The data on secular variation in rainfall, p. 19, *Monthly Weather Review* for April, 1887, show, however, that, even with these errors corrected, the rainfall at Leavenworth for the past twenty-five years has been considerably greater than for the previous twenty-five years. There is no doubt that material errors existed in the old records, some of which are due to neglect or falsification of records, while others, as in this case, are due to gross carelessness.

Rainfall data are now being collated by the Signal Office with a view to their examination and discussion; but the more the records are examined, the more possible it seems that observations prior to 1870 should be neglected, except in cases of well-known and reliable observers.

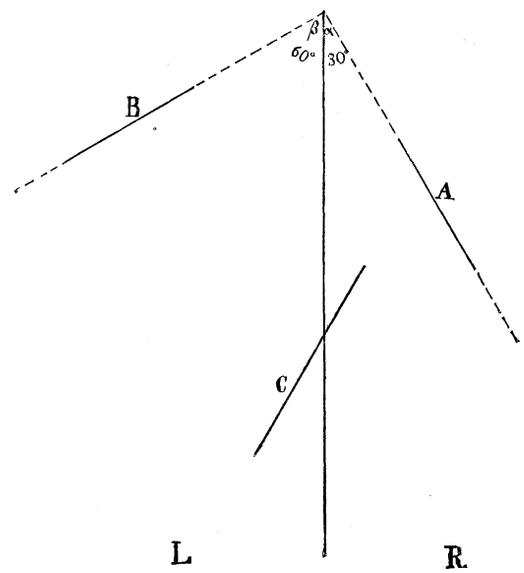
A. W. GREELY.

Washington, D.C., May 12.

Disparate Vision.

MR. HYSLOP'S experiments in physiological optics as detailed in *Science*, Nos. 261, 262, and 274, are interesting in that they show the importance of monocular perceptions in attaining what we may think to be binocular effects, even though they may not fully disprove the generally accepted theory of corresponding retinal points. Having devoted much time to this subject (see *American Journal of Science* for November and December, 1881, March, April, May, October, and November, 1882), I may perhaps claim some practice in experiments of this kind. The result of former investigations was my total abandonment of the geometric considerations which formed an integral part of Brewster's theory of binocular vision, and which have been repeated time and again since his day. The empiristic theory, as developed by Helmholtz, seems more consistent with the more general theory of evolution now universally accepted as fundamental in biology. According to this, we rapidly learn in infancy to interpret our binocular perceptions by experience that is too complex for analysis. Assuming a certain inherited structure for the retina, which is alike for the majority of individuals of the race, it remains possible to modify our perceptions slightly by training; and it would not be safe to deny that in exceptional cases binocular perceptions may result from simultaneous impressions on retinal points that are decidedly disparate. I have elsewhere adduced arguments to show that no strictly mathematical interpretation can be put upon the theory of corresponding points (*American Journal of Science*, May, 1882, p. 355 *et seq.*). The perception of the third dimension in space without any of the aids resulting from shading, comparison, or motion, has lately been shown to be quite possible with monocular vision alone (*American Journal of Psychology*, November, 1887, p. 99, article on the Horopter, by Mrs. Franklin). I had no difficulty in attaining this monocular perception in repeating Mrs. Franklin's experiments.

But although constrained to assign much greater potency to monocular vision than was customary after the stereoscope became generally known and used, and although our interpretation of binocular perception has to be much more elastic than it formerly was, there seems to be not yet sufficient ground for the belief that any large part of our binocular perceptions are the result of impression on pairs of retinal points that are widely disparate. The same perception may be changed by force of will or of imagination, and with various degrees of success by the same person at different times. Without denying the validity of Mr. Hyslop's perceptions, I do not succeed in getting exactly his results. Combining the two circles by either convergent or divergent vision, the binocular effect is an ellipse whose plane is perpendicular to the meridian plane only when their inclinations to this plane are equal. This perception is rigidly binocular. Let, now, their inclinations be different. For example: let the plane of the circle A make an angle of 30° with the meridian plane, and B an angle of 60°, the two being seen by cross-vision. In the accompanying diagram the cards are supposed to be seen edgewise, the two eyes being at R and L. The plane of the resultant ellipse changes about to the position C; the horizontal axis, which was previously the shorter one, becoming now much longer than the vertical axis, which has remained unchanged. The projection of the circle A on the retina L is quite a narrow ellipse, while that of B on the retina R is almost if not quite circular, the vertical diameters of these ellipses being nearly equal. At the top and bottom of the resultant ellipse the perception may be due to impression on corresponding retinal points, while for other parts the impression is on disparate points. Very little attention is required to perceive the separate monocular images. By still further diminishing the angle α and increasing β, a limit is reached at which binocular fusion ceases to be possible. Two ellipses are seen, apparently crossing each other in space about where C was; the plane of one being nearly parallel to A, and that of the other nearly parallel to B. By indirect monocular vision, A is still seen by the right eye, and B by the left. The locality of the crossed ellipses is not so definite as was that of the binocular ellipse; but the illusion of suspension in space still remains, and with it is the monocular perception of the third dimension in space. Even when α is very nearly equal to β, it is possible by rivalry of retinal impressions to gain or lose monocular perceptions alternately with binocular resultants. But the clearness of the binocular illusions is more pronounced than that of the monocular in proportion as the separation of the disparate points impressed becomes less. It is fair to conclude that binocular vision is at its best when there is perfect correspondence of at least a goodly proportion of the retinal points impressed, and but slight separation of disparate points. But it is quite necessary, in the majority of cases, that there shall be some such disparateness. The mental effect produced is instantaneous. Since double images, whether homonymous or heteronymous, are rarely ever perceived except as



the result of special ocular training, and since the binocular perception of depth in space may result where one element may, on geometric grounds, be considered to be combined with other elements so as to produce at the same instant both homonymous and heteronymous double images (*American Journal of Science*, October, 1882, p. 5), binocular vision is far from being so simple and easy of explanation as it seemed to the students of forty years ago.

W. LECONTE STEVENS.

Brooklyn, N.Y., May 5.

Agriculture and Late Quaternary Geology.

IN view of the effort now being made to endow the United States Geological Survey with the means of carrying into effect the "classification of lands" called for in the act creating it, it may be of interest to record one out of many instances where this classification, in connection with agricultural phenomena, affords information equally interesting to the geologist and the farmer.

At a late visit to the upper San Joaquin valley for the purpose of locating on a representative soil a culture experiment station under the Hatch Act, the writer was under the necessity of obtaining a cross-section of the great valley in the latitude of Tulare City, from Lake Tulare on the west, to the foot-hills of the Sierra Nevada on the east.

The dark-tinted loam-deposits at present forming on the edge of that lake being already familiar, it was easy to recognize in the 'black-lands' belt, that begins about two miles westward of the