SCIENCE

FRIDAY, MAY 5, 1899.

CONTENTS:

'OBSERVATIONS OF THE PLANET MARS.'*

THIS is the first volume of a series which promises to be important for the physical study of the planets. It contains a detailed account of the observations made on the planet Mars during an interval of ten months (June, 1894—March, 1895) by Mr. Percival Lowell and his two collaborators, W. H. Pickering and A. E. Douglass. The observatory, especially constructed near the small town of Flagstaff, occupies a central position in the great plateau of Arizona, at an elevation of 7,250 feet above the level of the sea, in latitude 35° 11′ and longitude 111° 40′ west of Greenwich. The choice of that location has been justified by the success attained. During the six months from June to November, 1894, the planet could be observed on nearly every day. On two days out of three it was possible to record useful observations of difficult objects. The atmospheric conditions prevailing during that period (and often during the following winter as well) are sufficiently characterized by the discovery of a great number of details unknown to previous observers. These observations suffice to give an idea of the optical perfection of the instrument employed, which had an objective by Brashear,

* Annals of the Lowell Observatory. Vol. I.—Observations of the Planet Mars during the opposition of 1894–95, made at Flagstaff, Arizona. Percival Lowell, Director of the Observatory. Boston and New York, Houghton, Mifflin & Co. 1898. Pp. xii + 392. Large quarto. Plates, xxi.

of 18 inches aperture and 315½ inches focal length. The magnifying powers used were commonly 440 and 617; an eye-piece of power 820 served for the micrometric measurements. Among the auxiliary instruments we mention an Arago polariscope, which has been employed, perhaps for the first time, upon Mars by W. H. Pickering at Flagstaff; also a scale of very fine lines of different sizes, which served for the comparison and estimation of the size and intensity of the lines observed on the planet.

The very numerous and varied observations which form the contents of the present volume have led to many results, the most important of which have been announced by Mr. Lowell in his book 'Mars,' published in 1895. That book contains many discussions and theories of great interest as to the physical constitution of the planet and its atmosphere, its habitability, and as to the most plausible manner of explaining the curious phenomena which have been observed. The substance of those researches and of those discussions has been reproduced in the present volume. The readers of SCIENCE have been made familiar with them by the critical analysis of them given by Professor W. W. Campbell in the number for August 21, 1896. I have, therefore, not occupied myself with the theoretical and hypothetical portions, and I am able to confine myself to the observations. In view of their great variety, I shall be obliged to limit myself to the consideration of some of the more characteristic points.

First, as to the polar spots and their periodic variations, which are known to be analogous to those of our polar snows. The manner of development of the polar caps and the phases of their increase are entirely unknown, and it is probable that they will always remain so; for during the period of their increase they are for the most part or wholly enveloped in the night of the pole. But the process of their dissolution can be followed without much difficulty when the inclination of the planet's equator with respect to our line of vision approaches the maximum value possible, which occurred in 1894. As for that, the observers at Flagstaff have been able to study the phenomena of the southern spot from the beginning of June, when its diameter was about 55°, up to its total (or nearly total) destruction, which occurred toward the end of October.

They were able to follow the changes of its size and shape, its division into several parts by the large black band, and to establish further the persistence of certain parts isolated from the greater body. They also observed the changes of color which took place in the surrounding dark regions. Plate II., page 46, gives the definitive results of that investigation, which, in comparison with similar work hitherto, sufficiently shows the superiority of the means with which Mars has been visually studied at Flagstaff.

I may be permitted to express here the conviction that it is by the exact and persevering study of the polar spots of Mars that we shall some day arrive at a sound knowledge of the physical nature of that planet, and the interpretation of its singular phenomena. I shall even venture to say that if the southern cap is very instructive in that respect, the northern cap is still more so. In fact, the latter develops to a large extent over the regions of a yellow color which it is customary to call continents. The obscure band which reaches to its edge has a direct relation to the system of canals and lakes surrounding it. In the same measure as the white spot diminishes under the influence of the solar rays, there take place in the neighboring regions very considerable changes, the connection of which with the successive phases of the cap is evident. The facts that I was able to

establish during the oppositions of 1886 and 1888 make me very strongly wish that the northern cap could be studied by the observers at Flagstaff with the same success as the southern.

A considerable portion of the work is devoted to the phenomenon which is called, according to usage, the *canals* of Mars, the nature of which is still entirely obscure, despite the theories, oftentimes pretty and very ingenious, which they have occasioned.

Mr. Lowell has given a description of these singular formations which seems to me to conform to the truth in the great majority of cases. He has succeeded in showing their character quite well in his drawings. See plates I, IV, V, VI. If there is any defect here, it is that the differences of the size and intensity of the different canals are not indicated with sufficient clearness. I have had occasion to gain some experience in that line of work, and I have no hesitation in saying that this part of the observations at Flagstaff seems to me to be worthy of the greatest consideration. Between the south pole and the thirtieth parallel of north latitude (three-quarters of the whole surface of the planet) previous observers have more or less clearly recognized the existence of 70 or 80 canals. At the Lowell Observatory that number has at one stroke been increased to nearly 200, without counting those whose existence could not be satisfactorily verified. The record of observations of these objects made from June 6, 1894, to April 3, 1895, occupies no less than 85 pages. Frequently 20 or 30 canals could be seen together. In less than an hour, on the night of October 6th, 42 were made out on a portion of the planet which did not amount to a quarter of the whole surface. All three observers took part in the work. The newly discovered canals naturally belong to the most difficult class, and a certain number of them have since been verified by two European observers, Leo Brenner at Lussinpiccolo and Cerulli at Teramo. I greatly regret that I am unable to add my own name to those, but my eye no longer has the power necessary for successfully carrying out such difficult observations.

Several canals were observed in a state of gemination, among others Ganges, Nectar, Euphrates and Phison. On the 8th of October Mr. Douglass made the very curious and remarkable observation of the gemination of the *Lacus Solis*, which seemed to be divided in two by a luminous band on the extension of Nectar. I made a similar observation in 1890, but then the luminous band was on the prolongation of Eosphoros. The same thing is being observed by M. Cerulli at Teramo during the current opposition of 1899.

As a result of these numerous discoveries and other subsequent ones, as well as future ones, areography is coming to find itself in a condition which may be called an embarrassment of riches. The network of canals has become so complex that there begins to be considerable difficulty in orienting oneself. Imagine three or four hundred of these lines traced all together over a globe of but a few seconds of apparent diameter! The identity of lines seen by different observers at almost the same place is very often doubtful. The difficulty of seeing well and of precisely locating the coordinates of the two extremities may easily give rise to ambiguity and errors. Add to this the frequent changes which the lines undergo in their aspect and their degree of visibility; being now fine and sharp, and again large and diffuse; sometimes double, often entirely invisible—and one is no longer astonished to see the same line, observed by two different men in a slightly different manner, regarded by them as two distinct objects; or, on the other hand, to see two essentially different objects confounded as a single one. The better remedy for avoiding these inconveniences

would be to give up the doubtful objects, and to make as complete and exact a study as possible upon those canals best known and most easily observed, following without interruption the variations of their aspect and of their course, and basing deductions upon precise measures. Precise measures! the thing most necessary and at the same time the most difficult, which ought to receive more attention from skilled observers.

The proportion of new discoveries at Flagstaff on the small dark spots called lakes (Mr. Lowell's *oases*) is relatively still more considerable. Prior to the opposition of 1894 ten to twelve of these formations were known. Mr. Lowell gives a catalogue of more than forty of them. He has shown that in most cases these oases are arranged in regular series on the routes of the longer canals. It is quite probable that minute dark spots, more or less readily visible, must exist at all points of intersection of any two canals.

There is still another class of objects on which the Flagstaff observers have instituted the first thorough research. These are the black lines which furrow the darker portions of the surface of Mars and are ordinarily called the seas. Some lines of that sort had been noticed before, and even a form of gemination had been established for two of them.* In general, previous observers had believed that they saw here lines of the greatest faintness rather than true canals; in only a very few special cases did they succeed in tracing the two edges distinctly. At Flagstaff these lines have been observed and reproduced with much care by Mr. Douglass, who seems to have a very sensitive and well-trained eye for that sort of objects. From measures of position angles he traced on two maps their course in the dark regions of the planet and their connection with the canals of the yellow region. See plates XII and XIII.

The third chapter of the volume is also the work of Mr. Douglass, and deals with a class of observations which are almost unknown, except for some essays in this direction at Nice and at the Lick Observatory in 1890 and 1892. I refer to the irregularities which have been very often noticed at the terminator, *i. e.*, on the line which at any instant separates the obscure from the illuminated hemisphere. These are very evident when the phase is considerable, near the quadratures. In by far the greater majority of cases these irregularities are merely optical illusions caused by the different proportion of the oblique solar illumination returned to us in the different regions traversed by the terminator. But there seem to be certain of these irregularities which can only be explained by the presence of elevations or depressions on the surface of Mars. Still others seem to depend upon the presence of very high clouds. These investigations are of much interest, not only from their possible bearing on the topography and orography of Mars, but also from the point of view of the physical history of the planet and its atmosphere.

The work is enriched by a large number of drawings of Mars, some of which are really excellent even from an artistic point of view. See especially plates I and IV. We have seen nothing as beautiful since the drawings made by Mr. Green on his expedition to Madeira in 1877. We can recognize here not only the geometrical configurations and the varieties of light and shade, but we can also get some idea of the magnificent coloration observed on the planet.

The chart placed at the end of the vol-

*See on my map of 1882 the two parallel lines which include between them the large island called *Noachis;* one of these is named *Prasodes* on Cerulli's map. See also the two lines which flank the right side of *Syrtis Magna* on my drawing of June 20, 1890, published by Flammarion (*La Planète Mars*, p. 476).

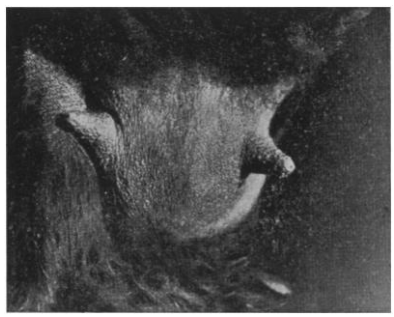

FIG. 1. Normal milk-bag of ewe showing two nipples.

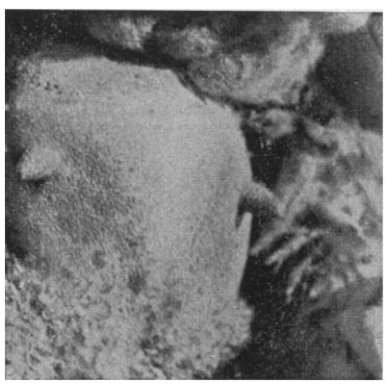

FIG. 2. One rudimentary extra nipple.—A Sport.

FIG. 3. Two rudimentary extra nipples. — A Sport.

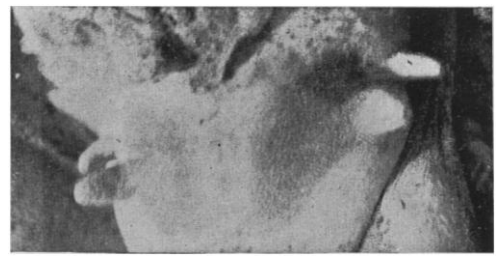

FIG. 4. Ewe born 1892, nipples increased by selective breeding.

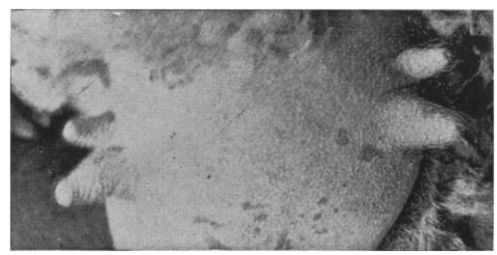

FIG. 5. Ewe born 1893, nipples increased by selective breeding.

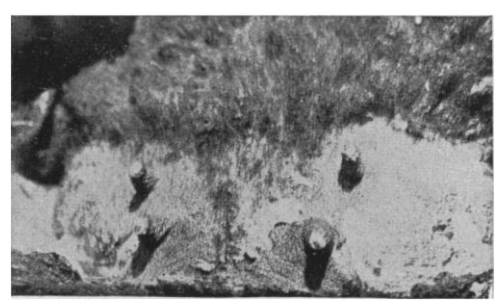

FIG. 6. Ewe born 1895, nipples of equal size increased by selective breeding.

BELL ON THE DEVELOPMENT BY SELECTION OF SUPERNUMERARY MAMMÆ IN SHEEP.

ume is a simple schematic representation, I venture even to say a little too schematic. Each object is designated by a number, and the corresponding name is to be sought in the special tables of regions, canals and oases. This makes the use of the chart troublesome and comparison with other charts inconvenient. All the large and small canals, of whatever degree of importance and visibility, are treated in a uniform manner and are represented by lines of equal intensity; and the same with the oases, with the exception of the largest one of all, called the Lake of the Sun. It is not easy to recognize promptly on the chart many of the objects which are ordinarily seen at the first glance and which are familiar to areographers. Such objects as Indus, Oxus, Ganges, Cyclops, Trivium and Elisium must be sought in an inextricable maze of lines. We have here not a simple index, but one which in use requires itself an index.

I will close this incomplete description of the work on Mars at Flagstaff with the expression of a hope and a wish, namely, that so important a publication should not be limited to a single opposition. The exact and complete knowledge of Martian phenomena demands that the planet should be examined under all possible inclinations of its axis and during all seasons of its year. This requires observations continued at least through *seven* consecutive oppositions. I say, 'at least,' for if the terrestrial seasons are far from following the annual period with mathematical precision, the phenomena of Mars seem still more divergent; and the existence of other periods, longer and more complex, ought to be included among the possibilities. Nevertheless, I think that if we could have before us seven volumes similar to the one under review, and corresponding to a complete cycle of seven oppositions, many facts would be revealed of which we are at present ignorant, and many others of which we have at present only dubious indications; especially would this be the case if the seven volumes were the work of the same observers. I therefore hope and wish, as do many others, that Mr. Percival Lowell may be in a position to continue the work so happily begun; that he will soon publish the results of the observations during the opposition of 1896–97, and that the same means which he has employed for the study of the southern hemisphere of Mars may be applied to the still more important observation of the phenomena of the northern hemisphere.*

G. SCHIAPARELLI.

MILAN, March 1, 1899.

ON THE DEVELOPMENT BY SELECTION OF SUPERNUMERARY MAMMÆ IN SHEEP.†

IN the year 1890 Dr. Bell found that 50 % of the lambs born upon his farm in Nova Scotia were twins, and he made an examination of the mothers in order to ascertain whether the twin-bearing ewes differed in any noticeable degree from those which produced single lambs.

Thirty-three per cent. of the twin-bearing ewes were found to possess supernumerary mammæ in a more or less rudimentary condition, whereas among the ewes having single lambs only 22% possesssed the peculiarity; 43 % of the ewes having supernumerary mammæ bore twin lambs, whereas only 30% of the normally-nippled ewes had twins.

Although the absolute numbers were far too small to yield reliable percentages, they afforded some ground for the idea that the extra-nippled ewes were more fertile than the others; and Dr. Bell thought it would be interesting to ascertain (1) whether by

* Translated from the author's MS. in French by E. B. F.

† Abstract of a paper read before the National Academy of Sciences at Washington, D. C., April 19, 1899, by Alexander Graham Bell.