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FOR THE OBSERVATION OF

**M A R S.**

*Director—E. Walter Maunder, F.R.A.S.*

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# SECTION FOR THE OBSERVATION

OF

## M A R S.

DIRECTOR.—E. WALTER MAUNDER, F.R.A.S.

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*REPORT OF THE SECTION, 1892.*  
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### Introduction.

The opposition of 1892 proved, on the whole, a very disappointing one. Although Mars at opposition was almost at its nearest approach to the Earth, it was far from being well placed for observation by European astronomers owing to its great southerly declination, and consequent low altitude. The weather during the autumn of 1892 was for the most part very unfavourable for observation of so difficult an object; and several Members who joined the Section at the beginning were unable to contribute either drawings or report. None of the few evenings which the Director was able to give to the examination of the planet were really suitable for the purpose, and as the pressure of other duties rendered it impossible for him to attempt to supply any detailed help to the Members, the Section was at a very serious disadvantage. Under these circumstances it was very gratifying to find that so large a number of drawings had been sent in, together with several interesting reports, and it said much for the earnestness and energy of the observers who have worked so well under such discouraging conditions.

The following are the names of those Members who either joined the Section, or who, without formally joining the Section, yet contributed sketches or reports.

TABLE I.

Name.	Reference Initial.	Place.	O.G. or Spec.	Aperture in ins.	Re-ports.	Draw-ings.
Antoniadi, E. M.	A.	Constantinople-	O.G.	4'2	2	10
Baikie, Rev. Jas.	—	—	—	—	—	—
Brown, G. L.	B.	Stirling - -	Spec.	10'2	—	3
Bryant, G.	—	Kennington.	—	—	—	—
Cottam, Arthur	—	Watford.	—	—	—	—
Craig, Rev. S. Runsie	C.	Londonderry -	O.G.	4'2	—	4
Davis, G. T.	D.	Reading - -	O.G.	3'7	—	8
Eddie, L. A.	L.A.H.	Graham's Town	—	—	2	2
Ellis, Henry	H.E.	Potter's Bar -	O.G.	6'0	—	7
Everett, Miss A.	A.E.	Greenwich	O.G.	12'8	—	8
			O.G.	10'0		
			O.G.	6'7		
Foulkes, Rev. T. H.	—	Devonport.	—	—	—	—
Freeman, Rev. A.	F.	Sittingbourne -	O.G.	6'5	1	4
Gale, W. F.	G.	Sydney, N.S.W.	Spec.	8'5	1	4
Kempthorne, Rev. P. H.	—	Wellington Coll.	—	—	—	—
Lemmon, G. F.	—	Hastings.	—	—	—	—
Lynch, H. F.	—	London.	—	—	—	—
Maunder, E. W.	E.W.M.	Greenwich -	O.G.	12'8	—	4
Molesworth, Lieut. P. P.	P.P.M.	Hong Kong -	Spec.	9'2	1	7
Monck, W. H. S.	—	Dublin.	—	—	—	—
Noble, Capt. W.	N.	Maresfield.	O.G.	4'2	—	4
Russell, Miss A. S. D.	R.	Greenwich	O.G.	12'8	—	2
			O.G.	10'0		
Smart, Dr. D.	S.	Bermondsey -	Spec.	10'0	—	2
Wardale, H. J.	—	Watford.	—	—	—	—
Waugh, Rev. W. R.	W.R.W.	Portland -	O.G.	4'5	—	3
Williams, A. Stanley	A.S.W.	Brighton -	Spec.	6'5	2	11
Wykes, James	J.W.	Weymouth -	O.G.	4'5	—	3

The circumstances of the opposition and the small apertures at the disposal of most of the English observers prevented them from being able to do more than delineate the most prominent features of the planet; the keenness of sight, patience, and great experience of **Mr. Stanley Williams** enabling him, almost alone of observers in the British Isles, to master the more difficult details. **Mr. Brown's** three sketches, also, show much delicate detail. But the Section was fortunate enough to possess skilled helpers in more southern latitudes, and **Messrs. Antoniadi, Eddie, Gale, and Molesworth** worked under much more favourable conditions, and all supplied valuable notes and drawings. Yet another

Member of the Association, but not of the Section, was also most successful in his study of the planet; Prof. J. E. Keeler, Director of the Allegheny Observatory, whose paper on the planet, illustrated by 12 excellent drawings, has been published as part of Vol. 51 of the Memoirs of the Royal Astronomical Society.

The following table gives a complete list of the drawings received by the Director, with the exception of six. Of these six, two had no note of the time at which they were made, and four are composite sketches, and do not represent the planet at any given time, but are the result of the combination of several different observations. The times of Prof. Keeler's drawings are likewise included for the sake of reference, and also that of a fine drawing by another Member of the Association, Prof. C. A. Young, which was published in "Astronomy and Astro-Physics," Vol. XI., 1892, pp. 675-8.

The Areographical Co-ordinates are from Mr. Marth's ephemeris. "Monthly Notices," R.A.S., Vol. LII., pp. 398-404.

TABLE II.

Reference Num-ber.	Number in Order of Date.	Areogr. Co-ordinates of Centre of Disk.		Observer.	G.M.T. 1892.	Power.	Definition, and Reference to Illustration.
		Long.	Lat.				
1	25	1°2	-12°0	Davis . . .	Aug. 12 - 10 30	165	
2	26	1°2	-12°0	Wykes . . .	" 12 - 10 30	120	
3	80	10°1	-13°3	Everett, Miss . . .	Sept. 17 - 8 45	300	
4	57	12°7	-11°8	Gale . . .	Aug. 31 - 22 55	320	Fig. 7.
5	81	13°7	-13°3	Everett, Miss . . .	Sept. 17 - 9 0	300	
6	4	16°3	-15°3	Maunder . . .	July 8 - 14 48	150	Bad.
7	82	16°1	-13°3	Williams . . .	Sept. 17 - 9 11	225	Fig. 1.
8	19	17°4	-12°1	Smart . . .	Aug. 11 - 11 0	250	
9	20	25°7	-12°1	Maunder . . .	" 11 - 11 34	150	Very unsteady.
10	77	30°0	-13°1	Everett, Miss . . .	Sept. 16 - 9 30	120	
K. 2	33	30°4	-11°8	Keeler . . .	Aug. 17 - 15 32	380	
11	70	32°6	-12°9	Everett, Miss . . .	Sept. 14 - 8 25	220	
12	21	35°7	-12°1	Maunder . . .	Aug. 11 - 12 15	150	Very unsteady.
13	71	38°7	-12°9	Russell, Miss . . .	Sept. 14 - 8 50	300	Fig. 8.
14	76	39°5	-13°0	Williams . . .	" 15 - 9 31	320	Fairly good.
15	69	37°8	-12°8	Brown . . .	" 13 - 8 8	170	
16	72	44°8	-12°9	Everett, Miss . . .	" 14 - 9 15	220	
17	93	47°7	-17°7	Antoniadi . . .	Oct. 15 - 4 45	260	Very fine.
18	73	48°2	-12°9	Williams . . .	Sept. 14 - 9 29	320	Fig. 2.
K. 1	34	50°7	-11°8	Keeler . . .	Aug. 17 - 16 55	380	
19	74	50°9	-12°9	Everett, Miss . . .	Sept. 14 - 9 40	220	
20	12	58°5	-12°5	Ellis . . .	Aug. 5 - 10 10	100	

Reference Num- ber.	Number in Order of Date.	Aroogr. Co-ordinates of Centre of Disk.		Observer.	G.M.T. 1892.	Power.	Definition, and Reference to Illus- tration.
		Long.	Lat.				
21	68	63°3	-12°7	Williams -	Sept. 12 - 9 15	320	Fig. 3.
22	60	67°2	-11°9	Molesworth -	" 3 - 3 53	225	Poor.
K. 12	83	71°1	-13°2	Keeler -	" 17 - 12 57	380	
23	8	82°4	-13°3	Molesworth -	July 28 - 6 57	225	Fair.
24	10	91°4	-12°6	Freeman -	Aug. 4 - 11 49	166	
25	11	91°6	-12°6	Ellis -	" 4 - 11 50	100	Fig. 9.
K. 11	84	93°7	-13°4	Keeler -	Sept. 18 - 15 8	380	
26	64	111°1	-12°3	Waugh -	" 8 - 10 0	200	Poor.
27	9	111°5	-13°1	Ellis -	July 30 - 10 10	100	Unsteady.
28	48	127°0	-11°7	Gale -	Aug. 25 - 2 25	320	Fig. 12.
K. 10	67	134°9	-12°6	Keeler -	Sept. 11 - 13 31	380	
29	58	147°4	-11°9	Antoniadi -	" 2 - 8 45	260	Fig. 10.
30	62	150°7	-12°0	Williams -	" 4 - 10 13	225	Fig. 4.
K. 9	65	157°1	-12°4	Keeler -	" 9 - 13 47	380	
31	55	158°3	-11°8	Antoniadi -	Aug. 31 - 8 15	260	Bad.
K. 8	63	177°8	-12°1	Keeler -	Sept. 6 - 13 19	380	
32	56	181°0	-11°8	Williams -	Aug. 31 - 9 48	225	Fair.
33	6	183°4	-14°2	Eddie -	July 20 - 9 0	—	Fig. 11.
34	49	200°5	-11°7	Brown -	Aug. 27 - 8 40	170	
35	50	201°3	-11°7	Freeman -	" 28 - 9 20	166	
36	51	209°8	-11°7	Noble -	" 28 - 9 55	154	Fig. 13.
K. 7	61	211°7	-11°9	Keeler -	Sept. 3 - 13 46	380	
37	52	213°3	-11°7	Williams -	Aug. 28 - 10 10	320	Fig. 5.
38	47	225°0	-11°7	Antoniadi -	" 24 - 8 30	260	Fig. 14.
39	27	234°5	-11°9	Molesworth -	" 14 - 3 3	225	Fair.
K. 6	59	235°6	-11°9	Keeler -	Sept. 2 - 14 47	380	
40	92	246°9	-14°9	Russell, Miss -	" 28 - 7 22	300	
41	41	251°9	-11°7	Antoniadi -	Aug. 21 - 8 30	260	Steady.
42	14	265°3	-12°4	Gale -	" 7 - 0 55	320	Fig. 15.
43	45	267°3	-11°7	Davis -	" 22 - 10 10	165	
K. 5	53	270°6	-11°7	Keeler -	" 29 - 14 42	380	
Y	7	277°9	-13°6	Young -	July 25 - 18 30	700	
44	42	280°4	-11°7	Noble -	Aug. 21 - 10 27	154	
45	43	280°7	-11°7	Freeman -	" 21 - 10 28	166	
46	44	281°1	-11°7	Williams -	" 21 - 10 30	225	Poor.
47	5	282°5	-15°0	Eddie -	July 11 - 10 15	—	
48	17	282°5	-12°2	Molesworth -	Aug. 9 - 3 18	225	Very good.

Reference Number.	in Number Order of Date.	Areogr. Co-ordinates of Centre of Disk.		Observer.	G.M.T. 1892.	Power.	Definition, and Reference to Illus- tration.
		Long.	Lat.				
49	36	282°8	-11°7	Waugh - -	Aug. 20 - 10 0	200	Poor.
50	37	287°7	-11°7	Davis - -	" 20 - 10 20	165	
51	38	290°1	-11°7	Smart - -	" 20 - 10 30	250	
52	85	290°7	-13°5	Antoniadi - -	Sept. 19 - 5 15	140	Steady.
53	39	292°0	-11°7	Williams - -	Aug. 20 - 10 38	225	Fig. 6.
K. 4	54	295°5	-11°7	Keeler - -	" 29 - 16 24	380	
54	13	296°1	-12°5	Gale - -	" 6 - 2 25	320	Fig. 16.
55	16	296°2	-12°3	Molesworth - -	" 8 - 3 38	225	Good at times.
56	87	297°2	-13°7	Brown - -	Sept. 21 - 6 20	170	Fig. 17.
57	40	297°4	-11°7	Wykes - -	Aug. 20 - 11 0	120	
58	89	303°3	-14°3	Davis - -	Sept. 24 - 8 40	165	
59	35	304°3	-11°7	Antoniadi - -	Aug. 18 - 10 15	260	Fig. 18.
60	90	304°5	-14°3	Williams - -	Sept. 24 - 8 45	320	Fair.
61	88	313°9	-14°1	Everett, Miss - -	" 23 - 8 45	120	Fig. 19.
62	15	317°2	-12°4	Molesworth - -	Aug. 7 - 4 28	375	Change- able.
63	91	317°9	-14°3	Davis - -	Sept. 24 - 9 40	165	
64	32	322°1	-11°8	Davis - -	Aug. 16 - 10 15	165	
65	1	330°8	-16°1	Williams - -	June 5 - 15 25	320	Poor.
66	86	330°9	-13°5	Ellis - -	Sept. 19 - 8 0	100	(Unfinished sketch).
67	2	333°4	-15°4	Ellis - -	July 7 - 11 15	100	Very un- steady.
68	28	334°6	-11°9	Davis - -	Aug. 15 - 10 30	165	
69	66	334°6	-12°6	Molesworth - -	Sept. 11 - 2 33	450	Fig. 20.
K. 3	46	334°6	-11°7	Keeler - -	Aug. 22 - 14 46	380	
70	78	336°9	-13°3	Antoniadi - -	Sept. 17 - 6 30	260	Excellent.
71	29	337°1	-11°9	Noble - -	Aug. 15 - 10 40	154	
72	30	338°3	-11°9	Wykes - -	" 15 - 10 45	120	
73	31	339°5	-11°9	Freeman - -	" 15 - 10 50	280	
74	75	340°8	-13°0	Antoniadi - -	Sept. 15 - 5 30	260	Very un- steady.
75	79	344°2	-13°3	Waugh - -	" 17 - 7 0	115	Poor.
76	22	345°4	-12°0	Ellis - -	Aug. 12 - 9 25	100	
77	3	357°2	-15°3	Maunder - -	July 8 - 13 30	150	Very bad.
78	23	357°6	-12°0	Ellis - -	Aug. 12 - 10 15	100	
79	18	358°6	-12°2	Antoniadi - -	" 9 - 8 30	260	Fig. 21.
80	24	358°8	-12°0	Noble - -	" 12 - 10 20	154	

In dealing with so large a number of drawings, the easiest method in which to utilise the amount of material available appeared to be to take limited portions of the surface, and study

together all the drawings referring to the district selected. For this purpose the surface of the planet has been arbitrarily divided into seven sections. Of these, six are comprised between S. latitude  $60^\circ$  and N. latitude  $40^\circ$  and have each an average breadth of  $60^\circ$  of longitude. The seventh is the south circumpolar region, from the pole to S. latitude.  $60^\circ$ .

The first six sections have been named after the principal dark spots, which in Schiaparelli's nomenclature bear the names of *Mare Erythræum*, *Lacus Solis*, *Mare Sirenum*, *Mare Cimmerium*, and *Syrtis Major*; the *Mare Erythræum* as it extends over  $110^\circ$  of longitude being treated in two sections, named after its principal arms; *Sinus Sabæus* and *Auroræ Sinus*. The sections are therefore as follows:—

TABLE III.

No. of Section.	Name of dark spot.	Limiting Longitudes.	Sketches referring to the District.
I.	<i>Mare Erythræum</i> - (a.) <i>Sinus Sabæus</i> .	$310^\circ-15^\circ$	Nos. 61-80, and 1-13, and K. 3 and 2.
II.	<i>Mare Erythræum</i> - (b.) <i>Sinus Auroræ</i> .	$15-60$	Nos. 77-80, and 1-25, and K. 2, 1, 12 and 11.
III.	<i>Lacus Solis</i> -	$60-120$	Nos. 13-27 and K. 1, 2 and 9-12.
IV.	<i>Mare Sirenum</i> -	$120-180$	Nos. 28-37, and K. 7-11.
V.	<i>Mare Cimmerium</i> -	$180-250$	Nos. 28-46, and K. 5-9.
VI.	<i>Syrtis Major</i> -	$250-310$	Nos. 38-74, K. 3-5, and Y.
VII.	<i>South Polar zone</i> -	—	All the sketches.

In the descriptions which follow both Green's and Schiaparelli's nomenclatures have been adopted, the names on the chart of the former being usually placed within brackets, whilst those of the latter are printed in italics. The initials of the observers have been printed in a heavier type.

The dark spots have been systematically alluded to as oceans, seas, and bays, and other names signifying water; the brighter spots in like manner by words appropriate to land. The practice has high sanction, is in general use, and appears decidedly convenient. If it be objected that the use of these terms implies a knowledge of the condition of the surface of Mars not warranted by the facts of the case, it may be replied that we habitually use "mare" and "sinus" "sea" and "bay," in reference to the moon, on the surface of which we have good reason to believe no water now exists; whilst in the case of Mars such evidence as is available decidedly points in the direction of some, at least, of the darker markings being actually caused by the presence of water. The term "canal" has also been retained, though "canals" in the



sense of being artificial productions, the markings on Mars, which bear that name, are certainly not. It is difficult indeed to understand how so preposterous an idea obtained currency for a moment, even with the most ignorant. Since, however, such a misapprehension has occurred, it would seem inadvisable to use the term in works intended for the general public. As a purely technical term, and in a publication where it will not be misunderstood, there appears no objection to its use, and much convenience in retaining it rather than supplanting it by some newly coined expression. "Canal," "sea," "bay," "shore," "island," "peninsula," &c., are therefore to be understood as being used in the following notes in a purely technical and not in a geographical sense. Though we may very reasonably think that water and land exist on Mars, these terms are not used as prejudging the question, but simply as a convenient and easily understood method for describing the appearances presented by different portions of the planet's surface.

In the following section "west" and "east" have throughout been used in their areographical sense, not in their ordinary astronomical sense. Thus, of two markings, the preceding has been always referred to as the eastern, the following as the western.

#### I.—MARE ERYTHRÆUM; (SINUS SABÆUS).

The *Mare Erythræum* (De La Rue Ocean) is the largest dark district on the planet, extending from the south polar cap nearly as far as the equator, and from *Hellas* (Lockyer Land),  $L = 310^\circ$  to *Thaumasia* (Kepler Land),  $L = 60^\circ$ . The principal branch of the *Mare* is *Sinus Sabæus* (Herschel II. Strait), separating *Aeria* (Beer Continent) from *Deucalionis Regio* (Phillips Island). For the sake of convenience this inlet or strait, with the regions north and south of it, are taken together, leaving the western portion of the *Mare*, the principal inlet of which is *Auroræ Sinus* (Christie Bay) for a separate section.

For this portion of the *Mare Erythræum* then, the limits adopted have been the west coast of *Hellas* (Lockyer Land) and the *Hammonis Cornu* (Bank's Cape) on the east, to the centre of *Thymiamata* on the west, or from  $L = 310^\circ$  to  $L = 15^\circ$ . Sketches Nos. 61–80, and 1–13, with K.'s 3 and 2.

PROGRAMME DETAILS.—The first and last questions in the Director's programme ("Journal," Vol. II., No. 8, p. 424) related to this district, and ran as follows:—

"(a.) *Deucalionis Regio* (Phillips Island). Distinctness as compared with continent to the north. Are any obscure regions to be seen in the channel between *Deucalion* and *Edom*? Special attention to the follow-end of *Deucalion*. Does it curve round to join *Thymiamata*? Does it undergo change?"

"*Mare Erythræum* (De La Rue Ocean). The various bright regions shown by Schiaparelli in this sea from *Hellas* (Lockyer Land) to *Ogygis Regio* (Jacob Land) want careful study, as Schiaparelli differs much from many other observers."

Most observers show no difference in brightness between *Deucalion* and the continent to the north. The exceptions are,

however, sufficiently numerous and important to make it probable that *Deucalion* was distinctly less bright than *Edom* and *Aeria*, at this opposition though much brighter than the *Sinus Sabæus* G., No. 4; A.S.W., Nos. 7 and 14; K., 2; and E.W.M., No. 9, agree in representing *Deucalion* as slightly but unmistakably below the continent in brightness. A. seems to have found it variable, for it was an easy feature on August 9, was visible on September 19, but a very difficult object when near the limb on September 17 and only just a shade lighter than the *Mare Erythræum* on August 18. A.S.W. gives reason to suspect a change in tint also, for he reports it as bright and plain on June 5, and its colour as "strongly reddish," whereas in 1890 it was much brighter and very white. On September 15 and 16 the same observer noted it at "moderately bright," and its colour as only "slightly reddish." The western part on the later date was decidedly fainter than the eastern. F., August 15, confirms the red colour, and G. describes it, September 1, as of the same tint, and of very little less depth of tone than *Aeria* and *Edom*.

*Conclusion.*—*Deucalion* in 1892 was slightly but not very strikingly less bright and less ruddy than the continent to the north. It probably varies in colour and brightness at different oppositions; possibly in the course of a few days.

The only observer to record the obscure regions in the *Sinus Sabæus* is A.S.W. He suspected the *Sinus* to be double on June 5, and perceived the presence of *Xisuthri Regio* on September 18 and 19, distinctly less dark than the rest of the gulf. In moments of inferior definition the presence of *Xisuthrus* caused the *Sinus* to appear coarsely double. L.A.E. observed the northern edge of the *Sinus* as very dark on July 11, but did not detect any island.

There is a considerable bulk of evidence with regard to the following or western end of *Deucalion* and its connexion with *Thymiamata*. The following observers closely follow Green's representation, and show a more or less cigar-shaped island, lying due east and west, and quite disconnected with *Thymiamata*, no trace of an isthmus being recorded:—B., September 13; D., August 12; E.W.M., July 8, August 11; P.P.M., September 3; S., August 11. Whilst the following record the isthmus, more or less distinctly and show *Deucalion* as represented by Schiaparelli:—A., August 9, September 15; A.E., September 14 and 17; G., September 1; K., August 17 and 22; N., August 12; and R., September 14. And A.S.W. gives a third version, and in his drawings of September 14, 15, and 17, shows a narrow channel separating Phillips Island from *Thymiamata*.

The dates, it will be seen, do not suggest the likelihood of real change, unless it take place with great rapidity. A comparison of the sketches available on September 17, renders this explanation improbable. On this date three sketches are available, Nos. 3, 5, and 7, at the times 8<sup>h</sup> 45<sup>m</sup>, 9<sup>h</sup>, and 9<sup>h</sup> 11<sup>m</sup>. Of these, Nos. 3 (A.E.) and 7 (A.S.W.) accord very closely indeed as to the positions and dimensions of the various markings. No. 5 (A.E.) is not so good. The fact that these three sketches taken within the course of half-an-hour show the strait as first, just closed, then wide open, and finally almost closed, seems to forbid our ascribing the difference to real change on the

planet. There is another explanation which is strongly suggested by many of the sketches which show the isthmus. It is that the western end of *Deucalion* is fainter than the eastern, and that the isthmus itself is probably fainter still, so that the contrast between it and the contiguous seas can easily be overlooked in moments of poor definition or by observers not sensitive to delicate differences of shade. Probably too, the isthmus is pierced by a canal parallel to the equator at its junction with *Thymiamata* and the peninsula by one perpendicular to the equator near its western end. Thus **K.** shows a very distinct shade in the first of these two positions, **A.** practically confirms it by marking a strong contrast in brightness between *Thymiamata* and the isthmus, and **A.S.W.** divides the two by a very narrow channel. And **G.** records a very distinct shade or canal in the second position which **N.** appears to confirm, whilst **A.S.W.** by rendering the western portion of Phillips Island as markedly fainter than the eastern may be held to afford a further confirmation. **A.E.** shows the isthmus as fainter than either the mainland or the peninsula; and **R.** appears not only to show the isthmus as faint, but to show both the two channels alluded to above. (See Fig. 8 in the Plate).

*Conclusion.*—The differences in the representation of *Deucalion* are probably not due to change on the planet, but to the fact that whilst the marking has the general form given by Schiaparelli, the isthmus and western end of the peninsula are fainter than the rest of the *Region*, and are perhaps divided from the rest of the peninsula and from the mainland by narrow channels. They are, therefore, probably difficult to observe if the atmospheric conditions either on Mars or on the earth are unfavourable, and under such circumstances the cigar-shaped Phillips Island is all that is noted.

The light markings in the *Mare Erythræum* S. of the *Sinus Sabæus* (Herschel II Strait) are very differently rendered by different observers. The entire district is filled with markings, less bright than the equatorial continent, but brighter than the sea. These are sometimes seen as one broad diffused light spot, sometimes broken up into a series of fairly definite stripes. A careful comparison of the sketches obtained during this opposition shows unmistakably that this difference is purely a matter of defining power. The smaller apertures almost always give a single spot, the larger always break it up into two or more separate markings. It may be taken that the resolution of this spot is about the limit of a good 4-inch telescope. **D.** shows it four times undivided, and once breaks it up into two. **N.** divides it very clearly on one occasion, but fails to resolve it on another. The 33 sketches concerned are so widely distributed in time that it is clear that any hypothesis of actual change on the planet may be ruled out of court. Besides, it curiously happens that of the two observers who found the marking just about their limit of vision, **D.** resolved it on August 12, when **N.** failed to do so, and **N.** resolved it on August 15, when **D.** failed to do so. Evidently a slight variation in the local seeing was sufficient to make all the difference.

Of the 21 sketches that resolve the marking more or less completely, the great majority show *Deucalionis Regio* divided by a

narrow strait (Arago Strait) from *Noachis* (Kunowski Land), which extends nearly to the polar cap. No. 65 (A.S.W.), No. 4 (G.), and No. 15 (B.), show a much more complicated condition. G.'s sketch, No. 4, is the most complete, and receives a considerable amount of support from those of A., Nos. 70 and 79, and A.S.W., Nos. 7 and 14. It falls short of the detail of Schiaparelli's chart, but considering that the amount of detail shown in this district is evidently so closely connected with seeing power, the further extent to which the Italian observer was able to resolve these markings probably merely indicates that his observations were made under more favourable circumstances than the Australian; not that any change took place in the planet. Neither Green nor Schiaparelli quite represent the state of things as shown by G., but the five islands he depicts appear to correspond roughly to *Deucalionis Regio*, *Yaonis Regio*, *Noachis*, *Pyrrha*, and *Argyre*. The three last-named markings will be treated of in the next division, and the *Yaonis Regio* in the sixth.

*Conclusion.*—Schiaparelli's chart is substantially correct as to the islands in the *Mare Erythræum*.

DAWES' FORKED BAY.—A most interesting marking in this Section is Dawes' Forked Bay, of Green and Proctor's charts. The tongue of land separating the two estuaries is the *Fastigium Aryn* of Schiaparelli. G. shows the fork very clearly on August 31; L.A.E. saw it well on July 11 and August 7; and A. found the bay "decidedly forked" in the rare moments of good definition on August 9. K. represents the fork with great distinctness on August 17 and 22. On the other hand, A.S.W. saw the bay on September 15 and 17 as a spot considerably darker than the rest of the *Sinus Sabæus*, but failed to make out clearly the actual fork on September 17. He seems, however, to have observed it on June 5. A. on September 15 and 17, and E.W.M. on July 8 observed the bay, but failed to detect the fork, and H.E. on July 7 reproduces the form of the circular spot under which Mädler observed the bay in 1830. Here, again, there is no clear evidence of planetary change; it is simply a question of defining power, whether due to the telescope, the atmospheric conditions, or the keenness of the observers' vision.

But the question of proportion is a different one, and it is clear that here we have to do with the observers' "personal equation." K. and A. give *Deucalionis Regio* of nearly double the area that G. does; A.E., E.W.M., N., and A.S.W., on a larger scale still. H.E. comes most nearly to G.'s scale, but still exceeds it.

The question is a very important one, for if we turn to Schiaparelli's map we find a succession of bright markings running parallel to the equator, and bending over towards it at their western end. These are the *Regiones*, *Japeti*, *Xisuthri*, *Deucalionis*, and *Pyrrhæ*, and beyond them lie *Noachis* and *Argyre* forming a fifth. Schiaparelli shows these as increasing in size in the order of their distance from the equator. It is clear that with markings so similar in form, and so near in position, if the strictest adherence to scale and to relative position be not preserved, the delineations of the district must give rise to the greatest discordances and confusion.

**THE CANAL SYSTEM.**—The canals observed are the following : *Phison, Euphrates, Hiddekel, Gehon, and Orontes.*

*Phison.* Clearly shown for a good part of its course by **P.P.M.** on August 8, and for a shorter distance on August 9. **K.** shows it for nearly its entire length as a faint streak on August 22.

*Euphrates.* Shown very clearly by **K.** as a faint streak on August 22.

*Hiddekel.* Seen by **A.S.W.** on June 5, and on September 18 and 19 with the *Ismenius Lacus*. It was distinctly seen as a narrow definite streak. **P.P.M.** also shows it clearly on September 11.

*Gehon.* Seen on June 5, and quite distinctly, as a faint dark streak on September 15 by **A.S.W.** The exact position of the N. end was doubtful. It was faintly glimpsed as a feeble streak on September 17. It is shown for a short distance by **P.P.M.** on September 3.

*Orontes.* Distinctly shown by **P.P.M.** on September 11. Suspected by **A.S.W.** on September 19.

**ILLUSTRATIONS.**—From the series of diagrams supplied by **Mr. A. Stanley Williams**, six have been selected, one to illustrate each of the six divisions in which the extra-polar portion of the planet has been divided. Fig. 1, subjoined, illustrates the region of the *Sinus Sabæus*.

<i>a</i> = Polar cap.	<i>h</i> = <i>Syrtis Major</i> .
<i>b</i> = <i>Hellas</i> .	<i>i</i> = Dawes Forked Bay.
<i>c</i> = <i>Arabia</i> .	<i>k</i> = <i>Gehon</i> .
<i>d</i> = <i>Argyre</i> .	<i>l</i> = <i>Indus</i> .
<i>e</i> = <i>Noachis</i> .	<i>m</i> = <i>Hammonis Cornu</i> .
<i>f</i> = } <i>Deucalonia</i> .	<i>n</i> = <i>Thymiamata</i> .
<i>g</i> = } <i>Regio</i> .	

*a, b, c,* and *d* are white, or whitish, *b* appearing to project beyond the limb.

Other illustrations referring to this district are Figs. 16–21 and 7–8 in the Plate; the two showing it most completely being Fig. 21, by **A.**, and Fig. 7, by **G.**

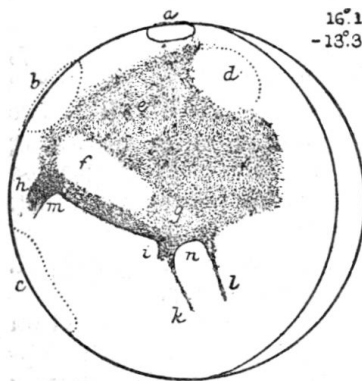


Fig. 1. 1892. Sept. 17. 9<sup>h</sup> 0<sup>m</sup> to 9<sup>h</sup> 22<sup>m</sup>

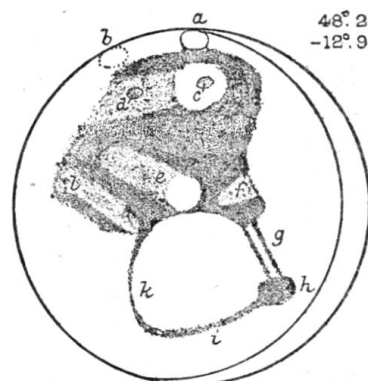


Fig. 2. 1892. Sept. 14. 9<sup>h</sup> 16<sup>m</sup> to 9<sup>h</sup> 41<sup>m</sup>

## II.—MARE ERYTHRÆUM (SINUS AURORÆ).

This Section has been taken as commencing in the centre of *Thymiamata*, and as extending to the E. coast of *Thaumasia* (Kepler Land), or from  $L = 15^\circ$  to  $L = 60^\circ$ . Sketches Nos. 77-80, and 1-25, with K.'s 2, 1, 12, and 11.

PROGRAMME DETAILS.—The only questions in the Director's programme referring to this Section are the following:—

“*Indus* (Burton Bay). The distinctness and shape of this marking should be noted. Does it trend due N., or is it strongly inclined to the W.? Does it completely separate the continents, *Eden* (Beer Continent) and *Chryse* (Mädler Continent)?

“*Protei Regio*. Look for this white spot and carefully chronicle appearances, if any.”

A.S.W. shows the *Indus* to be broad and dark at the mouth, and to be fainter and more difficult to trace further N. It runs due north for a considerable distance, and then curves to the W. to join the *Nilokeras*. It is not traced on any of the sketches so far N. as the *Mare Acidalium*. A.S.W. observed it on September 12, 14, 15, and 17; on the last date it was faint and not conspicuous, but on October 20 it was seen plainly, its colour very blackish. It was apparently seen by L.A.E. on August 1, 4, 7, and 16, on which last occasion it was observed to trend strongly towards the E., as shown by Green; its northern portion thus corresponding to Schiaparelli's *Oxus*. L.A.E. expressly remarks that he could not ascertain whether the canal cut right through the continent or not. G. records it as well-defined and dark on September 1, but as not being traceable very far N.; P.P.M. also shows it, but only for a very short distance, on September 3.

CHRYSE (Mädler Continent) evidently is more correctly represented as to shape and dimensions on Schiaparelli's map than on Green's. Colour on August 4, red; (F.) This district is one of the most important instances of discordance between the two great authorities on Martian topography.

PYRRHÆ REGIO.—Very variously shown, many observers not recording it at all. The evidence, however, for its existence is too strong to be called in question. It appears to be fainter than *Deucalion*, and a similar divergence of opinion as to its shape prevails as was noted in the case of its consort. A., August 9, shows *Pyrrha*, as a peninsula similar to *Deucalion* in accordance with Schiaparelli's chart. K., August 17 and September 17, confirms this with the difference, however, that he records a narrow dusky channel which keeps its from being quite joined to the *Prom. Aromaticum*. It should be noted that A.'s drawing gives a similar effect, as there is a marked contrast in brightness between *Pyrrha* and the promontory at the place of contact. The two observers, however, differ widely as to the distinctness of the *Region*. A. could only see it by glimpses on August 9, K. found it quite bright on August 17 and September 17.

A.S.W. appears to have failed to have seen *Pyrrha* at all on September 17,  $3\frac{3}{4}$  hours before K. saw it “bright.” On September 14 he had seen it rather plainly as a straight island, very similar to the form which he gave to *Deucalion*. It was clearly

separated from the *Prom. Aromatum* by a narrow dark channel. It was seen again, but not so well, on September 15, only the western end being discerned. Contrary to what prevailed in the case of *Deucalion*, the western half of *Pyrrha* is recorded by **A.S.W.** to be the brighter, and his observation is practically substantiated by other observers. **B.**, September 13, shows *Pyrrha* very well, but like **A.S.W.** makes it quite cut off from *Chryse*. **A.E.**, September 14, and **R.**, the same date, notice only the brighter western end, and represent it as **A.S.W.** does on September 15, as a small slightly elliptical island, not as a long cigar-shaped one, or as a hooked promontory. **G.** appears to show it as a very long marking on August 31, quite detached from *Chryse*. No isthmus is shown at all.

**K.** differs from the other observers in one important respect; he makes *Pyrrha* run into and amalgamate with *Deucalion* at their eastern end on both August 17 and September 17. None of the Section observers confirm this observation. On the contrary, the two markings are always shown quite distinct. **A.E.** on September 23, apparently saw the two markings fused together, close to the west limb, but, even under these unfavourable circumstances, occasionally suspected that the light spot which they together made up was bisected by a narrow longitudinal channel.

The general tenor of the observations goes to show that *Pyrrha* is separated from *Deucalion*, and separated, though but by a narrow channel, from *Chryse*. Its western end is the brighter, it tends to fade away towards the east. It is possibly variable in brightness, but if we ascribe all the discrepancies between observers to real planetary changes, these must take place with great rapidity. It is far more probable that we are simply dealing with a difficult object, only to be seen in its entirety under especially good circumstances, and easily lost in the general shade of the *Mare Erythræum* if the conditions for seeing are unfavourable.

*NOACHIS AND ARGYRE* (Jacob Land).—To many observers, as was noted in the preceding Section, these two islands appeared as a single bright spot, but **G.** and **A.S.W.** were able to resolve it into its two or more components. The latter observed *Argyre* as a bright spot on the *s.p.* limb, near the polar cap, on September 10. It was nearly as white and bright as this latter; whiteness =  $w_3$ . On September 14 it was a rather bright spot, nearly circular, fairly well defined, but fainter towards the edges. Colour, slightly reddish. On September 15 this observation was repeated, and irregularities were noted in its circumference. *Noachis* appeared as a faint tail or extension of *Argyre* on September 14 and 15, no dark interval being detected between them, but on September 17 a dark channel was distinctly seen separating the two. *Noachis* was not very bright, was much fainter than *Argyre*, and, like it, was slightly reddish in colour. **G.** shows the two very clearly separated on August 31, but represents both as long, narrow markings, longer than Schiaparelli gives them; fusing *Noachis* with *Argyre II.* to form one spot, and combining the three divisions of *Argyre I.* with *Ogygia* to form a second. **F.** and **R.** on August 4 and September 14 respectively saw *Noachis* and *Argyre* as a single marking. **B.** saw *Argyre* as an island on

September 13, *Noachis* being lost in the limb whiteness. **N.** shows the latter very distinctly on August 15, and **A.E.** on September 23 represents it as a faint whitish marking separated from *Hellas* by a faint dusky channel. **S.**, like **A.E.**, shows *Noachis* and *Argyre* separate on August 11. There is, therefore, quite sufficient evidence to conclude that these islands really exist, and exist as distinct islands, notwithstanding that some observers ignore them altogether, and others can only detect one large undivided greyish spot. On the whole, the best evidence goes to confirming Schiaparelli's chart in this district.

*OGYGIS REGIO* is distinctly shown by **B.**, September 13, and apparently by **A.S.W.** and **F.**, the latter of whom indicates its colour as yellow on August 4. It seems to have been faintly seen by **P.P.M.** on September 3.

*PROTEI REGIO* (Dawes Snow Island, or Hall Island). The *Auroræ Sinus* (Christie Bay) is, of course, seen on all the drawings of the district, but **K.**, August 17, shuts it in by a little bright arch. This is shown by **A.S.W.**, September 14 and 15, as a bright wedge standing out from Kepler Land. It may possibly be identified with Dawes Snow Island, the Hall Island of Green, *Protei Regio*, but if so is misplaced, either on the standard maps or on the drawings before us, further than seems admissible. The arch across the mouth of the *Auroræ Sinus* is drawn by **K.** as a complete one, whilst **A.S.W.** traces a distinct channel between *Proteus* and the S. coast of *Chryse*. **K.**, however, notes that *Proteus* is brightest in the centre, and fades off at either end, so the discrepancy is of the slightest. *Proteus* seems also very faintly indicated by **P.P.M.** on September 3.

**CANAL SYSTEM.** *Ganges*.—This canal was the most conspicuous of the 1892 opposition, and was frequently seen by **A.S.W.** On September 10, it was a very dark broad canal, and extended a long distance towards the N., curving so as to follow the curvature of the limb. Its appearance strongly suggested that it was double. On September 12 it was a very dark, straight, broad, very well-defined streak, distinctly double at times, one of the darkest and plainest canals the observer had ever seen, decidedly plainer than the *Solis Lacus*. The southern portion of the *Ganges* seemed plainer than the rest, either from a union with the *Fons Juventæ*, or else from its widening into an estuary at the *Auroræ Sinus*. The doubling of the canal was also distinctly seen on September 14 and 15, and it seemed double on October 20.

**K.** saw a broad ill-defined shade in which were two maxima, on August 17, September 17 and 18. This was probably the *Ganges* as a double canal. A broad faint streak is shown by **H.E.** on August 5 in the precise place of the *Ganges*.

*Fons Juventæ* was seen by **K.** as a minute dark dot on September 17 and 18. A local darkening of the *Ganges* on September 12 was thought by **A.S.W.** to be possibly due to this lake. **A.S.W.** also suspected its presence on October 20.

*Lunæ Lacus* was apparently seen by **F.** on August 4, and by **H.E.** on August 5. **A.S.W.** observed it on September 12 and 14; a nearly circular spot, distinct and dark.



*Titan* has already been dealt with under the "Programme details."

*Hydaspes*, *Hydrastes*, and *Jamuna* were looked for by A.S.W. on September 14 and 15, but not seen, but R. appears to show the last-named strongly marked on September 14.

*Nilokeras* was very dark and very well defined, possibly double, as seen by A.S.W. on September 14. On September 15 it was too near the limb to be properly observed, but was a very dark definite streak.

*Mare Acidalum*, (Knobel Sea) was apparently seen by L.A.E. July 24, 26, and August 1, and distinctly so, August 4; and by P.P.M. July 28.

ILLUSTRATIONS.—Fig. 2, above, acts as key-map to the *Sinus Auroræ* district.

*a* = Polar Cap.

*b* =

*c* = *Argyre*.

*d* = *Nouchis*.

*e* = *Pyrrhæ Regio*.

*f* = *Protei Regio*.

*g* = *Ganges*.

*h* = *Lunæ Lacus*.

*i* = *Nilokeras*.

*k* = *Indus*.

*l* = *Deucalionis Regio*.

Figs 21, 7 and 8 in the Plate, refer to this district, but none show it quite fully presented. Fig. 2 is the best in this respect.

### III.—LACUS SOLIS.

The *Oculus*, Green's Terby Sea, Schiaparelli's *Lacus Solis*, one of the most characteristic markings on the planet, is a round dark spot in the centre of a bright marking, also roughly circular in shape. It is often seen alone, but during the opposition of 1892, similar dark spots were seen in its immediate neighbourhood. The district may be taken as extending from  $L = 60^\circ$  to  $L = 130^\circ$ , and some portion of it is included on sketches Nos. 13–27. Unfortunately, only a few of these were made when the *Oculus* was near the central meridian, and practically there are only six available for the study of the district, and these not of the best. On the other hand, it was well seen by K., who has six drawings of it; 1, 2, and 9–12. Under these circumstances it appears the better course to take the several features of the district in succession, rather than first of all to set forth how far the programme has been fulfilled.

*SOLIS LACUS*. (Terby Sea.) Shown with certainty only on four drawings by Members of the Section. Evidently the lake was faint and inconspicuous during the greater part of the period of observation.

Thus L.A.E. does not report it on July 30, and could not see it on July 31. On August 4 it was clearly seen by K. and less distinctly by H.E.; who, however, appears to have failed to see it on the next night. A.S.W. looked for it on September 10, but failed to see it, but succeeded in glimpsing it occasionally on September 12 as a faint indefinite dark shade, its position being known. A. caught it by moments on October 15 as a circular or slightly elliptical dusky spot, and records his impression that it was fainter at this opposition than at those which preceded it. A.S.W. looked for it unsuccessfully again on

October 20, though the outline of *Thaumasia* was seen very sharply and brightly.

This record is a remarkable one for a spot usually so distinct and easily recognised. It is rendered more remarkable by the contrast with **K.**'s observations. On August 17, September 9, 11, 17, and 18, this last observer recorded the presence of the lake, which appeared to him a dark grey spot, somewhat darker than the *Mare Erythræum*, and practically circular in shape. So great a discordance in the case of one of the standard markings of Mars is most extraordinary, and is very difficult to explain. It is, of course, true that the difference of longitude between **K.** and the English observers tended to throw the date of his observation of any particular marking at a different time from theirs. This, indeed, is one great advantage of the association of observers on different meridians, that it is possible to retain a given part of the planet's surface continuously under observation, instead of losing it for a fortnight or more. But though difference of date might account for some of the observations, it cannot for all. We have, for instance, **A.S.W.** on September 10 failing to identify the lake, though it was carefully looked for, whilst **K.** records it on both September 9 and 11, though on both occasions it was badly placed, being close to the limb. It would seem as if no explanation were possible than that it was hidden from us for a few hours on September 10 by a veil of cloud in the atmosphere of Mars itself.

A beautiful little drawing on July 28 by **P.P.M.** unfortunately does not help in clearing up the difficulty, owing to a slight misplacing of some of the dark spots. Apparently the *Lacus Solis* is shown, connected by the *Agathodæmon* with the *Ganges*. A small dark lake, probably *Lunæ Lacus*, lies near the end of the *Ganges*, and the canal *Ceraunius* is shown further north, curved so as to lie parallel to the limb.

The tendency of the observers is to show both *Solis Lacus* and *Thaumasia* as a little smaller than Schiaparelli gives them, but with the same relative proportions. In this respect Green's chart is supported rather than Schiaparelli's.

*THAUMASIA* (Kepler Land) is shown with a nearly truly circular outline by **K.** The Members of the Sections all tend to give it a somewhat squarer form, except **A.** who reproduces **K.**'s representation very precisely. **A.S.W.** expressly notes, October 20, that it appeared to run up nearly straight from the *Sinus Auroræ*, not in a curve as on Schiaparelli's map. **K.** found it slightly narrower than on Schiaparelli's map, and suspected an encroachment on it of the *Mare Erythræum*. The same observer found the southern half of *Thaumasia* somewhat dusky on September 17 and 18, and fainter than the northern. **H.E.** fully confirms this on August 4.

*TITHONIUS LACUS* raises further difficulties. If **P.P.M.**'s sketch on July 28 has been correctly interpreted, the observer failed to see it on that date, whilst the *Ganges* and *Lacus Solis*, on either side of it, were conspicuous. **F.** seems to have seen it quite distinctly on August 4; but **H.E.** on the same night, and practically at the same time, did not see it. **A.S.W.** saw it

distinctly, but not very satisfactorily, on September 12. It seemed to be oval in shape and fairly dark. **K.** shows it on August 17, September 17 and 18, and found it a dusky red, not a grey marking, roughly triangular in shape, and *much* larger than the *Solis Lacus*. It was also crossed by a faint narrow bridge which was very well seen on September 18, when the marking was near the central meridian.

*LACUS PHÆNICIS* (Bessel Lake). There is considerable difficulty about this marking also. **K.** shows on September 11, 17, and 18, a round dark spot, somewhat like the *Solis Lacus*, but not so large. But it is not in the chart place for the *Phœnix Lake*, nor is there any known marking to correspond to it, and the *Phasis* appears to be clearly marked some  $13^{\circ}$  further east, and flows into the dusky marking already interpreted as *Tithonius*, the *f* angle of which occupies the true place of the *Phœnix*. It seems, therefore, preferable to interpret this great irregular marking on **K.**'s drawings as representing not *Tithonius* only, but also the *Lacus Phœnicis* and some portion of the canals *Agathodæmon*, *Fortuna*, *Iris*, and *Phasis*. If so, the new spot is, perhaps, part of the *Nodus Gordii*, though that would rather appear to be indicated by a dark spot on the canal *Sirenus* on September 18.

It is the greatest difficulty of the 1892 opposition to explain the great difference between **K.**'s representations of the lake district north and west of the *Lacus Solis* with those given by the Members of the Section. For **K.**'s five drawings, August 17, September 9, 11, 17, and 18, are in the closest agreement with each other, and have received confirmation from observations made elsewhere. Yet the only hint of the condition of affairs which **K.** delineates given by any Member of the Section are the following remarks by **A.S.W.** under date September 10:—

“Although one of the best nights of the season, the appearances were very strange and confusing, and it was difficult to recognise or identify the markings.”

*THARSIS* (Secchi Continent) was noted as yellow by **F.** on August 4, but **K.** gave it as red and very bright, September 17 and 18.

*ICARIA*.—(La Grange Peninsula) was wanting on August 31 and September 2, accordingly to **A.**'s drawings, the *Mare Sirenum* merging into the *Aoniæ Sinus*. **K.** and **A.S.W.**, however, show *Icaria*. This is a possible case of change. See page 175.

PROGRAMME DETAILS.—The part of the Director's programme referring to this district is recapitulated here, though, as has been seen, the observations mostly dealt with other points:—

(d.) *Solis Lacus* (Terby Sea).—Special attention to size and shape of the sea and of the land surrounding it. Do any canals proceed from the sea? Is *Tithonius Lacus* visible? If so, compare size, shape, and distinctness with *Solis Lacus* carefully and at frequent opportunities.

“Can the *Lacus Phœnicis* be made out? Do any canals diverge from it?”

CANAL SYSTEM.—*Agathodæmon*.—A.S.W. saw this canal certainly several times, but, as a rule, not very distinctly. It was rather dark on September 12, was seen plainly on September 14, and on September 15 it was very dark, rather broad and well defined. P.P.M. seems to have recorded it distinctly on July 28.

*Nectar* was seen on September 14 and 15 by A.S.W. N. of *Protei Regio*, and extending almost certainly to *Solis Lacus*. A faint opening through *Thaumasia* was occasionally suspected by K. on September 17 and 18. H.E. appears to show it on August 4.

*Chrysorrhœas*.—A.S.W. believed that he saw this canal on September 10, and saw it distinctly on September 12. It was faint as compared with the *Ganges*.

*Fons Fortunæ* was suspected to be present on September 15 by A.S.W.

*Ceraunius*.—A faint diffused marking, which may possibly have been this spot, was seen by A.S.W. on September 3 at the N. end of the Gigas. Apparently seen by P.P.M. on July 28.

*Aoniæ Sinus* was a rather difficult object to A. on September 2, and was much less dark than the *Mare Sirenum*. K. found the N. end of the bay not wedge-shaped, as usually shown, but truncated on September 18, even shallower still on September 11.

*Phasis* was seen by A.S.W. on September 4, but not well. Apparently seen by H.E. on July 30. The embouchure only perceived by A. on September 17.

*Herculis Columnæ* was suspected by A.S.W. on September 3, and seen very clearly and distinctly the following night as a dark narrow and very definite streak of a very sombre hue.

ILLUSTRATIONS.—The prevalence of bad weather when this district was best presented for English observers renders the typical diagram by A.S.W. (Fig. 3., below) much less serviceable than usual, as only a portion of the district is shown, and that is near the terminator. The drawings in the Plate are Figs. 9 and 10. The longitude of Fig. 3 should read  $63^{\circ} \cdot 3$  instead of  $65^{\circ} \cdot 3$ .

- |                                  |                                     |
|----------------------------------|-------------------------------------|
| <i>a</i> = <i>Indus</i> .        | <i>e</i> = <i>Agathodæmon</i> .     |
| <i>b</i> = <i>Lunæ Lacus</i> .   | <i>f</i> = <i>Tithonius Lacus</i> . |
| <i>c</i> = <i>Ganges</i> .       | <i>g</i> = <i>Solis Lacus</i> .     |
| <i>d</i> = <i>Chrysorrhœas</i> . |                                     |

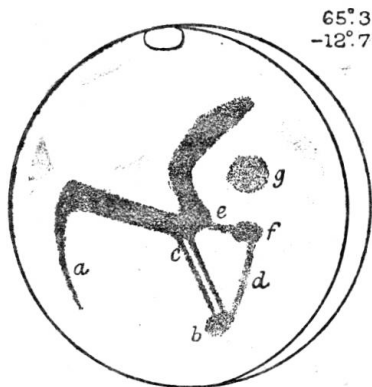


Fig. 3. 1892. Sept. 12. 9<sup>h</sup> 15<sup>m</sup>  
(Unfinished)

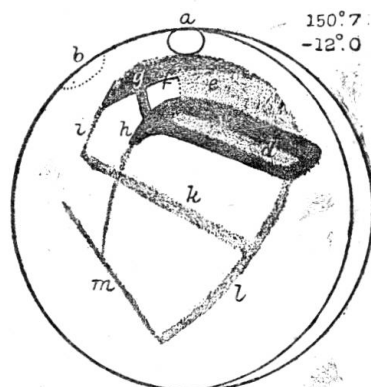


Fig. 4. 1892. Sept. 4. 10<sup>h</sup> 0<sup>m</sup> to 10<sup>h</sup> 25<sup>m</sup>

## IV.—MARE SIRENUM.

The long dark streak in S. lat.  $35^{\circ}$ , which runs nearly parallel to the equator for  $120^{\circ}$ , and which Green and Proctor call the Maraldi Sea, is divided by Schiaparelli into two parts, the *Mare Sirenum* and the *Mare Cimmerum*; a bright bridge, *Atlantis*, dividing the two *maria* from each other. It will be convenient to take the two divisions separately. The Sirenum district may be taken as beginning with the *Sirenum* canal,  $L = 130^{\circ}$ , and as extending to the second *Atlantis*,  $L = 180^{\circ}$ . Sketches, Nos. 28-37 and K. 7-11.

PROGRAMME DETAILS.—The questions of the programme relating to this district are as follows:—

“(p.) *Sinus Sirenum* (Pratt Bay). Can the canal *Sirenum* be seen? Is there a strait where Schiaparelli marks *Herculis Columnæ*?”

“(r.) *Titanium Sinus* (Trouvelot Bay). Is the long dark marking, called by Green the Maraldi Sea, but divided by Schiaparelli into the *Maria*, *Sirenum*, and *Cimmerium*, crossed by bright bridges, like the *Atlantides*? If so, by how many?”

An illustration of the curious manner in which the Martian markings are duplicated is afforded by the first sketch of the series, A., No. 29, September 2.

Assuming, as we have every right to do, that the drawing is rightly dated, the longitude of the central meridian is  $147^{\circ} \cdot 4$ . But the drawing bears a decidedly close resemblance to another by the same observer, with  $L = 225^{\circ} \cdot 0$ , and to a pair of the K. series, with  $L = 211^{\circ} \cdot 7$  and  $235^{\circ} \cdot 6$  respectively. The drawing is, however, supported by another, A. No. 31, August 31,  $L = 158^{\circ} \cdot 3$ ; it seems scarcely likely that two drawings should be wrongly dated and both by the same amount, about five and a half hours.

Accepting the date as given, then, the *Mare Sirenum* is represented as entirely open at the eastern end. The bright district, *Icaria* (Lagrange Peninsula), is non-existent, and the *Herculis Columnæ*, instead of a breadth of about  $2^{\circ}$ , have a breadth of about  $12^{\circ}$ . The neighbouring bright district of *Phætontis* fades away into an indefinite shading.

The embouchure of the canal of the *Sirens* (Pratt Bay), is, however, very strongly marked, but the canal itself is not shown.

The next sketch, A.S.W. No. 30, September 4, restores *Icaria*, but shows a very dark and distinct canal, the *Herculis Columnæ*, as dividing it from *Phætontis* (Webb Land). No. 31 (A. August 31), supports No. 29, but fails to throw fresh light on the subject, the district in dispute being now close to the east limb. But three of the K. series, K. 10, 9, and 8, September 6, 9, and 11, are available as evidence, and these, whilst showing a change of tone at the northern boundary of *Icaria* which may possibly correspond to the canal *Araxes*, show the eastern end of the *Mare Sirenum* as completely closed in. It is possible that we have here a real planetary change, but if so, it must have been a rapid one, as the drawings are within a short period of each other. The *Mare* is drawn as open on August 31 and September 2, as partially closed, leaving only the dark but narrow *Herculis Columnæ* as a

means of communication, September 4; and as entirely closed September 6, 9, and 11. One earlier drawing, L.A.E. No. 33, July 20, shows the *Phætontis* reduced to a small island, and the *Maria Sirenum* and *Cimmerum* united with the *Mare Chronium* and *Mare Australe*, into an ocean stretching right up to the polar cap. If twice or three times the number of drawings were available, or if some of the observers recorded the markings under two or more different aspects, the order in date of the drawings might be considered as establishing a progressive change.\* It may be, however, that we ought to accept the outlines of Schiaparelli's chart as practically correct, but to suppose that the various countries to the E. and S. of the Maraldi Sea, *Icaria*, *Phætontis*, *East and West Electris*, and *Eridania*, are less bright than the general continental area, and that *Icaria* and *East Electris* in particular are so little brighter than the *Maria* as easily to be confused with them. A slight amount of mist or cloud in the atmosphere of Mars might, under such circumstances, make all the difference in the visibility of such faint markings.

The sketches just referred to show a further discordance. Three of the K. drawings, K 7, 8, and 9, September 3, 6, 11, show a mere rootlet of *Atlantis*, in a dusky half shade projecting a short distance into the *Mare*, little, if anything, more than the Cape Noble of Green's chart. The A. pair, Nos. 31 and 29, August 31 and September 2, give it as a narrow bright band extending very nearly across the *Sirenum*, and practically separating the two, *Maria Sirenum* and *Cimmerium*, from each other. A.S.W. records two bright narrow well defined streaks near the place of *Atlantis* on August 31. Of these the more northern appeared to be much too near the N. coast of the *Mare Sirenum* to be *Atlantis I.*, and it was probably a new island, resembling that shown by Schiaparelli in the *Mare Cimmerium*. The Director has therefore called it *Sirenia* to correspond to *Cimmeria*. It was quite a hard definite streak, as bright as *Zephyria*. It was uncertain whether it extended right up to *Zephyria* on the W., or *Phætontis* on the E. On September 4 this streak was not prominent, and the great brightness of the neighbouring continents by overpowering the narrow streak, rendered it again impossible to determine whether it extended right to the two ends of the *Mare Sirenum*.

The more southern streak would appear to be the true *Atlantis I.* It was fainter than the more northern streak, and, as with its companion, it was not possible to say whether it extended right across the *Mare Sirenum*.

In this case the order of dates lends no countenance to the theory of change, and we have again to regard the difference as a personal one. There can be no doubt that the recurrence of a number of feebly bright narrow markings, parallel to each other, and separated by very small distances, renders this portion of the

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\* But F., No. 35, shows the *Mare* closed on August 28. *Icaria* was then, however, right on the limb, so that the evidence has no great weight.

planet a confusing one to draw, as the sketches Nos. 31 and 32 show. **A.S.W.** in No. 32 gives *Sirenia* and *Atlantis*, **A.** in No. 31 *Atlantis* and *Hesperia*. The resemblance of the two drawings is very close, and it is conceivable that the two observers might have really been depicting the same pair of objects.

The presence of the principal *Atlantis* is abundantly confirmed. **G.**, No. 28, August 25; **N.**, No. 36, August 28; **B.**, No. 34, August 27, and a further one of **A.**, No. 38, August 24, all represent it; whilst **L.A.E.**, describes it, August 27. **F.**, No. 35, August 28, shows it; but as an island, not as a bridge, its colour orange. As all the observers, with the exception of **K.**, are unanimous on this point, and as **K.** shows a portion of the marking, whilst **A.** does not trace it quite across the *Mare*, it may be accepted as one of the features of the 1892 opposition. If we suppose that **A.** represents it most faithfully, the difference between his representations and those of the other observers is only slight, less than might very reasonably be expected in the case of a marking of such comparatively small size. The island, *Sirenia*, rests on **A.S.W.**'s observations alone.

There is satisfactory evidence of the presence of the canal *Sirenum*. The inlet of this canal was seen strongly marked by **A.S.W.**, on August 31, and the canal itself was seen faintly, but certainly, on September 3 and 4. **K.** appears to represent this canal as a broad diffused shade on September 11, and as a somewhat narrower streak on September 18. **A.** saw the inlet strongly marked on August 31 and September 2.

With regard to the colour of the *Mare Sirenum*, and its coasts, it may be noted that *Memnonia*, and other continental districts N. of the *Mare*, were seen by **A.S.W.** as very red on September 3, and that the *Mare* itself was noted by **L.A.E.** as greenish-blue on August 24, but on August 26, as being a dark-brownish shading, especially along its northern border. **K.** also remarks, on September 9 and 11, on the darkness of the *Mare*.

**PHÆTONTIS** (S. portion of Lagrange Peninsula), as observed by **A.S.W.**, on September 4, showed its E. portion as bright as *Icaria*. The W. portion was fainter. **F.** found it widely separated from *Electris*, on August 28; colour deep orange. **K.**, on the other hand, found *Icaria*, *Phætontis*, *Electris*, and *Eridania*, a single undivided uniform streak, somewhat dusky, but fairly bright, September 2, 3, 6, 9, and 11.

**CANAL SYSTEM.—Thermodon.**—Possibly seen by **A.S.W.**, September 4, the W. half of *Phætontis* being shown as markedly fainter than the E. half, the dividing line being given as sharp and distinct. **A.**, September 2, and **L.A.E.**, July 20, show *Electris* and *Eridania* as an island, the former making it, however, larger than the latter. **P.P.M.**, August 14, and **F.**, August 28, also give a wide strait between *Phætontis* and *Eridania*. This appears to correspond to the E. part of *Electris*, between the canals *Simois* and *Ascanius*, which Schiaparelli represents as nearly as dark as the adjoining *Maria*. This appears like a possible case of progressive change; the open sea of **L.A.E.**, on July 20, having contracted to a broad strait by August 14 and 28, and to a mere canal by September 2, of which **K.**'s drawings on September 3, 6, and 9, show no trace.

*Pyriphlegethon*.—A dark straight canal was seen by A.S.W. on September 4, which was supposed to be the *Pyriphlegethon*, but owing to the unsteady definition it was impossible to satisfactorily fix its position.

*Eumenides*.—Seen by A.S.W., on August 31, as a rather broad dark streak, stretching with *Orcus* almost across the disk. On September 3 and 4 it was a faint broad diffuse streak; probably better definition would have shown it as double, as this is the appearance presented by double canals when the definition is bad. It was traced up to its junction with the *Phasis*. K. shows a broad diffused streak on September 9 and 11, near the position of this canal.

*Nodus Gordii*.—A.S.W. observed, on August 31, a fairly evident dusky patch, which was believed to be this marking, though it was too near the limb to be well distinguished.

*Gorgon*.—A broad faint streak near the place of this canal is represented on September 11, by K.

*Gigas*.—The presence of this canal was suspected once or twice by A.S.W., on August 31. It was a faint broad diffuse streak on September 3 and 4, extending from the W. end of the *Mare Sirenum* in a curved line to a faint dusky indefinite marking on the N. part of the disk, a little to the E. of the central meridian. From its breadth the canal would probably have appeared double if the definition had been good. The exact position of the canal was not satisfactorily determined.

*Titan*.—The canal was rather dark and plain, and suspected to be possibly double by A.S.W. on August 28. Only just traceable as a feeble dark streak on August 31. The *Sinus Titanum* was well marked on August 29 and October 7, and the canal extending northwards from it on October 7 was almost certainly double. L.A.E. found the *Sinus Titanum* very pronounced on July 19, 22, and 24, and the *Titan* as a dusky shading on July 22 and 24. K. shows a canal on September 7 and 8, which is clearly the *Titan*. A faint marking shown by B. on August 27 appears to correspond either to *Titan* or *Tartarus*.

ILLUSTRATIONS.—The diagram above, Fig. 4, by A.S.W., illustrates this division very admirably, though the true *Atlantis I.* is not far enough advanced on the planet to be properly shown. Figs. 10–14 in the Plate give also some portion of the district.

<i>a</i> = S. Polar Cap.	<i>g</i> = <i>Herculis Columnæ</i> .
<i>b</i> = <i>Ogygia</i> ?	<i>h</i> = <i>Sinus Sirenum</i> .
<i>c</i> = <i>Mare Sirenum</i> .	<i>i</i> = <i>Phasis</i> .
<i>d</i> = <i>Sirenia</i> .	<i>k</i> = <i>Eumenides</i> .
<i>e</i> = } <i>Phatontis</i> .	<i>l</i> = <i>Gigas</i> ?
<i>f</i> = }	<i>m</i> = <i>Pyriphlegethon</i> ?

#### V.—MARE CIMMERIUM.

This portion of the planet comprises about  $70^\circ$  of longitude, from *Atlantis II.*  $L = 180^\circ$ , to *Hesperia* (Burckhardt Land),  $L = 250^\circ$ . Sketches Nos. 28 to 46 and K. 5–9.



PROGRAMME DETAILS.—The programme questions are as follows:—

“(n.) *Cyclopus Sinus* (Huggins Bay). Is the *Mare Cimmerium* of uniform tint? Is *Hesperia* detached from *Eridania* or not? Is *Elysium* (Fontana Land) bordered by diffused shading or by hard straight canals? Pay special attention to *Trivium Charontis*, and note if any canals diverge from it.”

No observer has given a full and definite answer to the first question, that relating to the tint of the *Mare Cimmerium*, but so delicate an observation could only be expected to be made by the most experienced and the most fortunate observers. L.A.E. describes the colour of the *Mare* as steel blue August 20, greenish blue August 24. No island was detected in it either by A.S.W. or L.A.E., but F. appears to show a small island, corresponding to the central portion of *Cimmeria I.*, on August 28, colour orange. A.S.W. found the northern edge of the *Mare* very dark on the same night, August 28; the southern edge being presumably less pronounced. There appears, therefore, but very slight material upon which to answer this question, but such as there is against uniformity of tint.

On the next question, whether *Hesperia* is connected with *Eridania* by an isthmus (Green's Niesten Isthmus), there is a conflict of opinion. Schiaparelli's chart shows a very faint shade in the place of Niesten Isthmus, so that *Hesperia* and *Eridania* are disconnected. L.A.E. and N. support this view. A. and K. oppose it, and support Green's chart. The weight of evidence is in favour of the latter. G.'s drawing, No. 28, is indecisive. It shows a long bright marking which either may be *Hesperia*, or it may be *Cimmeria*, the long narrow bright streak shown by Schiaparelli in the middle of the *Mare Cimmerium*. If the latter, there will be no great discrepancy between G. and Green's chart as to the length of *Hesperia*. It is unfortunate that G.'s two drawings, Nos. 28 and 42, are just too far apart to make it possible to decide the question. N., in No. 36, had *Hesperia* so near the limb that but little weight can attach to the evidence of his drawing on that particular point. Several of the drawings of the other two observers, on the contrary, show the region in question very favourably. F., No. 45, if correctly interpreted, fails to show *Hesperia* at all.

With regard to *Elysium*, L.A.E. perfectly supports the well-known representations of Green and Knobel, in his drawing of July 20, reproduced in Fig. 11, and he reports a similar state of things again on August 27 and 30. In other words, he observed the Oudemann Sea of Green, and not the *Trivium Charontis*, *Hudes*, *Styx*, and *Boreas* of Schiaparelli's chart, which appeared to correspond to it. On the other hand, G. and A.S.W. support the rather more complex structure shown by the Italian astronomer. A.S.W. found no difference in tint between *Elysium* and *Aeolis* or *Aethiopia* on August 25 and 28. It was not at all white.

The *Trivium Charontis* was frequently observed very successfully, and especially so by G., sketch No. 28. An unfortunate difficulty arises with this last-named drawing (Fig. 12 in the Plate), the most interesting secured during the entire opposition. The date is given as August 25, 12<sup>h</sup> 30<sup>m</sup>, Sydney Mean Time, and the corresponding longitude for the centre would be 127° 0'. The

actual longitude is about  $60^\circ$  greater. Is it possible that the sketch was made a week earlier, on August 18? It is scarcely possible that it was taken between four and five hours later on August 25, or about 5 o'clock in the morning, which would give the desired longitude for the centre. In the uncertainty the Director has placed it in the table under August 25, but has used it for comparison as if taken on August 18. The co-ordinates of the centre would then be  $L = 189^\circ 6$  and  $\lambda = -11^\circ 7$ .

Adopting these values for its co-ordinates, we find that the drawing shows us just N. of the *Titanum Sinus* (Trouvelot Bay), a chain of four lakes, very nearly on the equator, and parallel to it. The most easterly of these nearly reaches to the position of the *Nodus Gordii*, and perhaps corresponds to it. Further N. and further W. the *Trivium Charontis* is very clearly seen as a large dark spot from which no fewer than eight canals radiate. These are easily identified as *Cerberus*, *Læstrygon*, *Tartarus*, *Orcus*, *Erebus*, *Hades*, and *Styx*, with a faint indication of a duplication of *Cerberus*, and the commencement of a canal not named by Schiaparelli. A long canal, *Gigas*, flows from the north-east, and turning sharply to the E. at the equator, enters the most westerly of the equatorial lakes alluded to above.

Of these canals **A.S.W.** gives *Orcus* single on August 31, double on August 28; *Cerberus* double, *Styx* single, and *Cyclops* double, all on August 28. The last canal was too near the limb to be seen in No. 28. **L.A.E.**, on July 20, gives *Læstrygon* very plainly, but, as mentioned above, instead of giving *Hades* and *Erebus* as canals, follows Green in showing here a broad dark spot, the Oudemann Sea of Green's chart, the boundaries of which correspond in position to the two above-named canals. **K.** shows several canals, September 2, 3, and 6, apparently *Cyclops*, *Cerberus*, *Orcus*, and *Styx*, the latter crossed a little to the north of the *Trivium Charontis* by a straight bright streak.

The *Trivium Charontis* was seen by **A.** on August 21 and 24, and appears to have been seen by **L.A.E.** on August 24 and 26. It appeared to **A.S.W.**, on August 28, as a triangular-looking patch. It was probably double in the direction of the *Orcus*, in fact, almost certainly so.

*HESPERIA* (Burckhardt Land) is recorded by **A.S.W.** under dates August 21 and 25, as showing substantially the form given by Schiaparelli, broad and bright on the W. and fading off towards the E. **L.A.E.** found it distinctly severed from *Eridania* on August 27. It was a very difficult object to **A.** on August 21, but beautifully seen as a straight line occasionally on August 24 and 31. **P.P.M.** failed to record it on August 14. **K.** found it inconspicuous on August 29, but represents it as distinctly connected with *Eridania* on August 29 and September 2. **N.** represents *Hesperia* as distinctly cut off from *Eridania* on August 28. **R.** records no trace of it on September 28. **A.** found it connected both with *Eridania* and *Aethiopia*.

There is a difficulty about its breadth. Green represents it as averaging about  $12^\circ$  in breadth, and as about  $48^\circ$  in length. **A.**, August 21 and 24, gives it a breadth of about  $7^\circ$ , and a length of  $60^\circ$ , and if we accept the long narrow streak in **G.**'s drawing, No. 28,

as representing *Hesperia* and not *Cimmeria*, it would have a breadth of barely 6°, and a length of nearly 85°. It seems more probable that it is the latter.

*MARE CIMMERIUM* (West portion of the Maraldi Sea).—The two drawings by G., Nos. 28 and 42, appear to indicate that Schiaparelli has divided the Maraldi Sea in a truer proportion than Green, the *Mare Cimmerium* being about double the length of the *Mare Sirenum*. The other sketches available do not altogether bear out this proportion. A., August 21, 24, and September 2, and N., August 28, rather support Green; L.A.E. indeed, July 20, supports Schiaparelli; but K., on the other hand, September 2, 3, 6, 9, and 11, gives an intermediate value. The other observers do not give a sufficient number of drawings to settle the point.

COLOURS OF THE CONTINENTS.—*Aeolis* and *Aethiopia* (Herschel I. Continent) showed, according to A.S.W., a very pronounced red colour on August 29, the tint being rosy; red according to F. on August 21, deep red on August 28. *Electris* and *Eridania* (Webb Land) was found deep orange by F. on August 28.

*MARE CHRONIUM* (Maunder Sea) was distinctly seen by L.A.E. on August 24, by F. and G. on August 28, and by K. September 2, 3, 6, 9, 11. G. departs from the accepted forms by closing in the western of the *Mare*, *Thule I.* being shown united to *Eridania*.

CANAL SYSTEM.—The following are additional notes:—

*Orcus* was suspected on August 25 on the S.E. of the *Trivium Charontis* and suspected to be double. It was seen distinctly and as double, August 28, 29, and 31, by A.S.W. On August 28 *Orcus* occasionally seemed in unsteady definition to extend right across *Elysium* to *Hephæstus*. A dark marking, apparently *Orcus*, is recorded by L.A.E. under date August 31. K. shows a canal on September 2 and 3, which closely corresponds to *Orcus*. B., gives several diffused markings on August 27, some of which appear to correspond to this canal.

*Propontis* was seen by A.S.W. on August 31 as a dark spot very near the N. limb, so near as to encroach upon the white run border. Possibly seen also by L.A.E. on August 27, a dark marking being detected in this region.

*Styx* was clearly seen by A.S.W. on August 28. It made almost a right angle with the *Cerberus*. A canal was also suspected from the N. point of the *Styx* to the junction of the *Titan* and *Orcus*. The *Styx* is clearly represented by K. on September 2 and 3 as a broad dark streak. It was crossed on both occasions by a long bright streak which extended some distance on each side of the canal.

*Antæus*.—A.S.W. suspected this canal to be double on August 25, but failed to see it on August 28.

*Cerberus* and *Cyclops*.—A.S.W. found these two canals almost in the same straight line, and almost certainly double on August 25, and on August 28 both were double, and very sharp and distinct. The *Cerberus*, which was broader and darker than the *Cyclops*, made a slight angle with it. On August 29 both were double. L.A.E. saw *Cyclops* distinctly July 20, August 24 and 26; and

the *Sinus Cyclopum* very distinctly July 19, 20, August 20, 24, 26. **K.** records canals on September 2 and 3, which correspond nearly, but not exactly, to these canals on Schiaparelli's map. **B.** appears to show an indication of *Cyclops* on August 27.

*Eunostos*.—A plain object to **A.S.W.** on August 25. Almost certainly double.

*Triton*.—This canal was seen by **A.S.W.** sharply and distinctly on August 21, making a slightly obtuse angle with *Nepenthes*. On August 25 it was only indistinctly glimpsed. **Y.** gives a distinct marking on July 26, which appears to correspond to it.

*Xanthus* was seen very distinctly by **K.** on August 29, by **A.** August 21 and 24, by **F.** August 21, **G.** August 7, and **P.P.M.** August 14.

ILLUSTRATIONS.—The diagram by **A.S.W.** chosen to illustrate this region shows a system of double canals very distinctly, *Orcus*, *Cyclops*, and *Cerberus*. Figs. 12–15 in the Plate also refer to this region.

- |                                 |                                       |
|---------------------------------|---------------------------------------|
| <i>a</i> = South polar cap.     | <i>e</i> = <i>Orcus</i> .             |
| <i>b</i> = <i>Phaetontis</i> ?. | <i>f</i> = <i>Titan</i> .             |
| <i>c</i> = <i>Cerberus</i> .    | <i>g</i> = <i>Styx</i> .              |
| <i>d</i> = <i>Cyclops</i> .     | <i>h</i> = <i>Trivium Charontis</i> . |

Spot *b*, a bright spot on the limb may be *Phaetontis* or *Memnonia*.

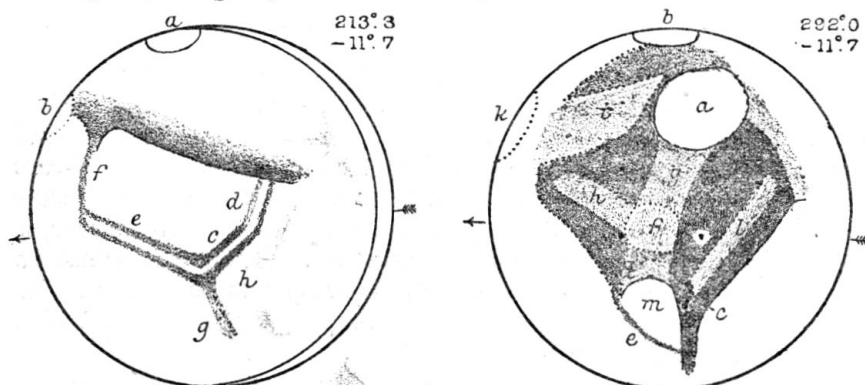


Fig 5. 1892. Aug. 28. 10<sup>h</sup> 0<sup>m</sup> to 10<sup>h</sup> 20<sup>m</sup>

Fig 6. 1892. Aug. 20. 10<sup>h</sup> 30<sup>m</sup> to 10<sup>h</sup> 45<sup>m</sup>

### VI.—SYRTIS MAJOR.

The *Syrtis Major*, the old Hour-glass Sea, the Kaiser Sea of Green's chart, is the most conspicuous dark marking on Mars, and forms the chief object in the present division of the planet. The limits adopted are *Hesperia* (Burekhardt Land), L = 250°, to *Hammonis Cornu* (Bank's Cape), L = 310°. Sketches, Nos. 38–74 and K. 3–5.

PROGRAMME DETAILS.—The following are the points of the Director's programme bearing on this region :—

“(f.) *Nilo-Syrtis* (Kaiser Sea). Watch if it is interrupted on any occasion by bright bridges. Pay special attention to the northern end and shape of the bend. Watch the *Lacus Maris*. Has the *Nilo-Syrtis* a branch in the *p* direction, as shown by Schiaparelli in *Astapus*? The shape and dimensions of the entire marking, the *Syrtis Major*, and the *Nilo-Syrtis* should be very carefully studied.”

On only one occasion was the Kaiser Sea found to be interrupted by bright bridges, but the observation seems quite unmistakable. **A.E.**, on September 23, found the *Syrtis* invaded by a broad bright band cutting it short at about  $10^{\circ}$  N. Lat. Further N. the *Nilo-Syrtis* became dimly visible, with a hint of the *Proto-Nilus*. This observation, obtained in a moment of very fine definition, is one of the few strong evidences of cloud formation on the planet. The observer records, "Definition "quite startling." "Bottom of Kaiser cut off flat, and below, "suggestion of continuation or a lake."

The *Astapus* was looked for by **G.** on August 7, but not seen; but apparently a trace of it was caught by **P.P.M.** on August 8.

A comparison of the six drawings given in the plate shows that **A.**, **B.**, **A.E.**, **G.**, and **P.P.M.** all agree in supporting Green's representation of the Kaiser Sea rather than Schiaparelli's. **A.** shows the Nasmyth Inlet under almost precisely the same form as the English areographer, and **G.** and **L.A.E.** support him in their delineation of the Main Sea. **A.S.W.** alone bears out the Milan designs.

The other details of this portion of the planet will best be studied marking by marking.

*AUSONIA*.—*Southern Ausonia* (Cassini Land) is most distinctly an island, the *Mare Tyrrhenum* (Hooke Sea) communicating with the *Mare Chronium* (Maunder Sea) by the *Xanthus*, no mere canal, but as broad a channel as the *Mare Tyrrhenum* itself. **A.**, August 21 and 24, **P.P.M.**, August 14, **G.**, August 7, **K.**, September 2, and **F.**, August 21, are all agreed as to the separation of Cassini Land from Webb Land. The evidence is less unanimous as to the division between Cassini Land and Dreyer Island. **F.** shows the two as widely separated on August 21, and **G.** records them as "certainly divided by *Euripus*" on August 7. **A.S.W.**, August 20 and 21, also shows the *Euripus* as a broad unmistakable channel. On the other hand, **K.** shows the two portions of *Ausonia* as united on August 29, but as the northern portion was much fainter than the southern, this may explain the discordance.

*Northern Ausonia* (Dreyer Island) is decidedly fainter than the companion marking, and is either shown as a separate island,—e.g., **G.**, August 7; **F.**, August 21; **K.**, August 29, September 2,—or no indication of it is given at all, as **P.P.M.**, August 14. Two or three of the smaller apertures fail, indeed, to break up any of the markings in this region, but this is evidently due to want of separating power, and can have no weight as compared with the direct and concurrent testimony of the more powerful telescopes. **A.** found it "only just a shade lighter than the *Mare Erythræum* on August 18; and "faint" on August 21; "very faint" on August 24; visible, September 19. **K.**, as noted above, found it much fainter than Cassini Land. **A.S.W.**, August 20 and 21, represents Dreyer Island itself as divided into two areas of different brightness, the eastern (*h* in Fig. 6) very faint, the western (*f*) brighter, but very feeble as compared with *Aeria* or *Libya*. A light band (*g*) united this brighter portion with *Hellas* and *Libya*. This was quite bright and conspicuous on

August 21 as to the part between *Hellas* and *Ausonia*, but perhaps doubtful as to that between *Ausonia* and *Libya*. The district *h* was very feeble. On September 24 *Ausonia* appeared plain and bright as it regards district *f*, and it was also traced, but only feebly, towards *Aeria*, but it could not be ascertained whether it reached it. This extension would correspond to *Oenotria*.

**F.** gives the colour of Cassini Land as deep orange on August 21, and of Dreyer Island as orange.

**CHERSONESUS.**—**A.S.W.** found this district show numerous variations both in brightness and outline. Usually, it seemed joined to *Hellas*, so as to form a fainter tail to it. On August 21 it was fainter than on August 20, and a dark interval separated it from *Hellas*. **P.P.M.** shows it joined to *Hellas*, August 8, but separated on August 9, when further from the limb. Apparently he represents it as divided from *South Ausonia* (Cassini Land), on August 14. **D.** appears to show the *Chersonesus* as a faint annexe to *Hellas* on September 24. **A.S.W.** and **B.** delineate it almost precisely as on the Schiaparelli charts. **P.P.M.** shows it under a slightly different aspect on August 9. It is, perhaps, implied by a number of observers with smaller telescopes who run both the *Ausonias* and *Hellas* together into one marking.

**TYRRHENUM MARE** (Flammarion and Hooke Seas).—The northern border of the Hooke Sea was dark and sharply defined on July 11. According to **L.A.E.** the Flammarion Sea appeared steel blue to the same observer on August 20; and the Hooke Sea as greenish-blue, August 24. **G.** found the *Mare* partially divided by a faint marking on August 7, a very narrow straight white streak lying in the centre of the channel. No other sketch shows this, but this in no way militates against the correctness of the drawing, which was evidently made under better observing conditions than those of the European observers for the same district.

**SYRTIS MINOR** (Gruithuizen Bay), is very strongly marked on most of the drawings, and is on some scarcely inferior to the better known gulf that follows it, and exceedingly like it in appearance. Three skilled observers, **A.**, August 18, 21, and September 19; **B.**, September 21; and **G.**, August 7 and 6, however, give it no emphasis. Still, on three of these six drawings the marking was near the limb. There practically remain, therefore, only the drawings made on August 7, 18, and September 21, to bear evidence against those who show the Syrtis as a strongly marked inlet. **L.A.E.**, July 11, gives it, perhaps, the least prominence; **K.**, August 29, comes next, and then, perhaps, **D.**, August 20, 22, and September 24. But **Y.**, July 25; **P.P.M.**, August 14, 9, and 8; **N.** and **F.** (both August 21) show it as but very little inferior in size to the Kaiser Sea. **Y.**, however, makes it much less dark. The other observers of this district, **A.S.W.**, August 20 and 21; **D.**, August 22 and 20; and **S.**, August 20, mark it strongly, though they do not represent it as quite so large and dark as do **P.P.M.** and **Y.**

The evidence here seems clear against a change in the planet, the dates showing no connexion with the change in the character of the spot. It is not legitimate to assume that even the best drawings made by the most skilled observers, and under the most favourable conditions, are *exhaustive*. One draughtsman will begin his sketch with one marking, another with another; and where there are a multiplicity of details some will attract the attention of one person the most, others of another. The fact, therefore, that A., B., and G. fail to record the *Syrtis Minor* as a deep inlet, and only show a shallow angle where *Hesperia* meets *Libya*, whilst they give so much less prominent detail, is not sufficient to controvert the strong direct testimony of so many other observers.

*LIBYA* (Hind Peninsula) is the subject of a corresponding discordance to the one just noted. Where the *Syrtis Minor* has been marked as a deep triangular inlet, there *Libya* has been naturally, if not necessarily, represented with its southern coast of high convexity; whilst the three observers who pass over the lesser *Syrtis* so lightly, make the coast line of *Libya* run very nearly straight, and almost parallel to the equator. The dates concerned being the same as in the case of the *Syrtis*, actual geographical change, inundation and the like, are negatived. Meteorological change, the formation of cloud when A., B., and G. were observing, either so as to hide the mouth of the *Syrtis*, or stretching in a more or less convex shape from the coast of *Libya* southward over the *Mare Tyrrhenum* when the other Members were at work, would explain the discordance. But, as in so many cases of the kind, the true explanation is most probably in the personal equation of the observer. The different drawings of the same observer usually closely correspond to each other, even when made at considerable intervals of time. In this instance several of the Members had the district under observation on two or three different occasions. If the differences in the mode of delineation were due to either real or merely apparent change (as from cloud) on the planet, it is contrary to every reasonable probability that the changes would have proceeded in such intimate connexion with the times when the planet was scrutinised as to afford to each several observer a special and peculiar phase, reproduced whenever the same observer chanced to be at work again.

*Libya* was very well defined on the S., E., and W. sides on August 20 as seen by A.S.W. It was as bright as the surrounding continent or *Aeria*. It was irregular in shape on August 23 and 25; a little fainter than *Isidis Regio* on August 25. Colour as given by F. on August 21, red. Well defined and clearly seen by G. August 6. Seen clearly, but of very small size, by L.A.E. on July 11.

*LACUS MOERIS*, which with its canal *Nepenthes* makes up the Main Sea of Green's chart, is one of the undoubted markings of the planet, but not one of the easiest. Hence there can be no surprise that most observers omit it. L. A. E., who discerned it on July 11 and August 18, gives it the most prominence; G. saw it well defined though faint on August 6. Both agree

closely as to its position and shape and fully support Green's chart. **A.E.** shows it faintly but unmistakably on September 23; not agreeing quite with either of the two standard charts, but favouring the English rather than the Italian.

**A.S.W.** appears to have only seen *Nepenthes*, the canal, but not to have distinctly made out the lake.

*Nepenthes*, as seen by **A.S.W.** on August 20, was a faint and rather diffused streak and rather strongly curved. On August 21 it was sharp and distinct, and made a slightly obtuse angle with *Triton*. The same observer fails to record it on September 24. He gives *Nepenthes* on August 20 and 21 a more northern latitude than the other observers give to Main Sea, and closely sustains the representation of Schiaparelli. The dates are not inconsistent with a change in the district, but the evidence is too slight to justify our concluding that such has really taken place. Probably the difference in the types of delineation is due to the cause suggested by Green in the "Journal," Vol. I., p. 113, and **A.S.W.** like Schiaparelli "apparently only discerned the stronger northern edge" of the Main Sea, "and represented this with a single stroke."

*SYRTIS MAJOR* (Kaiser Sea) is so conspicuous a marking that there should be a close agreement as to its representation by all the observers. And, indeed, this is pretty nearly the case, most reproducing the well-known "hour-glass" form. **A., B., L.A.E., K., P.P.M., N., S.,** and **Y.** are in very close agreement. The outstanding differences are as follows:—**D.** and **J.W.** give the gulf smaller proportions than the others, and show it as a mere wedge-shaped marking, without the sweeping outline which gives the "hour-glass" a distinctly graceful appearance. The difference is, however, but slight, and is probably simply the effect of small aperture. **F.**, August 21, agrees with the majority in every respect but one. He shows the western shore of the *Syrtis* deeply indented by a strongly marked inlet, apparently the embouchure of the canal *Typhon*. **P.P.M.** shows the same canal on September 11, but not with so strongly marked an estuary. A slight indication of it is also given by the same observer on August 8, close to its intersection with the *Phison*. **F.** and **P.P.M.** are in precise accord as to the place of the canal, which both put to the north of the position given by Schiaparelli. **K.** agrees with **A.E.** in giving emphasis to the peculiar blackness of a diamond-shaped area at the entrance to the *Syrtis*. **A.S.W.**, who narrows the entrance to the gulf very considerably as compared with the other observers, and one or two other members, partly confirm this.

*Oenotria, &c.*—At the mouth of the *Syrtis Major*, and between it and *Hellas*, several observers place some faint diffuse bright markings, which others interpret as mere local differences in the degrees of shade of the great dark spot the *Mare Erythræum*, or Dawes' Ocean. **A.S.W.** failed on August 20 and 21 to distinctly make out *Oenotria*, but shows one of these faint zones uniting *Hellas*, *Ausonia*, and *Libya*; a month later, September 24, the zone is only traced from *Hellas* as far as *Ausonia*, but there is a



suggestion of *Oenotria*, as a faint continuation of *Ausonia*, which very nearly closes in the mouth of the *Syrtis*. **K.**, August 29, shows *Oenotria* extending quite to *Aeria*, and throwing out a branch to *Libya*. These two branches of this faint marking define the two southern edges of the black diamond-shaped area described above. *Oenotria* is shown very distinctly by **Y.**, July 25, and less definitely by **L.A.E.**, July 11, and **G.**, August 7. The two latter, however, place it a little further S., and make it correspond in position and appearance to Green's Hirst Island.

*Japygia* (Hirst Island), or rather a long narrow faint streak corresponding in part to the *Japygia* of Schiaparelli, was seen by **A.S.W.** on August 20. Though faint it was perfectly distinct, extending for a great distance parallel to the coast of *Aeria*. It was quite distinct also on September 24. It was seen as a light grey marking in accordance with Green's map by **L.A.E.** on July 11. A faint trace is shown by **F.** on August 15; and **G.** suspected its presence in moments of good definition on August 7. **D.** seems to show a slight indication of it on August 16 and 20. **B.**, September 21, shows a broad diffused marking, partly corresponding to the long narrow streak observed by **A.S.W.** on August 20, and partly to *Yaonis Regio*.

*Yaonis Regio*.—A faint extension of *Hellas*, which may possibly represent this region, is shown by **F.**, August 15, colour orange. A faint whitish or orange area in the position of *Yaonis Regio* is recorded by **G.**, August 7. Apparently seen by **P.P.M.** on August 7, and distinctly seen as a small oval white spot on September 11. **K.** shows a faint diffused marking stretching from *Hellas* towards *Noachis* on August 22. These differences, though hard to reconcile, are only what are perfectly natural in the case of faint small details on the limit of visibility.

**NASMYTH INLET**.—The *Syrtis Major* only corresponds to the southern portion of the Kaiser Sea, the northern and narrower portion is denominated *Nilo-Syrtis* by Schiaparelli, who continues the same name past the commencement of Green's Nasmyth Inlet. The central portion of the inlet is called the *Proto-Nilus*, the western end *Ismenius Lacus*. Since such evidence as the Section could supply in 1892 supported Green's chart rather than Schiaparelli's in this region, the Director has thought it better to group the observations under the English rather than under the Italian title.

It is remarkable that so few observers record the Nasmyth Inlet, for those who do see it give it very considerable prominence. It was seen by **A.S.W.** on September 24, very strongly marked. It seemed distinctly to trend toward the W. It could not be seen by **L.A.E.** on July 11, but was well seen on August 8. **F.** shows it strongly marked, under date August 21, running nearly due W. **A.** describes it as "admirably visible," August 18, and as "very dark," September 18. **Y.** shows the Nasmyth Inlet under Green's form, not Schiaparelli's, on July 26. **A.E.** gives a very faint hint of it on her drawing of September 23. These are the only indications forthcoming. They are amply sufficient to prove its presence during the opposition of 1892, and the

scattering of the dates of observation is a strong argument against real change, though it becomes a very difficult enigma, "How is it that other first-rate observers failed to notice it?"

The ISMENIUS LACUS was seen separately from the rest of the Nasmyth Inlet by A.S.W.; as a distinct but faint dark spot on June 5; as a black elongated spot on September 19.

AERIA (E. coast of Beer Continent) was red on August 15 and 21 (F.), intensely coloured, orange-pink, September 19 (A.). The *Hammonis Cornu* was seen very sharply defined by A.S.W. on September 17, and is very plainly shown by Y. on July 26.

HELLAS (Lockyer Land) as observed by A.S.W. was a conspicuous oval spot on August 20, but little inferior in point of brightness to *Aeria*. It was not of uniform brightness, many slight irregularities being detected. The outline also showed slight irregularities, and on August 21 was not quite sharp. Its colour was very red, a copper colour, more pronounced than the tint of *Aeria*. On September 24 it was considered, perhaps, the reddest marking visible; but its northern edge was whiter than the rest. No canals were seen, but a faint dark spot in the centre was suspected on September 24, which might be the intersection of the *Alpheus* and *Peneus*. L.A.E. reports it reddish on August 18, and pink August 19; F. red on August 15, and deep red on August 21; G. ruddy orange on August 7. "It has throughout been the most ruddy marking on the surface, its tint being visible sometimes on the limb." (G.) Its form is described by A., September 19, as irregularly oval, and pointed to the S. It was very bright. A distinct ruddy orange tinge on August 7 is noted by P.P.M., who also notes it ruddy on September 11.

It will be seen that the foregoing descriptions are all very accordant, as might naturally be expected, in the case of one of the easiest markings on the planet. There is one point of difference, however, which is of considerable interest. On or near the central meridian, *Hellas*, as the preceding notes show, is a deeply ruddy object, the reddest region on the planet. The red tint is even, according to G., visible up to the limb. But on the limb it becomes white, and is often a very brilliant object, almost rivalling the polar snow. Indeed, when in this position, either from its actual elevation, or (and more probably), from irradiation, it appears to project beyond the limb. Such an observation is recorded by A.S.W., September 17. On September 14 and 15, the same observer records the presence of smaller white spots on the limb. These would appear to be nearly, if not precisely, in the position of *Hellas*. It would seem that, generally speaking, the regions which are most deeply ruddy when near the centre are the most likely to appear as bright white spots on the limb.

CANAL SYSTEM. Beside the canals already mentioned, the following are recorded:—

*Amenthes*.—A.S.W. A broad band, broad and distinct on August 25.

*Typhonius*. A canal is shown by P.P.M. on September 11, not quite in the place of this canal, but nearer to it than to *Astaboras*.

*Lethe* appears to be shown by Y. in his drawing of July 26.

*Boreo-Syrtis* (Delambre Sea) is plainly shown by P.P.M. on August 8, less plainly on August 9.

ILLUSTRATIONS. The Plate contains six drawings referring to this district, Figs. 15 to 20, and the diagram by A.S.W., Fig. 6, given above, is very clear and full.

*a* = *Hellas*.

*b* = *South Polar cap*.

*c* = *Syrtis Major*.

*d* = *Syrtis Minor*.

*e* = *Nepenthes*.

*f* = *Ausonia*.

*g* = Light streak.

*h* = *Ausonia*.

*i* = *Chersonesus*.

*k* = *Eridania* (?).

*l* = *Japygia*.

*m* = *Libya*.

*k* was a bright white spot on the limb.

## VII.—THE SOUTH POLAR ZONE.

The observations made during the 1892 opposition range from June 5, 16 (terrestrial) days after the spring equinox of the southern hemisphere of Mars, to October 15, two days after the summer solstice. Measures of the white polar cap, as shown on the drawings, prove that its shape as given by most of the observers is conventional merely; some drawing it as circular, others as elliptical, the degree of ellipticity varying with each observer. Yet, though each observer shows his own strong personality as to the *form* of the cap, nearly all agree in recording a slight but steady diminution in size during the period of observation, and the majority are in close accord as to the distance which the cap extended along the circumference. With regard to the distance from the limb to which it extended along the central meridian, a great diversity prevailed, it being evidently much easier to estimate a fraction of the planet's circumference than of its diameter. It should be noted that 1° of the Martial circumference is less than one-third of a second of arc, or one-thirtieth of an inch on the drawings. Hence the very close accord between the different drawings made by any given observer, especially as regards the extent of the cap in the direction along the circumference of the planet shows a most gratifying delicacy and accuracy of observation. But this very fact only renders the amount of personality more striking, and emphasizes the mere conventionality of the shape given to the caps.

In the following tables the first column gives the observer's initial, the second the number of days after the Martial spring equinox, the third the colatitude of the edge of the solar polar cap as measured on the circumference of the planet, the fourth, its colatitude as measured along the central meridian. The proportion between the two last columns indicates the deviation from true circularity ascribed to the cap by the observer.

TABLE IV.  
*Radius of the South Polar Cap.*

	days.	°	°		days.	°	°
<b>A.</b>	81	16	29	<b>G.</b>	78	14	27
	90	14	26		79	13	26
	93	14	23		90	12	21
	96	14	25		103	10	14
	105	12	23				
<b>D.</b>	84	24	27	<b>E.W.M.</b>	49	29	28
	87	23	27	83	23	24	
	88	26	32	<b>N.</b>	84	12	26
	92	19	25		87	12	26
	94	18	25		93	11	23
<b>L.A.E.</b>	52	18	21	<b>S.</b>	83	12	22
	61	16	20		92	12	25
<b>H.E.</b>	48	21	23	<b>W.R.W.</b>	92	16	18
	71	17	17	111	15	18	
	76	18	23	120	27	16	
	77	17	18	<b>A.S.W.</b>	92	10	13
	84	16	19		93	10	15
122	10	19	100		9	14	
<b>A.E.</b>	117	16	19		107	6	16
	119	17	22		115	7	13
	120	15	17	117	6	15	
	126	17	22	118	7	12	
<b>F.</b>	76	19	27	120	8	11	
	87	17	20	127	5	10	
	93	17	28	<b>J.W.</b>	84	9	22
				87	8	20	
				92	7	20	

The "personal equations" of the different observers are too large to allow of the entire series being combined together without correction to one standard, and the observations are not numerous enough to allow of a satisfactory determination of the amount of personality. Still, **A.**, **H.E.**, and **F.** agree closely together as to the scale which they have adopted in their estimates in position angle, and so do **G.**, **N.**, **S.**, and **A.S.W.**, so that these two sets of observers may be compared amongst themselves. The former set show a slow diminution in the radius of the cap from the 42nd day after the equinox to about the 90th, in which time the radius has shrunk from 21° to 15°. In the next 32 days it diminishes to 10°. The second set, which gives the cap on a scale about three-fourths of the first, begins with a radius of 13° on the 78th day from the equinox, and runs down steadily and pretty uniformly to 7°, seven weeks later. The cap, therefore, had still a very considerable size when the observations terminated, and there was no question in 1892 of its entire disappearance.

**CANALS IN THE POLAR CAP.**—Several of the earlier drawings of the opposition showed a very well marked dark line in the white polar cap. Thus **P.P.M.** on August 7, 8, and 9, shows a canal apparently lying along the 200th meridian, and nearly reaching the pole. **G.**, however, on August 6 and 7, shows a

canal near the edge of the polar snow, and nearly at right angles to that seen by P.P.M. Y., on July 25, represents a vast rift in the cap, which is no doubt the same canal as the above. If P.P.M. has placed his canal a little too near the limb, and either G. or Y., or both have made a slight error in the inclination of their markings, the discordance between the three would readily be explained. A canal lying along the  $75^{\circ}$  parallel of latitude, and stretching from about longitude  $180^{\circ}$  to  $300^{\circ}$  would represent the different observations very fairly.

MITCHELL MOUNTAIN.—Later on, when the snow cap had shrunk somewhat, the canal was lost sight of, evidently because the cap outside the rift had melted, so that the canal was merged in the sea which surrounded the cap. But the bank of the canal nearer the pole was still indicated by an irregularity in the snow cap. A projection was seen by G., K., and P.P.M., the mean position of which was about longitude  $330^{\circ}$  and latitude  $75^{\circ}$ . The dates of the observation were K., August 22 and 29; G., August 31; and P.P.M., September 11; G. found a bright detached point just free of the projection, corresponding to the Mitchell Mountains observed by Green in 1877.

Yet another projection was observed by K. on August 22, and by P.P.M. on September 11. This was about longitude  $30^{\circ}$ , and was further confirmed by A.E. on September 17, the latter observing a notch in the rim of the cap just beyond the projection. A.S.W., on August 21, found the western edge of the cap ill-defined, and suspected the presence of Mitchell Mountains here. There can be no doubt that the appearance of the rift was the first stage in the isolation of this object, nor that it was the same as that observed by Green in 1877.

The only other observation of interest referring to the polar cap is made by A.S.W. on August 25, when it appeared "slightly reddish, particularly on the northern edge, and not white." The observation was repeated on several other nights, but the dates are not recorded. All other observers record it as very white.

MARE AUSTRALE (Joynson Sea). This marking was generally noted as being dark around the south polar cap and fading off towards the north. A., G., L.A.E., and K., separated it from *Mare Chronium* by *Thyle*. G. separated the two *Thyles* by the *Ulixis Fretum* on August 18, but failed to show the *Palinuri Sinus*. K. observed the two islands as a single spot on September 2, 3, and 6, but separated them from *Eridania* by the *Palinurus*. Traces of *Thyle II.* were seen near the limb by A. on August 21, and of both islands, September 2. L.A.E. saw them as one spot on August 4 and 28, colour orange on the latter date, but separated them as a pair of oval islands on August 27.

### VIII.—MISCELLANEOUS OBSERVATIONS.

NORTH POLAR CAP.—Recorded by A.S.W. on June 5 as very minute, but bright and definite; on September 8, it was opposite the south polar cap, but was not very definite. L.A.E. remarked it on July 20.

**BRIGHT SPOTS ON THE LIMB.**—The observations on these are mostly supplied by F. and A.S.W.

The following are shown as white on the limb by F. :—

August 4, *Noachis*, *Eden*, *Phætontis*, *Zephyria*, and *Phlegra*.  
August 21, *Eridania*, *Aethiopia*, *Deucalion*. And by A.S.W. :—

August 20, *Eridania*; August 28, *Icaria*; September 4, *Argyre*; September 14, *Hellas*; September 15, *Hellas* and *Aeria*; September 17, *Hellas* and *Arabia*, *Hellas* projecting beyond the limb. *Hellas* was also seen on the limb, August 25, and *Argyre* probably on September 10. L.A.E. records *Hellas* as a bright spot on the limb on August 8.

*Hellas* certainly comes first in this category, *Argyre* second. *Eridania*, perhaps, would hold the third place; then various portions of Beer Continent, *Noachis* and either *Icaria* or *Phætontis*.

**DETERMINATION OF LONGITUDES.**—The following determinations of longitudes of twelve fundamental points were made by A.S.W. They appear very accurate except those of the *Ganges*, the longitudes for which would accord better with the place of the *Jamuna*. The observer's notes are given below :—

TABLE V.  
*Longitudes of 12 Points on Mars in 1892.*

No.	Object observed.	Date.	G.M.T. of Transit.	Longitude (Uncorrected).	Notes.
1	Dawes Forked Bay -	1892. Sept. 17	h m 8 49	° 10° 7	Not <i>Fastigium Aryn</i> , but the middle of the bay.
	" " "	" 19	10 6·7	11° 1	
2	<i>Indus</i> (mouth) -	" 15	9 16	35° 8	
3	<i>Aromatum Prom.</i> -	" 14	9 23	46° 8	
	" " -	" 15	9 56	45° 6	
4	<i>Argyre</i> (centre) -	" 14	9 46	52° 4	
	" " -	" 15	10 16	50° 4	
5	<i>Ganges</i> -	" 12	9 11·7	62° 5	Locality of <i>Fons Juventæ Mouth</i>
	" - - -	" 14	10 35	64° 3	
6	<i>Lunæ Lacus</i> -	" "	10 51	68° 2	
7	<i>Titanum Sinus</i> -	Oct. 7	9 1	186° 0	
8	<i>Hellas</i> (centre) -	Aug. 20	11 5	298° 6	
	" " -	Sept. 24	8 33·5	301° 8	
9	<i>Nilosyrtis</i> -	" "	9 6·5	309° 8	The mouth at the part shown by dotted line in fig. K.
10	<i>Hellas</i> (f. border) -	" "	9 35·5	316° 9	
11	<i>Hammonis Cornu</i> -	" 21	8 45	332° 6	
12	<i>Thymiamata Prom.</i> -	" 17	9 37	22° 4	

“In observing the foregoing objects an imaginary line was drawn from the centre of the S. polar spot through the centre of the disk to the opposite limb. The times given are those when the different markings appeared to be on that line. The longitudes given in the table have been calculated from the times of transit of the zero meridian given by Mr. Marth in his Ephemeris. No corrections have been applied to these longitudes, which, compared with Schiaparelli's are uniformly considerably too great. The corrections due to the polar spot being eccentrically situated with regard to the pole of the planet cannot be taken into account until the measures of position of the spot have been reduced. According to the provisional result given by Prof. Comstock in the October number of 'Astronomy and Astro-Physics,' the polar spot has been situated not far from the pole itself this year. Another correction would arise from the greatest phase not being at the equator. In the middle of September the position angle of the greatest defect of illumination was  $70^{\circ} \pm$ .”

**SPECTRUM.**—The only observation of the spectrum is by **F.** as follows:—

“On August 28th, 9<sup>h</sup> 44<sup>m</sup> p.m. I examined the spectrum of Mars with a single prism of  $60^{\circ}$ , and found it to be brightest in the red, very bright in the green, rich in indigo-blue, fainter in the orange and violet. A dusky line along the spectrum, not quite central, corresponded to the long dark marking S. of the horizontal diameter.” (*Mare Cimmerium.*)

**NEAR APPROACH OF MARS TO LL 1299.**—**Mr. Henry Mac Ewen**, though not a Member of the Section, sent the following account of his observations, on January 14, 1893, of this conjunction. Instrument, 5-inch refractor by Wray.

“5, Cathkin Terrace, Mount Florida, Glasgow.

“Power 45, M.G.T.,  $5\frac{1}{4}^h$ , definition fair. Noticed Mars advancing considerably above the star.

“Power 90,  $5^h 30^m$ . Estimated distance between star and N. limb to be  $1\frac{1}{2}$  diameters of the planet.

“Conjunction estimated at  $5^h 40^m \cdot 5$ , G.M.T., when the star was very carefully estimated to be  $1\frac{1}{2}$  diameters N. of the N. limb.

“At  $5^h 51^m$  the star was slightly more than  $1\frac{1}{2}$  diameters distant from the N. limb.

“The markings on Mars were fairly well seen with the 90 eyepiece.”

**SKETCH OF THE MOON WITH A LOW POWER.**—In answer to the Director's suggestion that the Moon should be drawn with a power of two or three diameters as a test of skill in detecting and delineating markings on a body of the same apparent size as Mars, when viewed with ordinary powers, **Mr. A. Freeman** sent the following letter with a sketch of the Full Moon.

“67, Freshfield Road, Brighton,

“9th September, 1892.

“I have attempted to make a sketch of the moon when near the full, with a power of only two diameters, using a small opera glass of  $1\frac{1}{4}$ -inch aperture. I have drawn the sketch on one of the Jupiter disks in order to be able to make some distinction to the brightest craters I was able to see.

“I did not send it at once, as before I had quite finished on the night of the 5th clouds came up and obscured the moon before I could examine my sketch with the moon. Last night I was able to do this, although the moon had passed the full and Mare Crisium was on the terminator.

“Last night with the same aperture, but with a power of *three* diameters, I could just see some of the rays from Tycho, and much more detail could be seen.

“With a field glass, diameter  $1\frac{7}{8}$  and power of four diameters, I could see the mountains round Mare Crisium projecting beyond the terminator, also

Langrenus, close to the terminator, stood out very distinctly, and Tycho Copernicus Aristarchus. Mare Humororum and Plato were very visible.

"My sight is long and I have to use glasses to read and sketch with, which all add to the difficulty of so doing.

"I hope the poor sketch may be of some little use to you.

"I have only to add that the low power of two, brings out the Maria with very much greater distinctness than can be seen with my unaided eye, and that Copernicus and Aristarchus are very visible with this power, and also a suspicion of Tycho and the rays from it."

AUGUSTUS FREEMAN.

The power **Mr. Freeman** used would give about the same apparent diameter to the Moon as a power of 160 would to Mars at the 1892 opposition. Usually a higher power than this was employed on Mars, but the much greater sharpness of the Moon's image would fully compensate for its inferior (apparent) size.

**Mr. Freeman's** sketch is a decidedly interesting one, and there can be little doubt that to imitate his example would be very good practice for observers of planetary markings. Practically it appears to show that any markings on Mars down to one second in diameter might be expected to be recorded under favourable circumstances. No detail finer than this is shown by **Mr. Freeman**; generally an object had to be larger than this to be recorded.

As the canals of Mars are usually considerably below this standard, it is quite easy to see how they escaped notice so long. No doubt further practice would have enabled **Mr. Freeman** to detect more minute details; but it may be fairly inferred that only the most patient and persistent study of the planet, and self training of the observer, will enable students of Mars, even under the best conditions, to register markings below this limit with any trustworthiness.

The positions and forms shown by **Mr. Freeman** have a somewhat greater degree of accuracy than we are able to predicate about any but a very few of the best representations of Mars.

#### IX.—SUMMARY.

In the annexed chart have been combined together so far as possible, the results expressed in the entire set of 80 drawings which the Members of the Section supplied. The work of combination has been a difficult one, and not quite as satisfactory as had been hoped. For, careful and conscientious as the observers most manifestly were, quite a number of the drawings showed certain defects which interfered with their usefulness for this purpose. And the very adverse circumstances under which the majority of the drawings were made diminished the number of those really rich in detail to so few as to fail to afford that completeness of comparison which is desirable. The standard adopted by **Mr. Green** in his chart of 1877 of adopting no marking that was not verified by three independent observers, a most proper standard where possible, was beyond the reach of the Director in 1892.

It may, perhaps, be allowable to refer further to the defects above-mentioned, since they are characteristic of drawings of Mars generally, and not to any special degree of the drawings made by the observers of the Section. They may be classified under four heads; time, centering, proportion, and position-angle. The first is the least excusable defect; but fully 10 drawings are dated



more than an hour out from the true time of their completion, in one or two cases the error approaches two hours. In drawings of Mars and Jupiter too much care cannot be given to secure that the precise time is recorded at which the planet corresponded to the finished drawing.

The matter is one of some difficulty, it is true, but the majority of the observers surmounted it; the numerous drawings by A.S.W. and A., for example, being all most carefully dated.

The error of centering consists in taking as the centre of the planet's disk a point which is really much above or below it. Even the best of observers fall into this mistake, and errors of as much as  $20^{\circ}$  of latitude have one or twice been met with.

The error in proportion is the most common of all. The markings of Mars are not usually traced right up to the limb. It follows, therefore, that there is a certain margin between the actual limits of the sketch and the circle within which it is drawn. Clearly if the breadth of this margin is much under or over estimated, the entire mass of the details of the sketch will be on too large or too small a scale.

The fourth error is only found on a few sketches, but it is very marked where seen. There is an inability to judge position angle correctly, and the outer markings are run together in some parts of the disk and separated in others, and straight lines become curved near the edge of the field.

A fifth error, and the one most potent of all, and shown by not a few of the sketches, is the personal error. A marking seen once under a given form is apt to be continually represented under that form whether it really presented it or not. Or it may be represented from the very first by a purely conventional form, adopted, perhaps, from some preconceived idea of how it ought to look.

This conventionality is strongly shown in the shape given to the polar cap. It no doubt accounts for the tendency of some observers to reproduce the forms of Green's chart, of others to reproduce those of Schiaparelli's, and generally to give the same form to the same marking whenever seen. Now the study of Mars is specially valuable on this very account, that the change in the presentment of the planet's axis and the rotation are always altering the amount and character of the foreshortening, and therefore markings are continually changing their appearances by known and calculable amounts. We have, therefore, a ready check on the accuracy of drawings of Mars, and the test is a most severe one.

These sources of error precluded the Director from obtaining any useful result from measures of the details of the drawings. A number were attempted, but the results were not encouraging, and therefore only measures of the polar spot have been given. The few observations of longitudes made by A.S.W. outweigh in value all the measures which could be made of the drawings. It is to be hoped, therefore, that in future all observers of Mars will consider it a duty to include such observations in their programme. If these were supplemented by estimations (or measures, if possible) of the latitude of the spots when on the

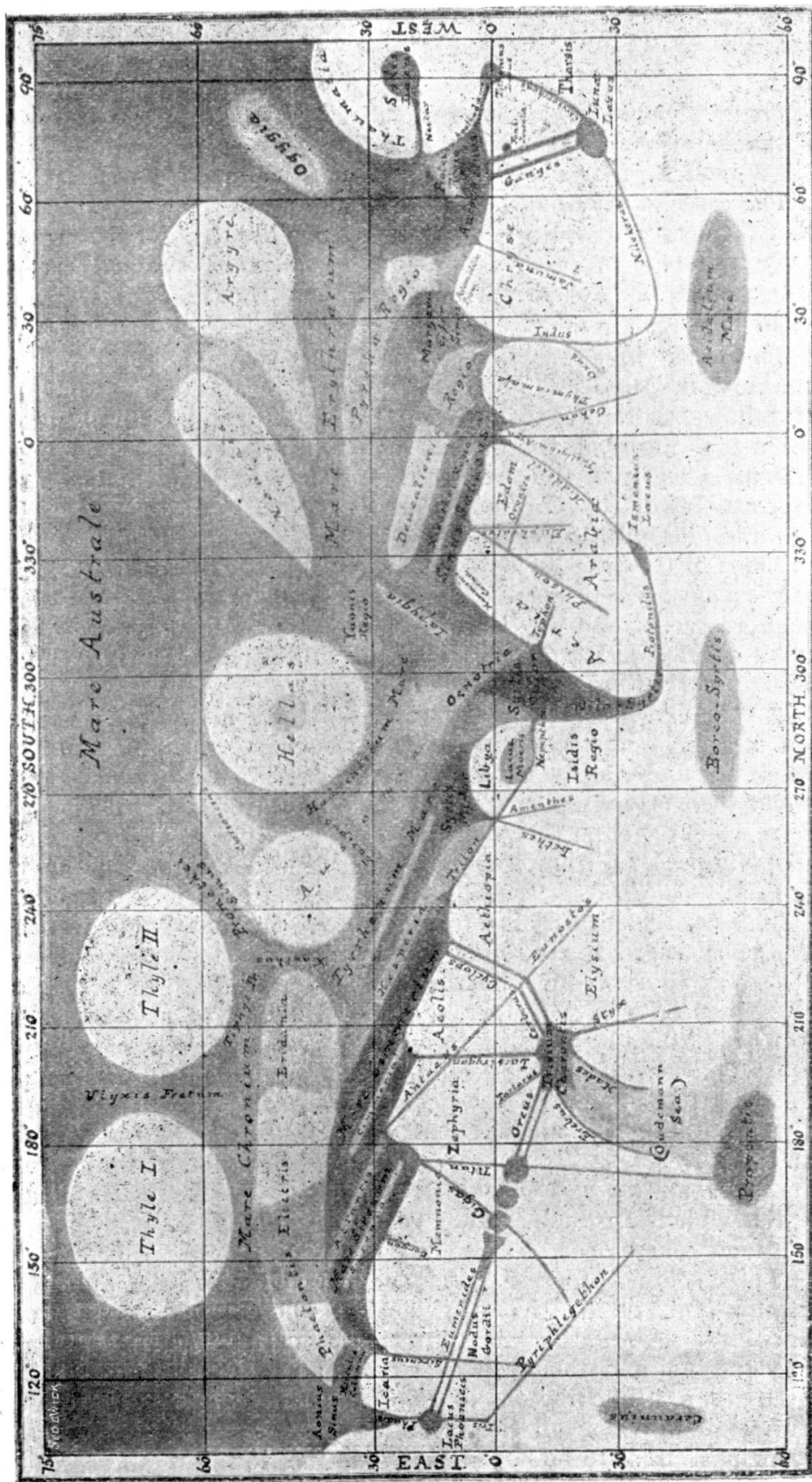


Chart of Mars, prepared from the observations of the Section, 1892.

central meridian, much good work would be achieved and with but little trouble.

But in spite of all these defects, enough satisfactory material remained to justify the composition of the accompanying chart.

In one point its composition was rendered more easy; there was but slight evidence of change taking place on the planet during the period of observation. The lands immediately to the E. and S. of the *Maria*, *Sirenum*, and *Cimmerium* afforded the most probable instances of progressive change. As compared with the two classic charts, Green's is confirmed in the neighbourhood of the Kaiser Sea, Schiaparelli's round about *Deucalion*, *Chryse*, and over the whole region between  $L = 120^\circ$  and  $260^\circ$ . And no few of the canals were confirmed.

Mostly by A.S.W.; but though practically alone amongst English astronomers in recording them in 1892, his observations were too fully supported from abroad for there to be any doubt as to their wonderful accuracy. In particular the three southern observers, A., G., and P.P.M., supplied a large amount of confirmation. The following extract from G.'s report is of special interest in this connexion:—

“August 25, 12h. 30m., S.M.T.—This was the best night of the opposition, and in intervals of perfect definition the aspect of Mars was a revelation. The planet seemed to stand out in relief upon the dark background, and the surface, especially the central and north following portions, was mottled, and striped in a manner quite unexpected, even after inspection on good nights. The lakes and canals shown”—(Fig. 12 of the Plate)—“are the more prominent only of the network of markings visible in the minutes of perfect seeing. The faint electric illumination of the drawing paper was sufficient so to affect the retina that some minutes would elapse before the delicate shadings were again seen. None of the canals (for such, I presume, they are) were noted as double. The marking from which they seemed to radiate consisted of three or four narrow lakes in close juxtaposition. A dark shading near the northern limb was also remarked. . . . The canals were fairly definite, *not* fuzzy . . . I may remark that having failed to detect any canal-like markings in 1890, and bearing in mind the many discussions of the matter, I was inclined to disbelieve in their objectiveness. The experience of August 25 has quite altered this opinion. The detection of such delicate features seems to demand the best of conditions and instruments, while keen vision is no doubt an important factor.”

The principal changes from the aspect of the planet in former years were the lake system detected by G., north of *Memnonia*, the faintness of *Lacus Solis*, whilst under observation by the Members of the Section, the remarkable appearance of the neighbourhood of that lake as given by K., and the narrow white streaks noticed in certain *Maria*. These last were very numerous. The islands *Sirenia* and *Cimmeria*, the island in the *Tyrrhenum Mare*, *Japygia*, *Xisuthri Regio*, and *Ogygia* form a series of markings of so strongly similar a character as to draw the attention at once. And it cannot escape notice how similar the appearance, say, of the *Mare Sirenum* or of the *Sinus Sabaens*, when bisected by these islands, is to that of the double *Ganges* or *Cyclops*. Can there be any reasonable doubt that the two phenomena are really of the same order? Probably the explanation of both is that evaporation takes place from the broader expanses of water on Mars with great rapidity, owing to the low

atmospheric pressure. A light wind sets off from the land surrounding the water, the moisture laden air rises, suffers some condensation, and a cloud bank is formed over the centre of the water in question. The canals, therefore, seen as single when narrow, very soon after they have broadened out, are seen divided down the centre by one of these white streaks of either cloud or mist.

Another feature noticed during the opposition, and of interest from a physical point of view is the fact, noted on page 188, that *Hellas*, the ruddiest marking on the planet, is seen as an intensely bright and white spot on the limb, and that other ruddy districts, as *Eden* and *Eridania*, show, though less strikingly, the same peculiarity. The explanation is a little difficult. Perhaps these are more elevated regions, on which clouds gather, or hoar frost is deposited, every morning and evening, more quickly than on the lowlands.

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It remains only for the Director, in completing his task, to express his hearty thanks to the ladies and gentlemen who worked so zealously, and with such success, in the Section under circumstances that were most adverse; and to tender to the Members of the Association generally the expression of his great regret that the publication of this Report has been delayed so long, since he was unable, until relieved from the duties devolving upon the Editor of the "Journal," to properly discuss the materials which the Members of the Section had provided with so much earnestness and skill.

1895, May 1.

E. WALTER MAUNDER,  
Director of the Section.

O B S E R V A T I O N S O F M A R S , 1 8 9 2 .



Fig. 7. W.F. Gale; Aug. 31; 22<sup>h</sup> 55<sup>m</sup>  
Long. 12° 7'; Lat. 11° 8' S.



Fig. 8. Miss A. S. D. Russell; Sept. 14; 8<sup>h</sup> 50<sup>m</sup>  
Long. 38° 7'; Lat. 12° 9' S.

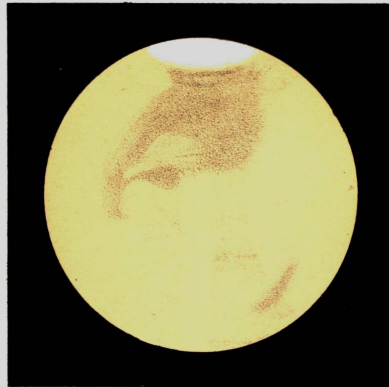


Fig. 9. H. Ellis; Aug. 4; 11<sup>h</sup> 50<sup>m</sup>  
Long. 91° 6'; Lat. 12° 6' S.

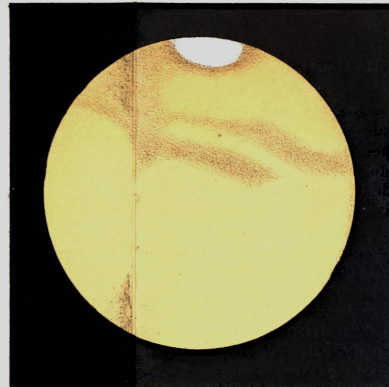


Fig. 10. E. M. Antoniadi; Sept. 2; 8<sup>h</sup> 45<sup>m</sup>  
Long. 147° 4'; Lat. 11° 9' S.



Fig. 11. L. A. Eddie; July 20; 9<sup>h</sup> 0<sup>m</sup>  
Long. 183° 4'; Lat. 14° 2' S.



Fig. 12. W. F. Gale; Aug. 18; 2<sup>h</sup> 25<sup>m</sup>  
Long. 189° 6'; Lat. 11° 7' S.

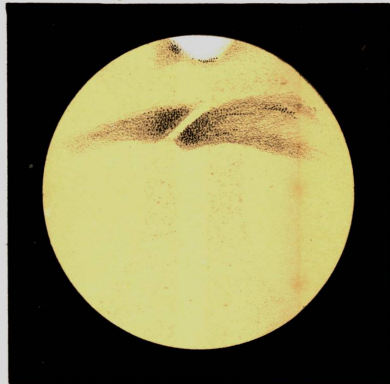


Fig. 13. Capt. W. Noble; Aug. 28; 9<sup>h</sup> 55<sup>m</sup>  
Long. 209° 8'; Lat. 11° 7' S.



Fig. 14. E. M. Antoniadi; Aug. 24; 8<sup>h</sup> 30<sup>m</sup>  
Long. 225° 0'; Lat. 11° 7' S.



Fig. 15. W. F. Gale; Aug. 7; 0<sup>h</sup> 55<sup>m</sup>  
Long. 265° 3'; Lat. 12° 4' S.



Fig. 16. W. F. Gale; Aug. 6; 2<sup>h</sup> 25<sup>m</sup>  
Long. 296° 1'; Lat. 12° 5' S.

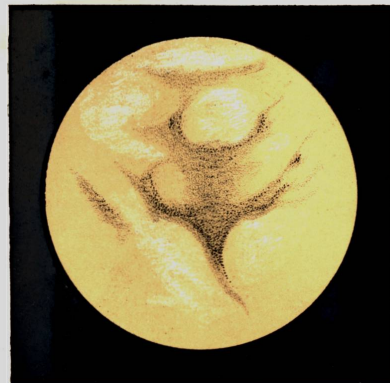


Fig. 17. G. L. Brown; Sept. 21; 6<sup>h</sup> 20<sup>m</sup>  
Long. 297° 2'; Lat. 13° 7' S.

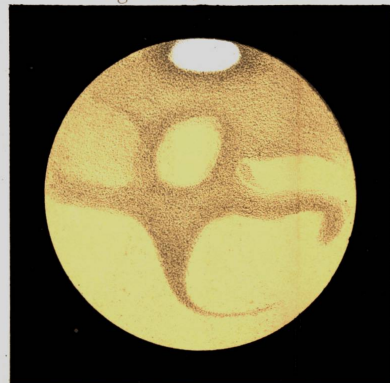


Fig. 18. E. M. Antoniadi; Aug. 18; 10<sup>h</sup> 15<sup>m</sup>  
Long. 304° 3'; Lat. 11° 7' S.

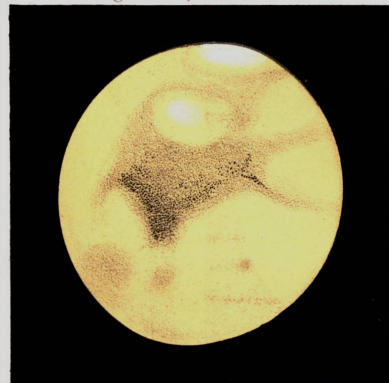


Fig. 19. Miss A. Everett; Sept. 23; 8<sup>h</sup> 45<sup>m</sup>  
Long. 313° 3'; Lat. 14° 1' S.



Fig. 20. Lieut. P. P. Molesworth; Sept. 11; 2<sup>h</sup> 33<sup>m</sup>  
Long. 334° 6'; Lat. 12° 6' S.



Fig. 21. E. M. Antoniadi; Aug. 9; 8<sup>h</sup> 30<sup>m</sup>  
Long. 358° 6'; Lat. 12° 2' S.

