

to some extent the influence of the other. The theory of precession and eccentricity depends on two well-known astronomical facts. First, owing to the elliptical form of the earth's orbit, our planet is about three millions of miles nearer to the sun in the winter of the northern hemisphere than in the summer, while the opposite is of course the case with the southern hemisphere; but 10,500 years ago this condition of things was reversed, and it will be reversed 10,500 years hence. If this has any effect on the seasons, it should be to make the climate of the northern hemisphere less extreme—that is, less warm in summer and less cold in winter; but the reverse of this is now actually the case, since the climate of the southern hemisphere is now the less extreme of the two, tho slightly the higher in temperature.¹ This we know to arise from the distribution of land and water, which must thus be a far more potent cause of difference. But there is a second cause affecting the result, and whose periods are much longer. This is the lengthening and shortening of the earth's orbit, placing the sun nearer to one end of it at one time than at another. The "eccentricity" of the earth's orbit is at present nearly at a minimum, or the sun is about as near the centre of our orbit as he can be; but about a hundred thousand years ago it was much greater, so that one pole of the earth would in winter be nearly eight millions of miles nearer to the sun than in summer. In these circumstances the effect of the north pole, for example, being nearer to the sun in winter would be much greater than at present in producing a difference of temperature; but it would be a difference not so much in the total amount of heat as in its distribution throughout the year. In the hemisphere which had the coldest winter there would be a correspondingly warm summer.

In order, therefore, to establish a probability that these changes could have any effect in producing cold and warm periods, it is necessary to call in other considerations, in themselves so important that they quite outweigh the astronomical causes, and to make some assumptions more or less conjectural. Let us consider the latter first.

It is assumed that the tendency of an exceptionally cold win-

¹ Fene!, "Meteorological Researches" (Washington), 1877.