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.

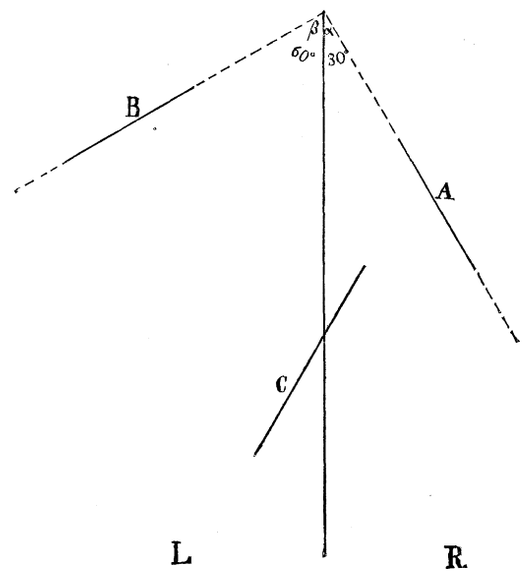
A. W. GREELY.

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

Southern Pacific Railroad (here running midway between the Sierra and the lake), the earliest border of that basin, distant quite fourteen miles from the lake-shore as recorded on the maps, but which itself is now several miles inland from the water's edge. The railroad and Tulare City lie on a belt of sandy land, obviously somewhat higher in level than the 'black lands,' and here about eight miles wide. In crossing this belt to the eastward we traverse several bands of 'alkali land,' characterized by the dense growth of *Brizopyrum*, or 'alkali-grass,' and evidently forming a summit plateau on the divide between the Tulare basin proper and the extreme southern branch of the delta bayous[1] of the Kaweah River, called 'Outside Creek,' or Elk Bayou. Approaching this watercourse, we again come to a 'black-lands' belt, about three miles wide, which borders the bayou on both sides, and evidently represents an estuary of the time when Tulare Lake was much higher than now, and the Kaweah delta bayous were mere swamps. Another 'alkali-land' belt is crossed after traversing the 'black-lands' of Outside Creek, towards the foot-hills: beyond these, lies a narrow sandy belt corresponding to that along the railroad, as above described. Then, at a distance of some eight miles from the foot-hills, the color of the soil begins to change toward the well-known red tint of the soils resulting from the decomposition of the 'bedrock' slates of the foot-hills; but the ascent is so gradual that to the eye the plain appears as level as ever, although the presence of the ferric hydrate in the soil proves that these 'red lands' were never submerged for any great length of time, since otherwise their iron would have been reduced and leached out, or gathered into 'black gravel' (bog-ore), as is the case in the 'black lands' of the lake and bayou borders. On inquiry, it was learned that all the larger streams of the region (including Tule River and Deer Creek, outside of the Kaweah delta) are accompanied by belts of such 'black land.'

Besides these main bayous, there appear in the sandy lands a few obvious sandy channels, usually dry, but carrying water in time of flood.

But a curious and at present very striking demonstration of the ancient drainage system of the region may be seen in the grain-fields. In consequence of the failure of the usual April rains, most of the wheat-fields of the region are now in a very precarious condition where not irrigated, and much of the wheat sown will not even make hay. Its condition is best on the 'black lands,' and in certain portions of the sandy belt that do not show any obvious difference in soil from adjoining tracts in which the crop is already dried up without having been able to form grain in the ears. The eye quickly recognizes the extraordinary resemblance of the outlines of the dead portions to meandering water-channels, but no difference of surface-level remains to indicate the fact. But, by digging in any part of these meandering belts of desolation, we find the sandy soil becoming sandier as we descend, until finally, at about three feet depth, an almost pure, coarse sand underlies, which obviously cannot raise moisture within reach of the root system. On the adjacent land, where the wheat is still green and growing, we find at the same depth a subsoil of increased closeness and capillary power, which keeps the moisture below within reach of the roots.

Thus a bird's-eye-view photograph taken of this region now, would show, traced out in minute detail by the color-contrast between the living and the dead grain, the ancient drainage of the country, of which its surface at present shows no indication, together with the broad bands of the ancient estuaries that have formed the 'black lands,' characterized by green, growing grain or an extraordinarily luxuriant growth of oaks, that likewise outlines the ancient margin of Lake Tulare.

We thus obtain a chapter of the geological history of the valley from a mere reconnaissance such as any one desiring to invest in its lands would need to make. The significance of the 'alkali lands' in both points of view remains for a future discussion.

It is hardly necessary to dwell upon the interest attaching to the study of these features, whether from a practical or a purely scientific standpoint. One point, however, should be specially noted; namely, that a great many of the characteristic marks of these late quaternary events are rapidly disappearing before the advance of cultivation, and the replacement of the native plant-growth (the result of secular co-adaptation of soils and plants) and of the natural surface by the well-known results of agricultural operations. The latter are already obliterating, on large tracts, the singular 'hog-wallow' mounds that form so striking a feature and so difficult a problem, the solution of which must largely depend upon the geographical distribution of these swarms of mammillary elevations.

It is hard to see on what ground the study of these latest phenomena, connecting the present with the immediate geological past, should be deferred until it is too late to complete the record, by giving precedence altogether to the ancient formations. The rocks and fossils of the older formations will remain undisturbed for ages, as in the past, awaiting the leisure of the student of geology; while the delicate tracings of the latest pre-modern epochs are liable to fade away rapidly before the advancing settlement of the country. Nor can it be maintained that the processes that gave them birth, and which are still active in the formation of soils, are not scientifically, as well as practically, at least of equal interest with those that formed the older rocks. It is true that their study does not offer the easy rewards of the naming of new fossils, minerals, and rocks, which in times not yet belonging to the far past seemed to be the chief aim of students of geology; but they are none the less worthy of the highest scientific effort, and their practical results bear on products of an importance at least as great as those of the richest mines.

E. W. HILGARD.

Berkeley, Cal., May 1.

[1] It should be understood that the Kaweah River, emerging from a cañon of the Sierra next to southward of King's River, divides into a number of forks or bayous immediately upon entering the valley plain. The extensive delta region thus formed is one of the richest, as well as the only forest-grown area of the great valley of California.

Queries.

32. HUMAN BEINGS AS PACK-ANIMALS. — In studying the history of transportation, I have ascertained that the first pack-animals were human beings, — men and women. Long before any of the animals were domesticated as beasts of burden, there were common carriers moving vast quantities of merchandise about the world. They toted (carried on the head); they hung great loads to their foreheads by means of a strap connected with a pack, wallet, basket, or frame on the back; they 'shouldered' their burdens, with or without yokes, front and rear, on one shoulder (like the Chinese) or on both shoulders (like the Dutch); they strapped their primitive knapsacks to their shoulders; they harnessed themselves to a load, as they did afterwards dogs, reindeer, horses, etc. Now, I should also like to know how much a man can tote, how much a woman can tote, and how long a time, without resting, the toting may go on. I should also like to know how much a man or a woman can carry in any particular manner, and how long a time the operation can be kept up without resting. The weight multiplied by the time will give a rough unit of human endurance. I shall be extremely obliged to any one who will give me valuable information on this subject.

O. T. MASON.

Washington, D.C., May 10.

Answers.

22. WASP-STINGS. — It is a fact not generally known, that, if one holds his breath, wasps, bees, and hornets can be handled with impunity. The skin becomes sting-proof, and holding the insect by the feet, and giving her full liberty of action, you can see her drive her weapon against the impenetrable surface with a force that lifts her body with every stroke; but, let the smallest quantity of air escape from the lungs, and the sting will penetrate at once. I have never seen an exception to this in twenty-five years' observation. I have taught young ladies with very delicate hands to astonish their friends by the performance of this feat; and I saw one so severely stung as to require the services of a physician, through laughing at a witty remark of her sister, forgetting that laughing required breath. For a theory in explanation, I am led to believe that holding the breath partially closes the pores of the skin. My experiments in that direction have not been exact enough to be of any scientific value, but I am satisfied that it very sensibly affects the amount of insensible perspiration.

W. L. WILDER.

Somerville, Mass., May 7.