IV.—*On the Revolution of the Seasons, (continued from Vol. IV. p. 257.)* *By the Rev.* R. Everest.

A correspondence between certain atmospheric phenomena, and certain positions of the moon, similar to what we have attempted to trace in the preceding papers, has been observed before in various ways, by others, and, in a degree, in all ages. But the objection may be fairly urged to such attempts, that, if we examine the supposed correspondence closer, no regular succession of phenomena can be made out. No state of the atmosphere can be expected to return of a certainty upon the recurrence of the assumed cause: nor, in such cases, can any probable circumstance be assigned, which might be supposed to have counteracted its operation. We may remark, however, upon this, that no two cases are precisely similar; one of the principal conditions of the problem, viz. the heating surface of the earth, never remaining the same, owing to the changes continually brought about in it, both by natural agents, and by the hand of man. Nor can the effect of this last be deemed unimportant, if we consider the many common processes, such as the felling of forests, ploughing, reaping, and irrigating, which are going on, at all times, more or less, over large tracts of country? Let us suppose it possible that a local irregularity of some kind might interrupt the operation of the cause—say (for instance) to such a degree, that the shower, which should have fallen with us, fell 5, or 50, or 500 miles distant from us; then, if, instead of the results of a single rain-guage or a single barometer, we could measure the amount of effect produced over an extensive surface of the earth, we might the more reasonably hope to obtain some approximation towards a regular succession of phenomena, in proportion as we were thus enabled to obviate the effects of disturbing causes. It occurred from this, that, in a country where the harvest depended almost entirely upon the quantity of rain that fell, the prices of grain in past years (the averages being taken as extensively as possible) might indicate, though imperfectly, a regular succession of the seasons, as far as drought and moisture were concerned; provided, of course, that such a regular succession had actually taken place.

This idea may appear so strange to many, especially to those who are not acquainted with the interior of India, that it may be as well to give it a little further consideration.

It must be familiar to every one that parts of the ancient world, such as Egypt and Judea, were subject at different times to famines

consequent upon drought. These are not uncommon at the present day in low latitudes. In *Australia*, for instance, 'frightful droughts occur in cycles of 9 or 10 years,'—(see *Westminster Review*, No. 45, July 1835, p. 223, and again p. 224 ;) and that such always have occurred in India, the history of the country abundantly shews. Perhaps the most remarkable one upon record is that which took place in Bengal in the year 1770. (See MILL's History for the particulars of this.) Now we have in the 1st vol. of the *Gleanings*, a list of the prices of different kinds of grain at *Chinsurah* in *Bengal*, from which we find that, in that year, rice was so dear that only 3 seers of it were sold for 1 rupee. If we examine this list further, we shall see that from the year 1733, the years of scarcity, or minimum quantity, and the intervals between them, were as follow :—

Years,.... 1733.... 1752.... 1770.... 1788.... 1807.
Intervals,.... 19..... 18..... 18..... 19.

If we add to the upper line, 1826, we have altogether 5 intervals of between 18 and 19 years for the recurrence of scarcities in Bengal. From 1733 to 1826 is 93 years, which divided by 5 gives $18\frac{3}{5}$ years. There are some, but faint, traces of scarcities intermediate to these. We must remember that $18\frac{3}{5}$ years is very nearly the duration of the Lunar Cycle.

Having proceeded thus far, we next ascertained by inquiry the dates of the principal scarcities that had occurred in the upper provinces within the memory of man. They are—

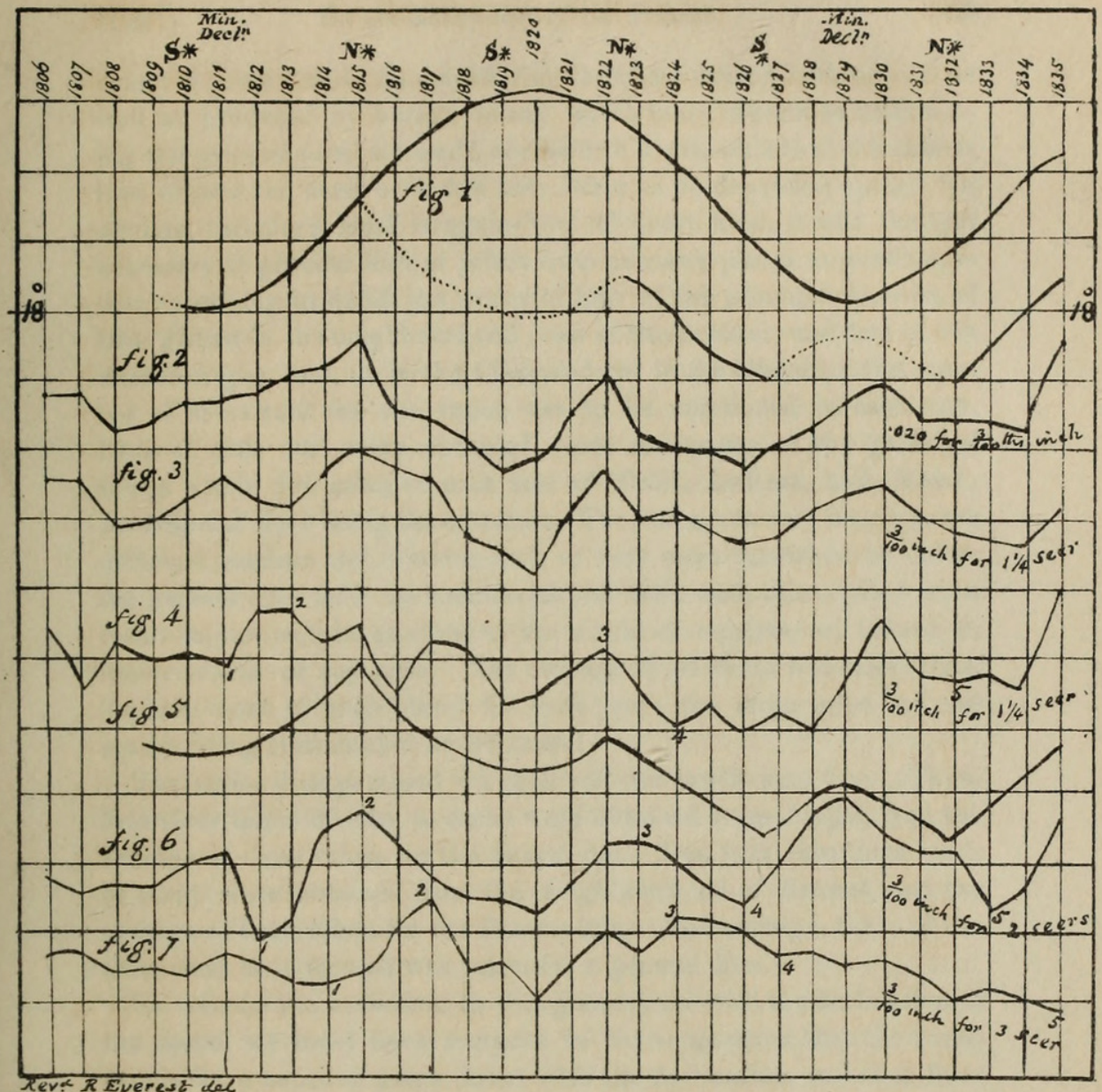
1782-3—1792-3—1802-3—1812-13—1819-20—1826—1832-3.

It will be observed that the recurrences here are nearly twice as frequent as in the former case.

The year 1829 being the year of minimum declination, the years corresponding to it in the previous cycles will be 1811 and 1792; and 1820 being the year of maximum declination, the years corresponding to it in the previous cyles will be 1802 and 1783. Thus we have a scarcity in each year of maxmium declination, besides another on, or close upon, the year of minimum declination, and in the case of 1829 a double one, viz. 1826 and 1832. We shall revert to this presently.

On obtaining one or two lists of the prices of corn, it was found, as might be expected, that these were the years when the least quantity was sold for a given sum ; and that, intervening, about midway, were years of extraordinary plenty, when the greatest abundance every where prevailed. So that it appeared as if the prices would form a curve of which the maxima and minima recurred at fixed intervals of

Variations of the Moon's Declination, and of the price of Grain.



Head of a Snake killed at Cuttack. Lt Kittoe

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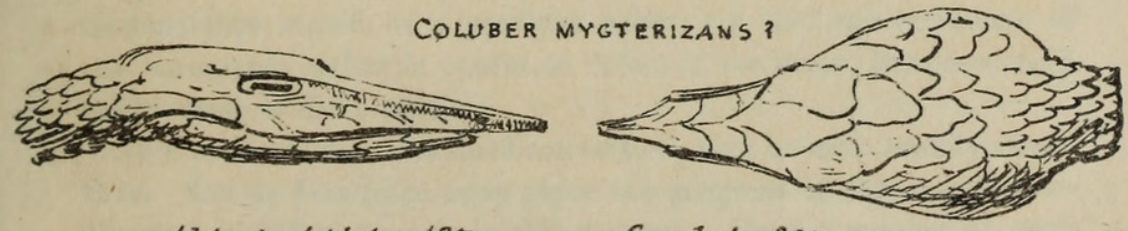

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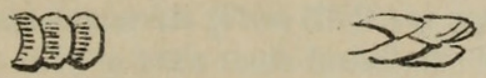

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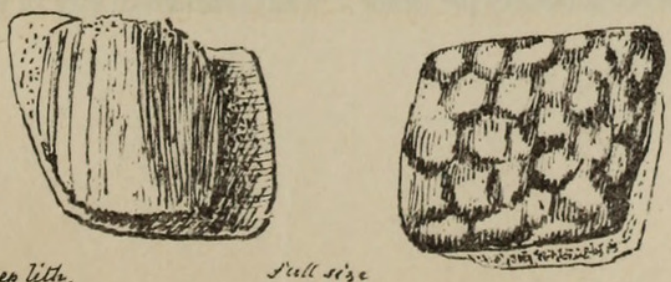
2nd Fossil Bone from Fort Boring, 36½ ft.



J. Prinsep lith. Half size

nearly 9 years. Still, on considering the many causes, both natural as well as produced by human means, which must operate in determining the price of corn, we could not believe it probable that the indication of one, or even of a few lists, were to be depended upon. To obviate, therefore, local irregularities of every kind, it was thought necessary to procure lists of prices from as many places as possible,—lists specifying in detail the prices of four of the principal varieties of corn grown in the neighbourhood (two of the summer, and two of the winter crops), and, as in the *Chinsurah* list in the *Gleanings*, the number of seers sold for one rupee was to be mentioned in each case. Lists of this sort were obtained from *twenty-two* of the principal towns within 200 miles on each side of *Delhi*, *Lodiana*, and *Hansi*; *Bareilly* and *Agra* being the extremes. They all agree very nearly in the principal maxima and minima, and, as they were furnished by different persons who had no communication with each other, their joint result cannot well be ascribed to the errors of copyists, or, indeed, to incorrectness of any kind. The average of all these was taken (four kinds of corn at each place) for each year; the mean price for the season being thus settled by 88 items.

The series thus obtained we shall call our north-west line. Three lists (four kinds of corn in each) were obtained from *Bengal*, and the average of them taken for the *Bengal* line. Two lists (also four kinds of corn) were obtained from the neighbourhood of *Benares*, and the average of them taken for the *Benares* line. The average, then, of the three lines thus formed was taken for a general line.

To connect the variations in this general line with the declination of the moon, we must have recourse to the supposition that the variation is for a series of years direct with the declination, and then for a series, inverse with it,—a supposition for which no reason can be assigned, but which will appear the less improbable, if we recollect a circumstance stated in a previous paper, viz. that the variations of the barometer, either in excess or defect of the mean, increased with the increase of declination.

This connection, or assumed connection, may be most readily shewn thus. Let us first trace upon paper the progress of the moon in declination in different years in this manner. Draw a number of vertical lines at equal intervals (Plate XXII.) to represent the years in succession from 1810 to 1835 (both inclusive). Take out of the Nautical Almanack the highest declination to be found in the month of July in each year, and mark that height upon the vertical line corresponding to the year at any fixed rate, (as 0.1 inch) for each degree that it is above

18°. When you have marked all the heights, join them, and you have the upper, or continuous line, fig. 1. The lower or dotted line in fig. 1, where it separates from the upper,—is formed from it, by substituting for the increments, equal decrements, so as to be exactly the inverse of it. Where this lower line again changes to a continuous one, it runs parallel (or varies directly) with the upper one, and again, where it changes to a dotted one, becomes the inverse of it. It is this lower line, partly direct, partly inverse with the upper, that appears to be the type of the variation of the seasons. As a proof of this, we subjoin below (fig. 2) the general average line of variation in the prices of corn during the same period. This line was thus formed. The three principal lines, the north-west, the *Benares*, and the *Bengal*, were first formed from the average of the different lists. When the maximum and minimum number in each line within the last 85 years (since 1750), were noted, and the difference between them reckoned as the whole amount of variation. This amount was divided into 1000 parts, and, for the actual number in each line, the proportionate parts of the variation were substituted. The average was then taken of the 3 lines, and this is the line expressed in fig. 2, which is there traced upon the paper at the rate of ·020 parts of variation for $\frac{1}{10}$th of an inch. The lowest line (fig. 3) is the general average, simply taken, of the principal lines, without any previous division of the variation into centesimal parts. A fourth, or southern line, was in this case included in the average, having been formed from prices at *Jubulpoor* (two kinds of corn), at *Bhopaul* (three kinds of corn), at *Indore* (two kinds of corn). But as the country in that direction was during part of the time the seat of war, and has been generally subject to unsettled government, and moreover the returns are not numerous, no great dependance can be placed upon it. In fact, the indications given by the north-west series are much more to be relied on than those of the others, owing to the more extensive induction.

In the last paper on this subject we noticed that there were certain years in which, about the solstices, the perigee of the moon fell on the same day with her maximum declination, either north or south, and that these were commonly extreme years, both of drought and moisture. These years are marked thus in the Chart N.* and S.* according as the declination is north or south, and it would appear on referring to the figures that these are usually the extreme years both of plenty and scarcity. They appear also to be the periods at which the variation changes from direct to inverse.