point of Aryn between its two bays has not yet appeared. It is expected to be visible this next month.

Few color changes have been noted during the past few weeks. The northern shaded regions continue to be colorless, save the marshes, which near the polar cap are usually blue, while the shaded region, in the southern hemisphere continue to be distinctly greenish. On November 30 Sabaeus was described as grey, on January 6 as a clear chocolate brown, which latter color was confirmed January 11. This color was first noted in Cerberus December 16. It was not seen on the 18th, but was strongly confirmed December 19 and 22. It was also noted in the preceding of the polar twin bays December 22, while the following one is described as bluish and fainter. In the identification of the canals observed, such as do not appear on Schiaparelli's map are taken from Lowell's work, mostly from his chart of the planet in 1896-7, published in the Annals of the Lowell Observatory **3**, 100. These names are followed by an (L). Sometimes the canal observed does not agree either with Schiaparelli's nearest canal nor with that of Lowell, but lies between the two. In such cases it has not seemed desirable to the writer to give it a new name, but to identify it with whichever canal it most closely coincided. Other things being equal the earlier name is preferred. The writer is not prepared to question the accuracy of the other observers, but for various reasons feels doubt if a number of the less important canals are really fixed markings. That is if, when they do appear, it is always in the same place. He is rather inclined to believe that some of them shift about laterally over the surface, a shift which may amount to several hundred miles. In other words sometimes one area of the desert develops vegetation, and sometimes the area next to it.

Owing to a combination of circumstances comparatively few canals were observed in November. On the 7th we recorded in section **4** Nilosyrtis, Thoth, Eunostos, Achelous (L), and Hyblaeus.

Dec. 3. **6** Indus was glimpsed, but it was very vague.

Dec. 4. **1** Solis lacus, Nectar, Agathodaemon.

Dec. 10. **5** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, Eunostos, Achelous.

Dec. 12. **5** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, Cerberus. Eunostos, Hyblaeus, Achelous.

Dec. 13. **4** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, Cerberus, Eunostos, Hyblaeus, Achelous, Pactolus, Styx.

Dec. 15. **4** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, Cerberus, Eunostos, Hyblaeus, Achelous, Pactolus, Styx.

Dec. 16. **4** Cerberus, Eunostos, Hyblaeus, Styx, Hades.

Dec. 17. **3** Cerberus, Eunostos, Hyblaeus, Styx, Hades, Achelous, Pactolus, Noes (L), Brontes (L), Trais (L), Teren (L).

Dec. 18. **3** Cerberus, Eunostos, Hyblaeus, Styx, Anian, Trais, Tartarus. The last two were very faint, and only showed following and north of their junction.

Dec. 19. **3** Cerberus, Hades, Erebus, Trais, Brontes. All were broad and excepting the first faint. Brontes did not extend north of Trais. The whole region between Erebus and Hades was slightly darkened.

Dec. 22. **3** Cerberus. Hades, Erebus. The breadth of the last was 600 miles, that of Hades 400, but they were clearly separated by a light region which persisted, but may have been cloud. The length of these two canals was 2000 and 1300 miles. It might be questioned whether we could properly call such broad markings canals, but a month later their breadth was reduced about one half, and doubtless later will be reduced still further, so there seems no other course to pursue.

Dec. 23. **3** Cerberus, Eunostos, Hyblaeus, Styx, Hades, Erebus, Brontes, Trais, Teren. Only a very short section of Erebus was visible, the rest of it probably being concealed by cloud.

Dec. 24. **2** Our first glimpse this year of Solis lacus, as a small rounded spot about 300 miles in diameter. It was probably seen through a break in the Martian clouds. Seeing 6.

Dec. 25. **2** Solis lacus now appears as a narrow band 200 miles wide, and nearly 1000 miles long. Agathedaemon, Daemon (L), Araxes, Acampsis (L), Ceraunius. Acheron.

Dec. 29. **3** Only Cerberus was visible, although the seeing was recorded as 7. Later Erebus came out when the seeing was reduced to 6. The planet seems to have been covered by general Martian cloud or haze. Even the wider markings were faint, although sharply defined.

Dec. 30. **2** Solis lacus, Tithonius lacus, Juventae Fons, and an unnamed lake at the southern end of the Ambrosia canal that might properly be called Ambrosia lacus. Agathodaemon, Daemon, Nectar, Ambrosia (L), Baetis (L), Glaucus (L), Acampsis (L) Araxes, and two unnamed canals. The canals connecting Ambrosia, Solis, and Tithonius lacus with the preceding *maria* were quite broad, nearly as broad as the lakes themselves, but by the following night they had appreciably narrowed. Seeing 12 and 10.

Dec. 31. **1** The lakes visible were Ambrosia, Solis, Tithonius, Juventae, Auri, Protei, and an unnamed one designated by Antoniadi in 1909

as (b). The canals were Agathodaemon, Daemon, Nectar, Caicus (L), Baetis, Garrhuenus (L), Erannoboas (L), Dargamanes (L), Glaucus, Eosphorus, Jamuna, Nilokeras, and a previously unnamed canal leading to Ambrosia from the Protei regio.

This is the first appearance this year of the smaller lakes and of the canals in the dark regions of the planet. It may be of interest to recall that the first announcement both of the finding of these lakes in number comparable to the canals, and of the first finding of the canals in the dark regions of the planet, was made in "Astronomy and Astrophysics" the precursor of POPULAR ASTRONOMY" in the year 1892. The interest of the latter discovery lay in the fact that it showed that these regions were not water as was at that time generally assumed.

Jan. 4. **6** Protonilus, Callirrhoe (L), Aurum (L). The first of these apparently ended in the desert, there being neither lake nor canal at its termination. This was formerly supposed to be an unknown condition, but it has occasionally been noted of late years. The appearance was very like the Margaritifer sinus.

Jan. 5. **1** Tithonius, Solis, and Ambrosia lacus, Agathodaemon, Nectar.

Jan. 6. **6** Protonilus.

Jan. 10. **6** Aenarium lacus (L). This lake was situated on Protonilus, with the canal stretching and ending beyond it. Orontes, Arsanias (L), Apis (L).

Jan. 11. **6** Aenarium and Sirbonis lacus. Protonilus, Orontes, Arsanias, Apis. None of these canals were over 100 miles in width and were quite a contrast in this respect to many of those previously recorded.

The three as above noted were extremely faint.

Jan. 12. **6** Aenarium lacus, Protonilus, Orontes, Arsanias, Apis.

Jan. 15. **5** Boreosyrtis, Nilosyrtis, Nepenthes, Thoth, all very conspicuous.

The greatest number of lakes and canals visible on any single sketch was on Dec. 31, where seven lakes and thirteen canals were recorded.

The following Table of data is arranged precisely like the one which appeared last month, the only headings needing explanation are: ☉ which is the longitude of the sun as seen from Mars, and measured from the Vernal equinox of the planet; M.D. which is the equivalent date of our terrestrial year or we might say simply the Martian date; and Sun which is the declination of the sun as observed from Mars.

TABLE OF DATA.

No.	1913-4.	⊙	M.D.	Long.	Lat.	Sun	Diam.	Seeing
		°		°	°	°	″	
36	Dec. 17	8.1	Mar. 28	185	+8	+3	14.5	10
37	18	8.6	"	177	"	"	14.6	8
38	19	9.0	29	162	"	+4	14.7	9
39	22	10.5	30	168	+7	"	14.8	9
40	23	11.0	31	172	"	"	14.9	10
41	25	11.9	Apr. 1	125	+6	+5	"	12
42	"	"	"	155	"	+6	15.0	8
43	30	14.3	3	78	"	"	"	12
44	"	"	"	101	"	"	"	12
45	31	14.7	"	64	+5	"	"	10
46	"	"	"	95	"	"	"	8
47	Jan. 4	16.6	5	5	"	+7	"	10
48	5	17.1	6	41	+4	"	"	12
49	6	17.6	"	351	"	"	"	8
50	10	19.4	8	342	"	+8	14.8	12
51	"	"	"	358	"	"	"	—
52	12	20.4	9	338	+3	"	14.7	8
53	15	21.8	11	281	"	"	14.4	6
54	"	"	"	301	"	"	"	5

Besides describing the writer's own observations of Mars, he proposes to make very brief notes of any publications relating to the planet that may come to his attention. As he is located far from any library, he would be glad to receive copies of any such publications as may be generally distributed.

The Astr. Nach. 4706 is devoted to a micrometric survey of the planet by Professor Lau. Comparing his results with those of Schiaparelli, he finds that the earlier determined longitudes require a positive correction of about 5°. In this he states he is corroborated by the results of Wislicenus, 1890, Astr. Nach. 3034, and Lowell 1894 M. N. **56**, 405. As an instance of a striking deviation, he finds that Schiaparelli makes the longitude of Aryn 4°.4 too great, and that of Margaritifer 2°.4 too small, thus giving a distance between them of 21°.3, while he makes the distance 28°.1. That so large an error could have been made by so careful an observer as Schiaparelli seems almost inconceivable.

It occurred to the writer therefore that it might be of interest to see what bearing his own drawings, made this year, would have on the question. While Aryn is not yet visible, the two bays between which it lies, as well as Margaritifer are well placed for measurement upon five of his drawings. The results are as follows: Nov. 30 28°.3, Dec. 2 26°.7, Dec. 3 26°.7, Jan. 6 20°.8, Jan. 10 19°.5. The result can hardly be called conclusive, but it looks as if both observers might be right. Measures of the writer's drawings made at Arequipa in 1892 agree with Schiaparelli. In latitude, Lau finds that Schiaparelli's results are all too far to the north, the difference in one case amounting to 6°. Here it seems very probable that merely a seasonal change is indicated.

The next number of the Astr.Nach., 4707, contains two telegrams from Lowell. One of January 9 states that the transit of the Martian zero meridian was twelve minutes ahead of the Ephemeris. This is corroborated by the writer's observations, which will appear elsewhere. The other of January 13 states that the Martian southern cap is beginning in stippled patches of hoarfrost between longitudes 30° and 60°. Our last observation of this region was made on January 5, when the polar region was recorded as yellow. A telegram of January 12 from Jarry-Desloges states that the "régions australes présentaient troubles importants", that Hellas is nearly invisible, and that the Moeris Nepenthes Nuba system is very large and dark. According to our observations Hellas does seem to be rather under a cloud at present, and this may be one of the "troubles" to which he refers. We wish he had been more explicit about the others. The Moeris Nepenthes region we found very dark in December, and it received a further sudden accession of darkness, if such a phrase is allowable, between January 15 and 17. Observations and drawings by others of this interesting region will be welcomed.

JANUARY NIGHTS.

Now beams the fairest tract of heaven's expanse,
As winter deepens skies more radiant glow,
The rainy Hyads lead the stellar dance
And mock the boreal rage of Aquilo.

Full overhead Capella's yellow star
Gleams near the Milky Way's elusive blurs,
Castor and Pollux too, and, southward far,
Shine Rigel white and ruddy Betelgeuse.

Not distant sparkles Procyon's topaz light,
Gleams red Aldebaran and the Pleiads seven,
And, ranking as the monarch of the night,
Glows blue-white Sirius, Kohinoor of heaven!

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