Built on wild fancies which thy name surround?
Or doth the story of thy classic ground
With the stern facts of Nature's face agree?
What if no tongue may tell!—thy halo fair
Still lingers round the isles which slumber there."
("Lyra Devoniensis," p. 135).

## LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

### Indian Rainfall

As Dr. Hunter has been good enough to mention my name in his letter to NATURE (vol. xvii. p. 59) in connection with a comparison of the rainfall of Northern India and the sun-spot period, I may, I trust, be allowed to express my opinion regarding the validity of some of the conclusions he draws therefrom. In the first place I would remark that Dr. Hunter's idea of the *winter* rainfall of Northern India being due to the *immediate rebound of the summer monsoon* from the Himalayan barrier is at variance with facts in the meteorology of the country. The rebound ought to take place directly the monsoon vapour-current impinges upon the Himalaya, *i.e.*, in the *summer*. In fact, it is by a succession of oblique rebounds from this impassable barrier that the monsoon is gradually reflected towards the N.W.P. and the Punjab.

The *winter* rains, on the contrary, have nothing to do with the monsoon, being, as is well known, due to a branch of the anti-trade, which, descending in the Punjab, is deflected by the Himalayas towards Behar and Bengal, occasionally reaching Calcutta, lat. 22° 35′ N.

Now between the rains of the summer monsoon and those of the anti-trade (or anti-monsoon as it is occasionally called), there is a well-marked interval of bright, clear, settled weather for two or three months throughout Northern India. After this interval the skies again become clouded, and about Christmas, or shortly after, the gentle but soaking rain of the cold weather sets in, and is repeated at intervals up to the end of March. It is evident, therefore, that the two currents, monsoon, and anti-trade, are totally unconnected with each other; and hence arises the desirability, especially in a question like the present, in which its secular variations are being discussed, of completely separating the rain of the former from that of the latter vapour current. I cannot but think that it is his omission to allow for these vapour currents that has led Dr. Hunter to offer such an erroneous explanation of the results obtained. According to him, copious precipitation should take place in the interval (October to December) between the two seasonal falls, during which clear weather is invariably present. It may be added that the period (December to April) which I took to comprise the winter fall, commenced after this interval.

The real explanation of the direct variation of the summer, and the inverse variation of the winter rainfall of North India, with the sun-spot period, is the hypothesis which first led to its verification coincidently and independently, by Mr. Hill and myself.

To enter upon a complete exposition of this hypothesis would occupy too much of your valuable space, but as it has been found to explain most of the anomalies which have hitherto proved such powerful obstacles (especially in extra-tropical regions) to the universal extension of the theory of sun-spot influence (I use the term advisedly) on the different elements of terrestrial meteorology, I will here briefly indicate its general outlines for the benefit of other workers in the same field of investigation.

The hypothesis, to start with, assumes *the solar radiation to vary inversely with the sun-spot frequency*.

It then takes account of the probable effects of such a variation upon the vapour-bearing currents throughout the globe with respect to velocity, direction, season, and latitude. According as trade, anti-trade, monsoon, or anti-monsoon, prevail (1) at different places at the same season, (2) at the same place at different seasons, so will specifically distinct effects arise both from the amount of vapour brought and its conditions of precipitation, to determine which, not only the general conditions introduced by latitude and season, but the local and peculiar meteorological functions of the region must be carefully studied.

Now as the principal effect of a secular change in solar radiated heat must be to cause a similar direct secular change in the normal convection currents of the atmosphere, we may expect the tropical trade-wind and monsoon regions to furnish us with some evidence, whether direct or indirect, in favour of the above hypothesis.

Little direct evidence has at present been adduced besides that given by Mr. Hill from a comparison of wind velocity in the N.W.P. (NATURE, vol. xvii. p. 505). A good deal of indirect evidence, however, is furnished in the monsoon regions by the occurrence of abnormal droughts and floods in contiguous districts (the drought in the N.W.P. and floods in Assam and Burmah last year were good examples of this kind) at the time of minimum sun-spot, when the velocity of the current being increased it travels in a more contracted channel, and, by a more equable distribution of rain at the time of maximum sun-spot, when the velocity of the current being decreased, it is more liable to extend laterally. In the trade-wind regions similar evidence is furnished by the fact of a deficiency of rain and cyclones at the time of minimum sun-spot, with a corresponding excess of both at the time of maximum sun-spot. The augmented velocity of the wind currents at the former epoch, preventing the formation of local areas of condensation and precipitation, and therefore (according to Messrs. Blanford and Eliot's theory of cyclone generation) of cyclones and their accompanying downpours; while the diminished velocity at the latter epoch favours the same.

Finally, the anti-trade which in its seasonal shifts north and south traverses the entire temperate zone, in the winter bringing rain to North India, Palestine, Madeira, California, &c., and in the summer to Northern Europe and Siberia, should give signs of a secular change in intensity and humidity, corresponding according to the hypothesis inversely with the sun-spots. In the summer, when large continental areas like Europe are more immediately under the direct influence of solar heat, local convection currents being set up will tend to disturb and complicate the effect of any general change in the strength of the anti-trade. In the winter, on the other hand, the obliquity of the incidental solar rays leaves the anti-trade in undisputed possession of the field. At this season, therefore, there should be a marked variation in the rainfall of the temperate zone, more particularly in those regions between 25° and 40° N. and S. lat., where the rainfall of *this season* is the chief rainfall of the year, corresponding *inversely* with the sun-spots. Even in those regions where the rain falls at all seasons, if we pick out the winter from the total annual falls, as was done by Mr. Draper, for New York (NATURE, vol. xvii. p. 15) in accordance with Mr. Hill's admirable suggestion (vol. xvi. p. 505), the results favour the hypothesis. But they do this in a far more marked manner where the rain of the entire year falls during the winter months, as in the Mediterranean and at Jerusalem, which have consequently hitherto been considered by Dr. Jelinek and Mr. Meldrum to afford strong evidence against the theory of a direct connection between rainfall and sun-spots. The inverse variation of the winter rainfall of Northern India is only another example of the same law, and shows how extremely important it is to analyse the seasonal variations separately before deciding the question by a mere cursory glance at the *total annual* falls. The apparent anomalies which Dr. Hunter finds presented in the North American rainfalls are, I think, due to his having compared the total annual falls. If he, and other investigators will only take the hint dropped by Mr. Hill, and which I cordially endorse, of comparing the seasonal falls separately, they will find, I think, that while the summer rainfalls of the temperate zone show either a non-periodic variation, or symptoms of one coinciding directly with the sun-spots, the *winter* falls will in general show unmistakable signs of a variation coinciding *inversely* with that of sun-spot frequency and area.

E. D. ARCHIBALD

### Sun-spots and Rainfall

I HAVE read with much interest Dr. Meldrum's paper on Sun-spots and Rainfall in NATURE (vol. xvii. p. 448), particularly that part of it in which Dr. Hunter's method of discussing the rainfall of Madras is criticised, and a method of inquiry in sun-spot researches is proposed. This method is, so far as I am aware, a new one, and as such, is deserving of careful examina-