REPORT ON MARS, No. 17.

WILLIAM H. PICKERING.

The Work of the Associated Observers of Mars.

This organization was founded in 1913. Its object, besides general work on Mars, in part coöperative, is to obtain and publish a collection of the best drawings of the planet available, systematically arranged at each successive opposition, for the use of future astronomers. This is necessary, because the details of the surface are constantly changing, not only with its varying seasons, but also at the same season, from year to year. Well known markings constantly disappear, or shift their positions, while others previously unknown are at the same time making their appearance. By the study of these constant changes, it is hoped that future astronomers may be able to draw conclusions regarding the character of the life supported by the planet, and it is possible also that they may even gather information that will be of use to ourselves.

The scope of the Association is entirely international, and sets of drawings have been received this year from Europe, America, and the Pacific. The best six were selected, three being by European, and three by American observers. Anybody interested, and willing and able to make the drawings according to the specifications (Reports 8, 11, and 15), is invited to forward his work to the writer at the close of the coming opposition, and the best series received will be published.

The drawings here shown, like those of the previous opposition published in Report No. 8, are arranged in six horizontal rows. The upper row represents region **A** upon the planet, each drawing being made with meridian 0° as nearly central as practicable. The central meridians of the other regions are 60°, 120°, 180°, 240°, and 300°. Each vertical column represents the work of a single observer, and gives a complete view of the surface of the planet The previously adopted plan was to arrange these columns according to the longitude of the observers, the left hand drawings in general therefore preceding in date those that followed them. Since there are 36 drawings this year, involving six plates, it is not possible to present all six drawings of each region at a single view, as heretofore, and this plan has had therefore to be slightly modified. The observers have been divided into two groups, the first group of four employing the largest instruments, whose extreme range of aperture is nevertheless not very great, and the second group of two, the smaller ones.

PLATE XL

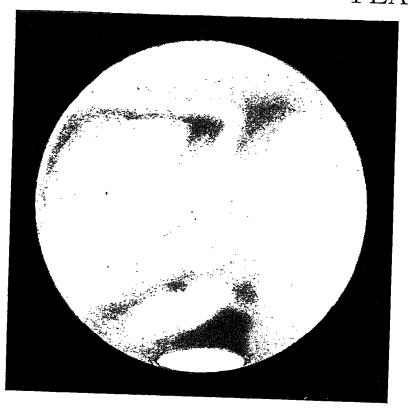

Fig. 1
Phillips
359° **A**

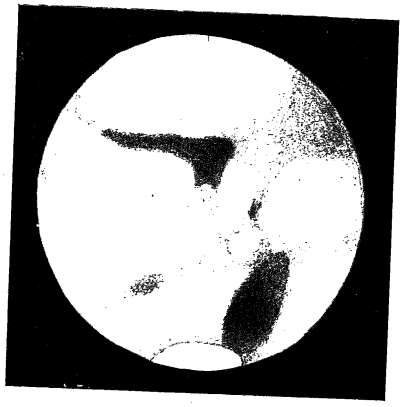

Fig. 2
Pickering
0° **A**

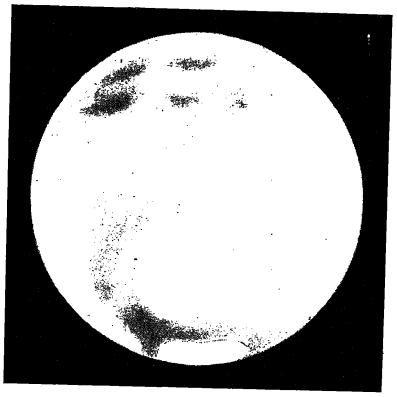

Fig. 5
Phillips
74° **B**

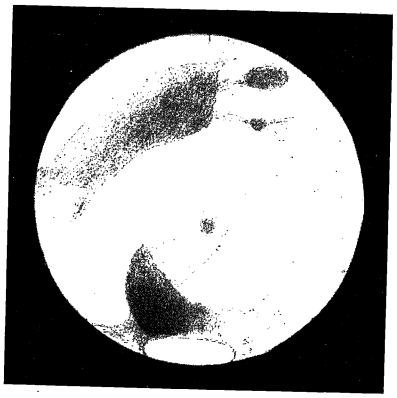

Fig. 6
Pickering
61° **B**

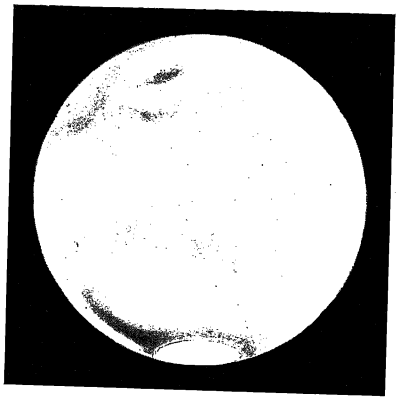

Fig. 9
Phillips
110° **C**

Fig. 10
Pickering
126° **C**

Fig. 3
Wilson
1° **A**

Fig. 4
Douglass
4° **A**

Fig. 7
Wilson
45° **B**

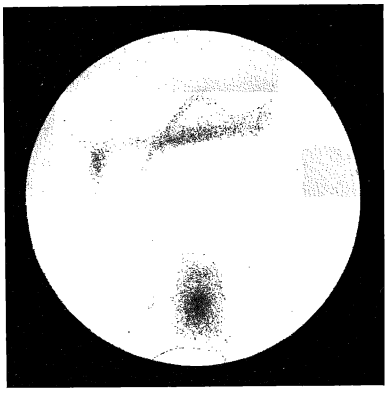

Fig. 8
Douglass
33° **B**

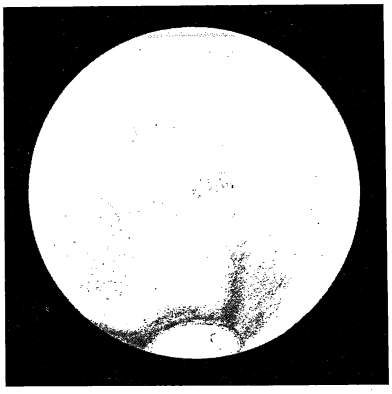

Fig. 11
Wilson
127° **C**

Fig. 12
Douglass
107° **C**

The names and addresses of those whose work has been selected for publication together with their equipment, are as follows:

Rev. T. E. R. Phillips, Epsom, England. 12¼-inch reflector by Calver, and 8-inch refractor by Cooke. Magnification employed 275 to 600. Seeing on Standard Scale ranging from 6 to 10, where the higher the number, the better the seeing.

Professor W. H. Pickering, Mandeville, Jamaica. 11-inch refractor by Clark. Magnification 430 and 660. Seeing on Standard Scale ranging from 5 to 12.

L. J. Wilson, Esq., Nashville, Tennesse. 11-inch reflector made by himself. Magnification 360. Seeing 8 to 10 on Standard Scale.

Professor A. E. Douglass, Tucson, Arizona. 8-inch refractor by Clark. Magnification 350 and 450. Seeing on Standard Scale ranging from 6 to 9.

Dr. H. E. Lau, Hörsholm, Denmark. 3¾-inch refractor by Bardou. Magnification 170 and 300. Seeing on personal scale ranging from 1 to 3, where 1 is very fine, 2 good, and 3 rather bad.

H. McEwen, Esq., Glasgow, Scotland. 5-inch refractor by Wray. Magnification 160 to 200.

In Table I are given the fundamental data regarding the figures as far as they could be determined. The first seven columns require no explanation, the eighth gives the central longitude of each drawing, the ninth its difference from the proposed value, the tenth the central latitude, the eleventh the angular diameter of the planet, corrected from that given in the ephemeris, the twelfth the solar longitude as seen from the planet, and the last the corresponding Martian date as deduced from Report No 10.

In Report No. 8 we saw that the planet presented a somewhat different appearance to the observers of the Lowell Observatory from that which it did to the other three. The present six observers on the other hand, all see it very much alike. Any one of the thirty-six drawings herewith shown would be satisfactory to the writer, as indicating the general appearance under certain more or less favorable conditions. If there is any difference at all among them in the style of representation, it would appear to him as if his own drawings and those of Mr. Phillips gave the broader canals a more curving shape and the resulting appearance of the planet a less angular aspect, than is shown in some of the others. This is most marked in regions **D**, **E**, and **F**. Observers at the next opposition should endeavor to determine which of these two appearances is the more correct. Dr. Lau's drawings seem rather lacking in detail as compared with the other figures, and this is undoubtedly due to his very small aperture, only 3¾ inches, yet he shows a very considerable number of canals, as we shall see later, when we deal with the matter statistically.

TABLE I.

FUNDAMENTAL DATA OF THE FIGURES.

No.	Obs.	Aper.	Magn.	Seeing	1916	Reg.	Long.	Δ Long.	Lat.	Diam.	⊙	M.D.
							°	°	°	″	°	
1	Pl	—	—	6 (?)	Feb. 27	**A**	359	− 1	+15	13.2	60.2	May 17
2	Pk	11	660,430	9, 7	Mar. 5	"	0	0	14	12.5	63.2	" 23
3	W	11	360	—	Jan. 23	"	1	+ 1	18	13.2	44.7	Apr. 38
4	D	8	450,350	7, 9	Mar. 7	"	4	+ 4	14	12.3	64.0	May 25
5	Pl	12, 8	—	8 (?)	Feb. 19	**B**	74	+14	15	13.6	56.5	" 8
6	Pk	11	660,430	7	Feb. 26	"	61	+ 1	15	13.2	59.7	" 16
7	W	11	360	—	Feb. 24	"	45	−15	15	13.3	58.8	" 14
8	D	8	350	6, 7	Mar. 1	"	33	−27	14	13.0	61.5	" 19
9	Pl	12, 8	—	10	Feb. 19	**C**	110	−10	15	13.6	56.5	" 8
10	Pk	11	430	6, 5	Feb. 24	"	126	+ 6	15	13.3	58.8	" 14
11	W	11	360	—	Feb. 16	"	127	+ 7	16	13.7	55.3	" 6
12	D	8	350	7	Feb. 26	"	107	−13	15	13.3	59.7	" 16
13	Pl	12, 8	—	7	Feb. 8	**D**	175	− 5	16	13.9	51.8	Apr. 54
14	Pk	11	660	10	Feb. 12	"	179	− 1	16	13.8	53.6	May 2
15	W	11	360	—	Feb. 14	"	183	+ 3	16	13.8	54.5	" 4
16	D	8	350	8	Feb. 17	"	158	−22	15	13.7	55.7	" 7
17	Pl	8	—	7	Feb. 5	**E**	240	0	17	13.8	50.4	Apr. 51
18	Pk	11	660	9	Feb. 7	"	242	+ 2	16	13.9	51.4	" 53
19	W	11	360	—	Feb. 10	"	250	+10	16	13.9	52.8	" 56
20	D	8	350	8	Feb. 7	"	256	+16	16	13.9	51.4	" 53
21	Pl	8	275,387	7	Jan. 22	**F**	315	+15	18	13.2	44.2	" 37
22	Pk	11	430	10, 12	Mar. 9	"	303	+ 3	14	12.2	65.0	May 27
23	W	11	360	—	Feb. 3	"	303	+ 3	17	13.8	49.7	Apr. 49
24	D	8	350	9	Mar. 13	"	287	−13	14	11.7	66.7	May 31
25	L	4	170,300	1	Feb. 20	**A**	350	−10	15	13.6	57.0	" 9
26	M	5	180	—	Feb. 20	"	4	+ 4	15	13.6	57.0	" 10
27	L	4	170,300	2, 3	Feb. 15	**B**	62	+ 2	16	13.8	55.0	" 5
28	M	5	200	—	Feb. 16	"	64	+ 4	16	13.7	55.5	" 6
29	L	4	170,300	1	Feb. 8	**C**	128	+ 8	16	13.9	51.7	Apr. 54
30	M	5	180	—	Feb. 9	"	124	+ 4	16	13.9	52.2	" 55
31	L	4	170,300	1, 2	Jan. 27	**D**	213	+33	18	13.5	46.6	" 43
32	M	5	160	—	Feb. 4	"	184	+ 4	17	13.8	48.1	" 50
33	L	4	170,300	2	Jan. 27	**E**	244	+ 4	18	13.5	46.5	" 42
34	M	5	160	—	Jan. 28	"	230	−10	17	13.5	47.0	" 44
35	L	4	170,300	1, 2	Feb. 23	**F**	304	+ 4	15	13.4	58.2	May 12
36	M	5	160	—	Jan. 22	"	303	+ 3	18	13.2	44.2	Apr. 37

Mr. Phillips describing his own work says that it was done under certain disadvantages, on account of the removal of his observatory from Ashtead to Headley. He had no driving clock on his reflector until after February 8. He also had a good deal of bad weather. He thinks there was considerable haze or mist in the Martian atmosphere early in the season, soon after the melting of its northern polar cap.

In speaking of the region of Nilokeras and Lunae Lacus, regions **B** and **C**, Figures 5 and 9, which he observed under unusually favorable circumstances, he says "the general appearance of this region is totally un-Lowellian in character, and the term canal altogether unsuitable." He remarks especially on the unexpected invisibility of the Ganges. On March 3 the preceding end of the polar cap was much darker than the following end. This was undoubtedly due to cloud over the former. He indicates certain cloudy regions by dotted lines in Figure 21.

The writer would point out that the clouds always lie over the so-called desert regions of the planet, apparently being precipitated as soon as the fertile regions are reached. This is clearly shown in Figure 14, where the cloud following Charontis is also indicated, half covering Elysium. This was not an unusual feature in this region in the Martian mornings, indicating doubtless that Charontis like Acidalium is composed of moist or marshy land. Incomplete canals, i. e. elongated marshes disappearing in the desert, are shown in many of the drawings, by most of the observers. Such a thing like an incomplete canal was formerly supposed not to exist. The broad hazy character of some of the early markings is clearly shown in Figure 10. These darker areas will it is expected later develop into well defined canals. In most of the Jamaica drawings the canals are still broad and curved, but in the last one secured, Figure 22, the straight narrow canals had already begun to form, and were not afterwards absent from that side of the planet.

In a letter from Mr. Wilson he speaks of the bad weather during the past winter. He also points out particularly the small projection due to cloud shown on the morning terminator of Figure 7, located over the region just following Solis Lacus. Clouds were frequently noted on the northern side of the dark regions of the planet, as in Figures 15 and 23.

Professor Douglass sends several notes relative to the clouds visible on the planet, and calls particular attention to the small white spot near the polar cap shown in Figure 12. Regarding their frequent rapid dissolution, which we have mentioned in some of our earlier reports, he notes that on February 7 at $15^h\ 45^m$ G.M.T. both sides of the Syrtis were whitish. Half an hour later only the following side remained so. This was in the early Martian morning.

Dr. Lau shows bright cloudy areas by means of dotted lines in several of his drawings, but makes no reference to them in his letter of transmission. Mr. McEwen sends a set of beautiful colored sketches in red, yellow, and violet, which it is a pity should have to be reproduced in simply black and white. Like all the other observers he shows well marked cloudy areas. But a few years ago some observers claimed that unlike the Earth, clouds were never seen on Mars, or at all events were extremely rare. During the present opposition the planet has scarcely ever been seen without them.

The More Important Divergencies of Representation.

It will be noticed that in Figure 3 Aryn, lying within the forked bay of Sabaeus, is represented as having appeared, to be sure rather vaguely, as early as January 23. This the writer believes is an error. To Messrs. Lau and McEwen it was invisible as late as February 20 (Fig-

PLATE XLII

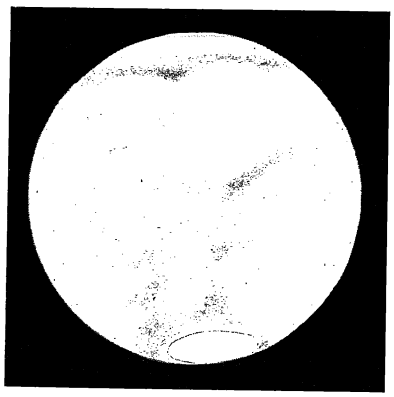

Fig. 13
Phillips
175° **D**

Fig. 14
Pickering
179° **D**

Fig. 17
Phillips
240° **E**

Fig. 18
Pickering
242° **E**

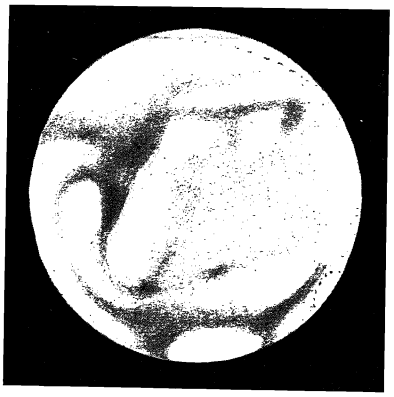

Fig. 21
Phillips
315° **F**

Fig. 22
Pickering
303° **F**

PLATE XLIII

Fig. 15
Wilson
183° **D**

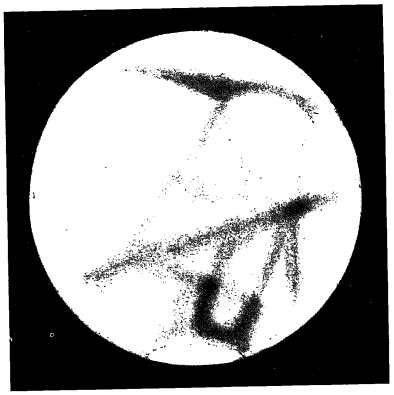

Fig. 16
Douglass
158° **D**

Fig. 19
Wilson
250° **E**

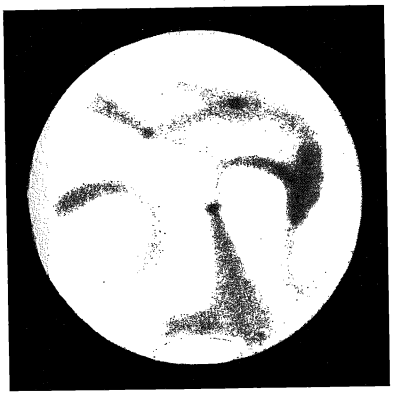

Fig. 20
Douglass
256° **E**

Fig. 23
Wilson
303° **F**

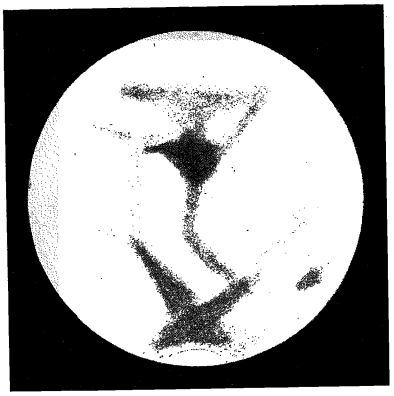

Fig. 24
Douglass
287° **F**

ures 25 and 26). If well defined, it should have been visible in their telescopes. Mr. Phillips shows it in Figure 1, drawn February 27. To the writer it was first suspected March 1, and clearly shown although only slightly marked March 5 (Figure 2). March 7 Professor Douglass writes regarding it, "Sabaeus Sinus possibly double, not sure." He does not show Aryn however in his sketch of that date (Figure 4). It may therefore be taken as fairly certain that it first became visible this year early in March. $\odot$ 62° ± 2°, M. D. May 21. On the other hand it should be noted that Dr. Lowell shows it very conspicuously in his sketch of January 28, published in Popular Astronomy 1916, **24** Plates 26 and 27, 423, 426. He apparently did not notice that it was then invisible. The writer has an excellent drawing made January 30, seeing 9, which shows not a trace of it.

As an illustration of the differences that are sometimes found in the work of different observers, the canal Laestrigon is shown on Figures 15 and 19 by Mr. Wilson, and on Figures 16 by Professor Douglass as a straight line, yet on February 12 to the writer (Figure 14) it was clearly crooked. On March 21 and 24, however, he too drew it as straight. If it really was crooked, this shows about the maximum length of an average curved canal that present appliances will erroneously indicate as a straight line. Its length was 2″.8, or 800 miles, (1200 km).

This statement is corroborated by the fact that the larger telescopes, in Figures 14, 17, 18, and 20, represent Elysium as circular. In Figure 13 it is slightly angular and in Figures 15 and 19 clearly so, with four straight bounding canals. The circular form is confirmed by a drawing sent me some months ago, made at the observatory of M. Jarry-Desloges with a 12-inch objective. Dr. Lowell in his paper in Popular Astronomy, above mentioned, represents it still differently, with two straight sides and two curving ones, giving it a rather hexagonal form, but agreeing fairly well in general appearance with the majority. This is much too difficult a point to be decided by a small telescope, but it is of interest to note that in Figure 34 Mr. McEwen represents it as a square, strongly inclined to the position shown by Mr. Wilson in Figure 19, and that in Figure 32 one of the sides is slightly curved. In former oppositions it was often represented as a pentagon, with a strongly marked angle at the south. In 1916, however, it appeared circular to the writer.

No such rapid changes of detail are recorded on our drawings this year as were found in 1914. Indeed it is rather too late in the Martian season for such changes to present themselves, but there is nevertheless evidence of a flooding of the Syrtis marsh on two occasions. It will be recalled that one flood occurred about the end of December (Reports Nos. 14 and 15). The Syrtis then narrowed and dried up, as shown in

Figures 21 and 36, both taken on the same date, January 22. A very slight darkening is shown in both of them, but it is so slight that the observers do not agree very well as to its location.

Another flood occurred January 31, ⊙ 48°.3, as recorded on the Jamaica drawings, the flood broadening and spreading for the next few days, but by February 3 (Figure 23) Mr. Wilson shows that it had already begun to recede towards the northern tip of the Syrtis. The longitudinal canal Dosaron, however, still marked its central axis. The increased breadth of the Syrtis was now clearly noticeable. This recession of the marsh is confirmed by a Jamaica drawing of February 7. By February 23 (Figure 35) Dr. Lau shows that the Syrtis had again narrowed, and the dark area and canal had entirely disappeared. The canal is however faintly shown in a drawing by Mlle. Renaudot, made at Juvisy February 24, and more conspicuously in a drawing by M. Le Coultre of Geneva, dated March 1. It is is further shown in a drawing by M. Dufour on the same date (L'Astronomie 1916 **30**, 308, 269, and 270). The narrowing of the Syrtis and disappearance of the dark area is confirmed by all three of these drawings.

By March 9 (Figure 22) the Syrtis had broadened again, and the dark flooded area had become quite conspicuous. Four days later (Figure 24) according to Professor Douglass, the flood had receded slightly, and Dosaron had begun to appear, but the width of the Syrtis was still as great as ever. This is the last great flood in this region of which we have any evidence. ⊙ 65°, M. D. May 27. The approximately square flooded area measured at maximum about 700 miles (1100 km) on a side, thus indicating the power of our Sun even at the distance of Mars.

As pointed out two years ago, these floods on the Syrtis should be carefully observed in the springtime of the Martian year. Every interested observer should draw the Syrtis every night that it is visible to him at the next opposition, timing his drawing so that the Syrtis shall be as near as possible to the central meridian. See Report No. 15 for instructions how to compute the time. Then by combining the observations made in Europe with those made in America, we could get a series of drawings for this particular Martian longitude extending through fully a half presentation of the planet, or twenty days. The next opposition will be our last chance for several years. When a flood comes it begins to darken first towards the tip of the Syrtis, and gradually spreads and broadens, turning first dark and then blue. At length the southern boundary of the dark spot, which was at first indistinct, becomes sharply defined, and this gives us our first definite date for the flood. The blue color and the sharpening of this boundary are the most definite indications that we have, and observers should be particularly on the lookout for them in the future.

Identification of the Canals.

The identification of the canals and lakes of this opposition has been made by means of our standard map published in connection with Report No. 15. This map, which is probably the best yet constructed, has proved very satisfactory, and much better than its predecessor, but careful study has shown certain defects in it which may be pointed out in this place. It would be better if it contained a few more canals, and also a few more lakes. As in the case of the previous opposition, it has been necessary occasionally to refer for an identification to Lowell's map of 1896 (Annals **3**, 100) and sometimes to his other maps, and to that of M. Jarry-Desloges (Observations **3**). Several of the canals shown are taken from Lowell's maps, but one of them, Evenus, leading northeasterly from Titanum Sinus is wrongly named. It should be called Steropes, Evenus according to Lowell indicating another canal in the immediate vicinity. Cyclops to the north of Elysium should be considerably more inclined, as it was drawn by Schiaparelli. Nuba Lacus, situated on Thoth, should, according to all observers who recorded it this year, be located appreciably farther to the south,—perhaps 10° for the average. There seems to be some ambiguity about a few of the canals to the north of Solis Lacus, lying between Aurorae Sinus and Phoenicis Lacus. The accompanying sketch map Figure I shows the

Fig. 1

names which it has been decided to adopt in these Reports. The three small lakes are Messeis, Tithonius and Phoenicis, the first named by Lowell in 1896 (Annals **3**, 100).

The canal N M as is shown by the standard map is Agathodaemon, so named by Schiaparelli.

The canal M T P is Daemon, so called by Lowell in 1901 (Annals **3**, 144).

The canal A M has been called Agathodaemon by Lowell in 1896, 7, (Annals **3**, 100). It has been called Coprates by Desloges in 1912, (Observations **3**, 317) but this name Lowell has already applied to another canal in this immediate vicinity. On our standard map the name Ophir has been placed immediately below it, but the type employed indicates

a region, not a canal. The name Ophir is however a good one, and it is proposed to adopt it for this canal.

The canal ST is Tithonius, so named by Lowell (Annals **3**, 100).

The little crooked canal MK is occasionally prolonged to T. It was first seen, it is believed, by the writer in 1892, when it was also drawn by Professor Douglass. It appeared again in 1914 (See Report No. 8), where it was sketched by Professor Douglass, Figure 7. It had again appeared this past year, see Figures 6 and 12. In the Lowell Annals **2** the name Agathodaemon has been applied to a portion of it, on a map which has been superseded in Volume **3**, Append. 24. On the latter map this use has been discontinued. It is otherwise unnamed. It is now proposed to call it Kedron.

The identification of a large number of canals and lakes always involves the exercise of a certain amount of judgment, for not only do the observers themselves sometimes draw them in the wrong places, but also, in the case of the canals, sometimes in the wrong position angle. Moreover, as we have already seen, these objects sometimes shift their positions, travelling occasionally several hundred miles over the surface of the planet. If even the clearly marked ones, whose latitudes and longitudes we are able accurately to determine, do this, what shall we do with the fainter ones, which we can only just distinguish? Under the circumstances it is perhaps surprising that any two specialists will agree on the proper names for the markings as well they do, or that the same observer will corroborate his own identifications at different oppositions. Of course the conspicuous markings are easy enough; it is usually only the fainter ones that give trouble.

The best method to adopt, is first to determine the latitude and longitude of the central point of the disk, and then to name the more obvious markings. We next determine the latitude and longitude of any point near the centre by means of a central point. It is always well to identify the lakes first. For the canals their position angles will also help. Finally in many cases assistance may be derived from the neighbouring detail.

In Table II is given a list of all the canals shown on the drawings of the six observers. The canals are arranged and numbered alphabetically, and the successive columns indicate in which drawings of each observer the canal is found.

The dark areas bounded on one side by the polar cap, and which often coincide more or less closely in position with some of the canals given on the map, are not considered to be really canals, unless they are clearly separated from the snow. As shown in Report No. 14 they appear to be more ephemeral in their nature, often changing in breadth and visibility in the course of a few hours, and in any case clearly

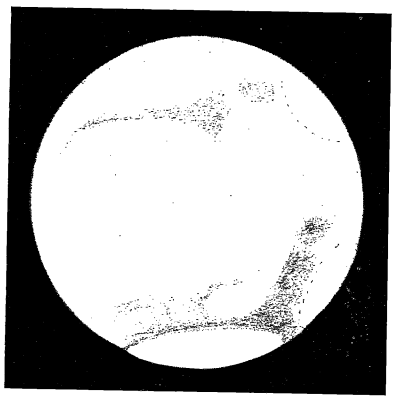

Fig. 25
Lau
350° A

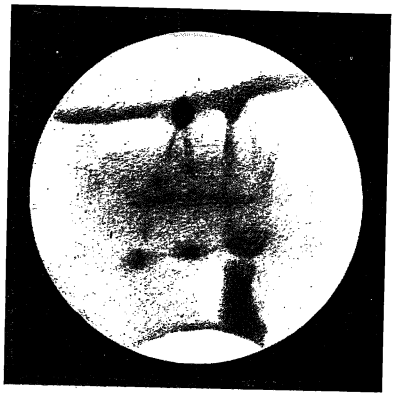

Fig. 26
McEwen
4° A

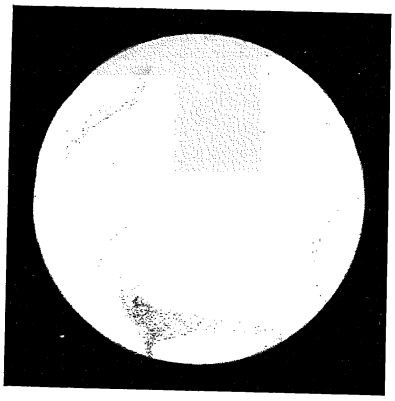

Fig. 27
Lau
62° B

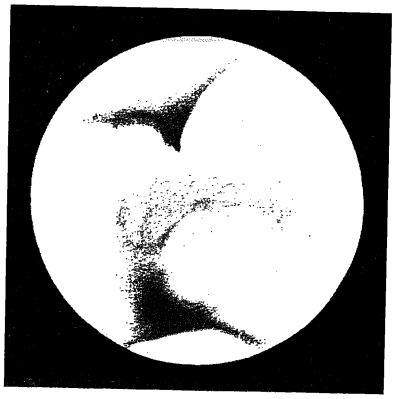

Fig. 28
McEwen
64° B

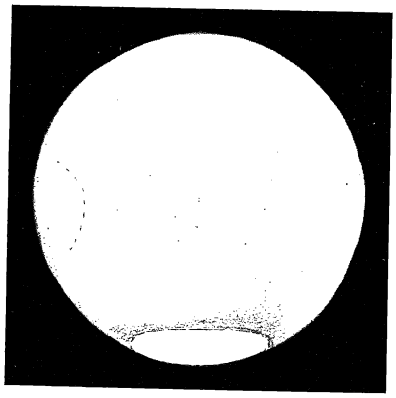

Fig. 29
Lau
128° C

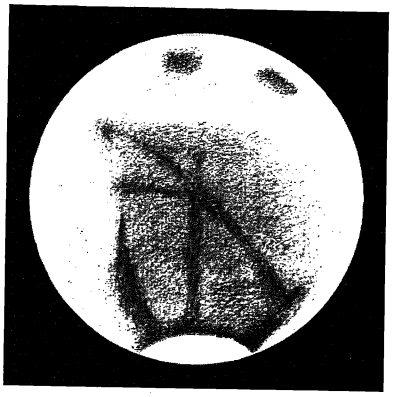

Fig. 30
McEwen
124° C

PLATE XLV

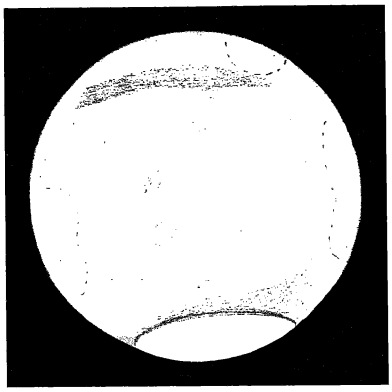

Fig. 31
Lau
213° **D**

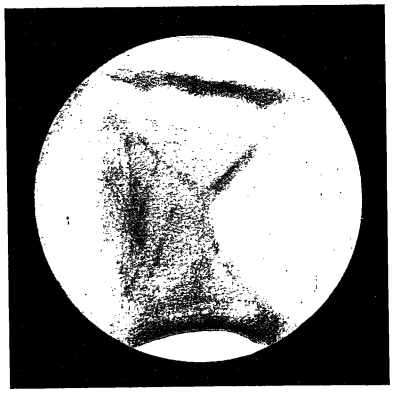

Fig. 32
McEwen
184° **D**

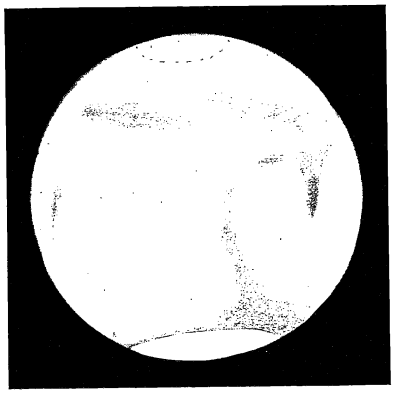

Fig. 33
Lau
244° **E**

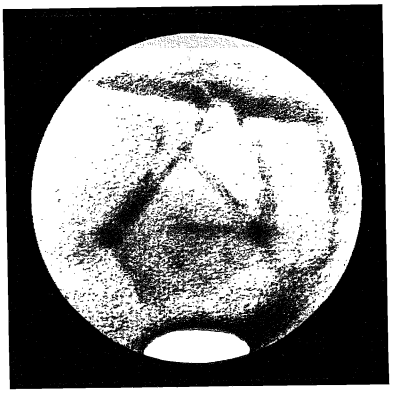

Fig. 34
McEwen
230° **E**

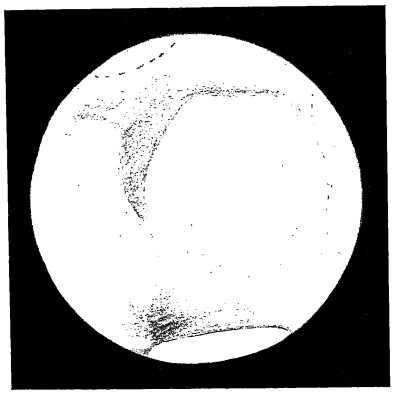

Fig. 35
Lau
304° **F**

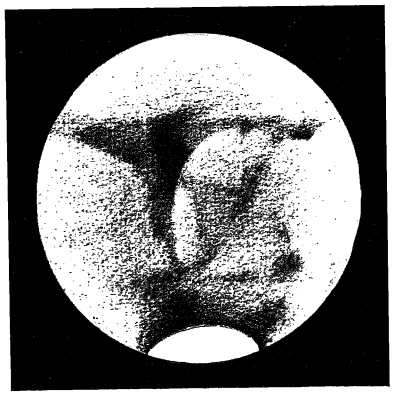

Fig. 36
McEwen
303° **F**

TABLE II.

CANALS IDENTIFIED ON THE DRAWINGS.

No.	Canal	Pl	Pk	W	D	L	M	Obs.
1	Acheron		C *		D			2
2	Aesacus			E				1
3	Aethiops						E	1
4	Alander (L)					BC		1
5	Anian			DE				1
6	Asopus						F	1
7	Astusapes		F	DE	F		F	4
8	Avernus		D				D	2
9	Boreas		E					1
10	Boreosyrtis	E	E	F	EF		F	5
11	Bosporus		B		C			2
12	Brontes	C	D	D	CD	C	C	6
13	Casius	EF	EF	FF	EF	EF	E	6
14	Ceraunius	C	C	C	C	B	BC	6
15	Cerberus	DE	DE	DE	DE	DE	DE	6
16	Chaos		DE	DE				2
17	Chlorus (L)				B			1
18	Cyane (L)				B			1
19	Cyclops	E	DE	E	E	DE	E	6
20	Daemon (L)	BC	BC		C			3
21	Dargamanes (L)				B			1
22	Deuteronilus	FA	FA	A	AB	A	A	6
23	Dosaron (L)			F	F			2
24	Erebus		D		D		D	3
25	Eumenide	D	C		D			3
26	Eunostos	DE	DE	DE	EF	D	E	6
27	Euphrates	F	F	A	A		F	5
28	Fortuna			C				1
29	Ganges		B	B	BC			4
30	Gehon		A	AB	AB		A	4
31	Gigas		C	C	C	C	C	5
32	Granicus			D				1
33	Hades	D	DE	D	D		D	5
34	Hebrus			C			C	2
35	Hephaestus		E	E	E			3
36	Hiddekel					F	A	2
37	Hyblaeus	E	DE	E	E	D		5
38	Hydaspes						AB	1
39	Indus		A	AB	AB	B	A	5
40	Jamuna			B				2
41	Jordanis				A		AB	2
42	Kedron (P)		B		C	A		2
43	Laestrigon		D	DE	D			3
44	Laus (L)				E			1
45	Lycus		C	C	C			4
46	Nar (L)			E			C	2
47	Nasamon		F		F		E	2
48	Nectar	BC	B	B	BC			4
49	Nepenthes	EF	EF	EF	E	E		5
50	Nilokeras	BC	A	B	B	AB		6
51	Nilosyrtis	EF	EF	EF	EF	EF	B	6
52	Nilus	C			C	B	F	3
53	Ophir (P)	BC	B	B	C			4
54	Orcus	D			D			3
55	Oxus		A	A	A		D	3
56	Pandora	F	F	A	A			5
57	Phison	F			F		F	2
58	Phryxus (L)							1
59	Protonilus	FA	FA	FA	FA	F	F	6

* EDITOR'S NOTE:—The letters in this table refer to the corresponding heavy face letters in the titles of Figures.

TABLE II.—CONTINUED.

No.	Canal	Pl	Pk	W	D	L	M	Obs.
60	Pyramus			F				1
61	Simois		D					1
62	Sirenius					B	C	2
63	Sitacus	F	F	A	A		F	5
64	Steropes (L)				D			1
65	Styx	D	DE	DE	D	DE	DE	6
66	Subus (D)		F	F	F			3
67	Tartarus		D		D			2
68	Thoth	EF	EF	EF	EF	EF	E	6
69	Titan						D	1
70	Triton		E	E	EF	E	E	5
71	Uranius	C			C		B	3
72	Anon. (*a*)				A	A		2
73	" (*b*)					E		1
74	" (*c*)					E		1
75	" (*d*)						A	1
76	" (*e*)						D	1
77	" (*f*)						D	1

differ from the canals properly so called. In accordance with this view they have been omitted from the table. Ten canals not given on our map have been identified on that of Dr. Lowell. Their names are all followed by an (L). One canal, Subus, followed by a (D) was identified on the map of M. Jarry-Desloges. Six other canals could not be identified, and are recorded as anonymous. They may be described briefly as follows:

Anon. (*a*) This canal lies just to the south of Deuteronilus. It connects with Margaritifer through Oxus which has shifted to the south to connect with it, and now leads directly to Ismenius instead of to Siloe.

Anon. (*b*) Preceding and nearly parallel to Casius.

Anon. (*c*) Following and nearly parallel to Casius.

Anon. (*d*) Parallel to Deuteronilus and 0.4 of the distance towards Sabaeus.

Anon. (*e*) Preceding Titan and slightly inclined to it.

Anon. (*f*) Following Titan and slightly inclined to it.

The last column of the table gives a number of observers by whom each canal was seen.

STATISTICS OF THE CANALS.

A statement of the number of canals recorded is given in Table III, where the first column indicates the visibility, by the number of observers who recorded the canals, and the following columns the

number of such canals recorded by each observer, and the total. Thus, of those canals recorded by all six observers, Mr. Phillips saw 12, of those recorded by five observers, he saw 7, etc. The next to the lowest horizontal row shows the number of canals seen that were confirmed by at least one other observer, and the lowest row the total number seen. The three southern observers saw more canals than the three northern ones, which was perhaps to be expected, since the seeing seems to be a function of the latitude. Indeed they each saw all of the canals recorded by six, five, and four observers, 28 altogether. They saw 32 canals in all in common. It was only in the canals seen by but three observers where they began to break down. The last column shows that there were ten of these, all of which were seen by Professor Douglass. Dividing the observers into these two classes, it would seem that the special usefulness of the northern observers was to classify the more conspicuous canals as to their relative visibility, and to confirm the fainter canals when possible. The usefulness of the southern observers is to find the fainter canals, and determine their relative visibility when found. Both classes of observers are therefore needed in this investigation. It cannot be too strongly emphasized however that all the drawings are useful for studying the existence, location, and shapes of the more conspicuous markings, and that this work is considered of far more importance than the discovery of the fainter canals, Observers are again cautioned not to see too many faint and doubtful canals.

TABLE III.

THE NUMBER OF CANALS RECORDED.

Obs.	Pl	Pk	W	D	L	M	Total
6	12	12	12	12	12	12	12
5	7	10	10	10	5	8	10
4	2	6	6	6	1	3	6
3	5	7	4	10	1	3	10
2	1	7	5	9	4	6	16
1	0	2	6	4	4	7	23
Confirmed	27	42	37	47	23	32	54
Total	27	44	43	51	27	39	77

Owing to the fact that Mr. Wilson's observatory is so near the track of the great anti-cyclone disturbances, which are undoubtedly the prime source of all the bad seeing that we experience, he might properly be classified with the northern observers, whom he would then lead as far as the number of canals recorded are concerned. He really holds a position intermediate between the two classes, but owing to the lack of southern observers we have classified him with them.

On the principle of the division of labor among the observers, it has been decided, even at the risk of losing several of the canals that were really there, to omit all those recorded by the northern observers which were not confirmed by at least one of the southern ones. This measure has not been applied to the canals recorded at the southern observatories, because it seemed more likely that a favorably situated observer, such for instance as Professor Douglass, who saw a great many canals that were confirmed by others, might very well have seen a few which no one else had recognized. This plan will eliminate the following canals from our list:—Aethiops, Alander (L) Asopus, Cyane (L), Hiddekel, Hydaspes, Sirenius, Titan, and five of the six anonymous canals. This reduces the total number of canals from 77 to 64. It should be pointed out that this does not indicate the total number of canals seen by all of the observers at this opposition, but only the total number seen on certain selected drawings. Earlier and later, moreover, other canals appeared not here recorded.

On our finally accepted list the following canals have been seen by all six of the observers: Brontes, Ceraunius, Cerberus, Cyclops, Casius, Deuteronilus, Eunostos, Nilokeras, Nilosyrtis, Protonilus, Styx, and Thoth.

Five observers saw Boreosyrtis, Euphrates, Gigas, Hyblaeus, Hades, Indus, Nepenthes, Pandora, Sitacus, and Triton.

Four observers saw Astusapes, Gehon, Ganges, Lycus, Nectar, and Ophir.

Three observers saw Daemon, Erebus, Eumenides, Hephaestus, Laestrigon, Nilus, Orcus, Oxus, Subus, and Uranius.

Two observers saw Acheron, Avernus, Bosporus, Chaos, Dosaron, Hebrus, Jamuna, Jordanis, Kedron, Nar, Nasamon, Phison, Tartarus, and Anonymous (*a*).

One observer only saw Aesacus, Anian, Boreas, Chlorus, Dargamanes, Fortuna, Granicus, Laus, Phryxus, Pyramus, Simois, and Steropes.

The arrangement of Table IV is similar to that of Table III, except that instead of giving the total number of canals seen by each observer, it gives the proportion of the total number recorded. These total numbers are given in the last column, as modified by the above mentioned omissions. As we descend the columns to fainter and fainter canals, the proportion of the total number seen by each observer should rapidly decrease, and this we find in general to be the case. We note by the last column that as the canals grow fainter, they first decrease, and then increase in numbers, averaging eleven to each class. The lower row of the table gives the modified number of canals seen by each observer.

TABLE IV.

PROPORTION OF THE CANALS VISIBLE TO THE DIFFERENT OBSERVERS.

Obs.	Pl	Pk	W	D	L	M	Total
6	1.00	1.00	1.00	1.00	1.00	1.00	12
5	.70	1.00	1.00	1.00	.50	.80	10
4	.33	1.00	1.00	1.00	.17	.50	6
3	.50	.70	.40	1.00	.10	.30	10
2	.07	.50	.36	.64	.14	.29	14
1	.00	.17	.50	.33	.00	.00	12
Total	27	44	43	51	21	30	64

In the opposition of 1914 nearly all the canals were broad, while the more difficult ones were faint. To detect them therefore did not require particularly good seeing, but it did require an eye sensitive to small contrasts. In 1916 more narrow canals appeared, especially immediately after the opposition, good seeing was therefore more important. It is expected that still more of the narrow canals will appear in 1918. These will require large apertures, that is to say as large as the climate of the observer will permit. Apertures as large as 12 inches can probably be used to advantage at times in northern Europe, and still larger ones in the Mediterranean section. Observers should not forget, however, that when the seeing is poor, a very appreciable advantage may be gained, on bright objects like the Moon and Mars, by reducing their apertures.

COMPARISON OF THE OPPOSITIONS OF 1914 AND 1916.

Comparing the past year's work with that of the previous opposition (Report No. 8), we notice first that the present drawings were made appreciably later in the Martian calendar year. The earlier observations were all taken between ⊙ 5°.5 and 26°.1, corresponding on the Revised Calendar of Report No. 10 to between the Martian dates of March 12 and 54. By Table I, the present set of drawings were made between ⊙ 44°.2 and 66°.7 corresponding to the Martian dates of April 37 and May 31. As a result on comparing the two sets of drawings, we notice at once that the northern snow cap has appreciably decreased in size. It has turned also more directly towards us. In 1914 the central latitude lay between +2° and +9°. This year it lay between +14° and +18°. The maximum size of the planet was somewhat less, 13″.9 against 15″.0,—indeed such a remote opposition is unusual, and will not occur again for many years.

There was a general complaint of poor seeing among the different observers. Professor Douglass found little difference, however; his range of seeing on the standard scale in 1914 was 5 to 9, and in 1916, 6 to 9.

For the writer in 1914 it was 10 to 12, averaging 10.5, and this year 5 to 12, with a rather low average of 8.4. Yet in spite of the smaller disk and poorer seeing, he saw more canals, and they were increasing in number when the time limit for the drawings expired. Moreover this year there were no canals visible in the Protei regio, region B, where owing to a flood a number were seen before.

Treating the matter statistically with regard to the more conspicuous and therefore assured canals, we find that in 1914 there were 24 that were seen by all three observers. Three of these lay at the border of the polar cap, and adopting this year's regulation, they were eliminated as not being really canals, properly speaking. Achelous (L) also, in fact appeared on only two of the drawings in 1914, Mr. Phillips' representation coinciding more nearly with Cyclops than Achelous. Phlegethon was very faint on two of the drawings, so much so indeed that it shows only in the reproduction of the drawing by Professor Douglass, Figure 15. These canals will also be eliminated, leaving 19, which we will compare with the 22 seen this year, by six and by five observers.

TABLE V.

COMPARISON OF THE CHIEF CANALS SEEN IN 1914 AND 1916.

Part I				Part II			
1914	Vis.	1916	Vis.	1916	Vis.	1914	Vis.
Agathodaemon	6	Ophir	4	Brontes	6	Titan	4
Boreas	6	Boreas	1	Cyclops	6	Cyclops	2
Boreosyrtis	6	Boreosyrtis	5	Euphrates	5	Euphrates	4
Bereosyrtis	6	Casius	6	Hades	5	Hades	4
Cerberus	6	Cerberus	6	Indus	5	Indus	4
Daemon (L)	6	Daemon (L)	3	Protonilus	6	Protonilus	4
Deucalionis	6	Pandora	5	Sitacus	5	Hiddekel	4
Deuteronilus	6	Deuteronilus	6	Triton	5	Triton	4
Eunostos	6	Eunostos	6				
Gigas	6	Gigas	5				
Hyblaeus	6	Hyblaeus	5				
Lapaden (L)	6	Ceraunius	6				
Nectar	6	Nectar	4				
Nepenthes	6	Nepenthes	5				
Nilokeras	6	Nilokeras	6				
Nilosyrtis	6	Nilosyrtis	6				
Styx	6	Styx	6				
Tartarus	6	Tartarus	2				
Thoth	6	Thoth	6				
Tithonius	6	——	0				

In the first part of Table V the first column gives these nineteen canals. The second column gives their visibility, calling those seen by all three observers 6. Those that were seen by two observers are marked in another column 4, and those seen but by one observer 2. The third column gives the corresponding canals seen in 1916, and the fourth their visibility taken from the last column of Table II. Since different maps were used in the identification in the two oppositions, this sometimes causes a change in the name of the canal, but allowing

for this fact, in most cases the difference in recorded visibility is not very great. Certain exceptions occur, however, Boreas being seen by but one observer this year, Daemon by but three, Tartarus by two, and Tithonius not at all.

In the second part of the table the first two columns refer to the past opposition, and contain the names of the remainder of the clearly visible canals, the other columns referring to the opposition of 1914. The only marked change recorded is that of Cyclops, which, as above stated, was seen by one observer in 1914. Achelous and Cyclops are parallel and lie side by side, although 700 miles apart, both connecting Cimmerium with Elysium. Since the former was clearly visible in 1914, and the latter alone the past opposition, we may well wonder if the latter really took the place of the former in the physical economy of the planet, and if so in what way.

The Lakes of Mars.

A list of the 33 lakes seen by the different observers is given in Table VI which is arranged exactly like Table II. There are two or three curious points about it. No single lake was seen by all six observers. Ismenius and Lunae were the two most frequently recorded. Oddly enough Solis was not seen at all with the two smaller instruments, presumably because it was so near the southern limb. The two observers who saw the most canals were with one exception the two who saw the fewest lakes. The anonymous lakes were located as follows:—*A* 100°, +30°,

TABLE VI.

Lakes Identified on the Drawings.

No.	Lake	Pl	Pk	W	D	L	M	Obs.	No.	Lake	Pl	Pk	W	D	L	M	Obs.
1	Acidalius (L)				AB			1	18	Nuba	E		EF	E	E		4
2	Ammonium			D				1	19	Orontes (D)			A			A	2
3	Arethusa			A				1	20	Oxia		A					1
4	Ascraeus						C	1	21	Pambotis			DE				1
5	Caloe	F	F	F				3	22	Phoenicis						C	1
6	Castorius				D			1	23	Propontis I	D						1
7	Charontis			DE	D	D	D	4	24	Propontis II	D						1
8	Coloe (L)			F				1	25	Pseboas		F					1
9	Cyclopum (L)				E			1	26	Siloe			A			A	2
10	Hecates	D		E				2	27	Solis	BC	BC	B	C			4
11	Hesperidum (L)				E			1	28	Stymphaline	D						1
12	Ismenius	AF	AF	A	AF		AF	5	29	Triviae (L)			D			E	2
13	Lunae	B	B	B		B	B	5	30	Anon *A*	B						1
14	Maricae			D				1	31	" *B*	D						1
15	Messeis (L)	C	B	C				3	32	" *C*						E	1
16	Morpheos (D)			DE				1	33	" *D*			F				1
17	Niliacus	AB		B		A	A	4									

B 180°, +60°, *C* 235° +20°, and *D* 275°, +25°. Only twelve lakes out of the 33 recorded were seen by more than one observer, which leads one to wonder if all the others were real. These twelve named in the order of their visibility were (5) Ismenius, Lunae, (4) Charontis, Niliacus, Nuba, Solis, (3) Messeis (L), Caloe, (2) Hecates, Morpheos (D), Siloe and Triviae. Of these Wilson saw all 12, Phillips 8, McEwen 7, Pickering 5, and Douglass and Lau 4 each. Only 6 of them were seen at the previous opposition, namely Messeis, Niliacus, Charontis, Solis, Caloe, and Nuba. The last two were those designated as anonymous, numbers 21 and 22, since they were not given either on Schiaparelli's or Lowell's map.

Table VII contains the usual data for the final drawings of the opposition, that were made in Jamaica. These were omitted from the last report on account of its length.

TABLE VII.

DATA OF THE DRAWINGS.

No.	1916	☉	M. D.	Long.	Lat.	Sun	Diam.	Seeing
		°		°	°	°	″	
68	Feb. 28	60.0	May 18	30	+15	+21	13.0	10
69	Mar. 1	61.5	" 19	3	14	"	12.9	8, 7
70	" 1	"	" "	35	"	"	"	7, 6
71	" 5	63.2	" 23	0	"	"	12.5	9, 7
72	" 8	64.5	" 26	332	"	22	12.3	9
73	" 9	65.0	" 27	303	"	"	12.2	10, 12
74	" 11	65.8	" 29	273	"	"	12.0	9, 7
75	" 19	69.3	" 37	246	"	"	11.3	6, 4
76	" 21	70.2	" 39	209	"	"	11.0	9, 10
77	" 24	71.5	" 42	180	15	"	10.8	10, 9
78	" 26	72.4	" 44	149	"	23	10.6	7, 8
79	" 29	73.7	" 47	121	"	"	10.3	9, 10
80	" 31	74.5	" 48	96	"	"	10.1	9, 6
81	Apr. 5	76.7	" 54	46	"	"	9.7	8, 10
82	" 5	"	" "	62	"	"	"	11, 12
83	" 6	77.1	" 55	33	16	"	9.6	9, 7
84	" 7	77.6	" 56	9	"	"	9.5	11, 10
85	" 12	79.8	June 5	331	"	24	9.1	6
86	" 17	82.0	" 9	297	17	"	8.6	8, 9
87	" "	"	" "	331	"	"	"	8, 9
88	May 1	88.2	" 23	183	18	"	7.9	6
89	" 3	89.0	" 25	122	"	"	7.8	7, 6
90	" "	"	" "	158	"	"	"	8

The following canals and lakes were seen:

Feb. 28 **A** Protonilus. Deuteronilus.

Mar. 1 **AB** Protonilus, Deuteronilus, Jordanis, Gehon, Oxus, Indus, Jamuna, Nilokeras, Ganges, Chrysorrhoas, Ophir, Anonymus, and Ismenius, Siloe, Oxia.

Mar. 5 **A** Protonilus, Deuteronilus, Gehon, Oxus, Indus, Nilokeras, and Ismenius, Oxia.