

there is nothing adventitious ; the pipe is a mechanism designed to a precise end which it fulfils ; it speaks but as it must ; there is no selective power, for the hand that fashions it, ordains.

HERMANN SMITH

Periodicity of Rainfall

In his second letter (NATURE, vol. x. p. 263) Governor Rawson makes the following remarks:—"Mr. Meldrum, in his letter (vol. viii. p. 547), writes, that I have 'taken 1846 and 1871 as middle maxima years [in my first paper I also took 1848], whereas 1849 and 1872 are probably more correct.' Mr. Meldrum is in error as to my having taken 1846 as a middle maximum, as a reference to my former letter will show. . . . I demur to the changes to 1849 and 1872 : to the first because, without any sufficient reason, a dry year (48.10 in.) is discarded, and a wet year (67.88 in.) is added ; and to the second, not because it affects my calculations, but because no reason is given."

In reply, I beg to observe that 1846 is either a misprint for 1848, or that in my manuscript 6 was inadvertently written for 8. This, I submit, is evident from the words immediately following the mistake, namely, "in my first letter, I also took 1848."

If Mr. Rawson supposes, or if his remarks imply, that I made 1849 a middle maximum, to avoid the small rainfall of Barbados in 1847 (48.10 in.) and at the same time to take advantage of the large fall in 1850 (67.88 in.), in order to make out a favourable case, I beg to say that he is entirely mistaken ; for long before I saw his rainfall returns, I had invariably taken 1849 as a middle maximum year. The only instance in which I took 1848 was, as I said, "in my first paper" read before the Meteorological Society of Mauritius on Oct. 10, 1872. In all subsequent papers on the subject, including one read before the Royal Society, 1849 was taken. Rightly or wrongly, therefore, the Barbados rainfall has been subjected to exactly the same treatment as that of the British Islands, the Continent of Europe, India, America, &c.

Assuming a causal connection between sun-spots and rainfall, it seemed to me that the effects, if any, would be most apparent about the times of the turning-points of the sun-spot curve, and that a comparison of the rainfall of each maximum period of three years with that of each minimum period of three years, for a considerable time and space, would be a preliminary test of the hypothesis. The difficulty was to know the exact epochs of maximum and minimum sun-spot frequency, and at the same time the rainfall for equal periods on either side of them. If we had the monthly rainfalls, and knew in what month the maximum and minimum of sun-spots occurred, it would be comparatively easy to compare the rainfalls for equal times with respect to the epochs. But there was another point to be considered, namely, that a cause requires time to produce its effect.

According to Prof. Wolf 1848.6 was a maximum epoch ; which, I presume, means that the turning-point occurred in August 1848 ; the figures, however, might mean six-tenths of a year after 1848, or August 1849.

Taking August 1848 for the maximum epoch, the strict course, in order to place the epoch at the middle of thirty-six months, would be to give the rainfall from the 6th of February 1847, to the 6th of February, 1850. But this could not be done. It was necessary to choose a whole year as the middle maximum year. And the reason why 1849 was chosen in preference to 1848 was, that the object being to find whether the periodic changes indicated by sun-spots had any effect upon rainfall, and time being required for a cause to produce its full effect, there was a presumption that the maximum rainfall would take place after the maximum of sun-spots, somewhat in the way in which the maximum diurnal temperature occurs, not at noon, but an hour or two after noon.

For a similar reason 1872 was taken as a middle maximum in preference to 1871.

This allowance of time for the supposed cause to produce its effect is, though apparently unintentionally, made by Mr. Rawson himself when he adopts 1844, 1856, 1860, and 1867 as middle years ; for, according to Wolf, the epochs were 1844.0, 1856.2, 1860.2, and 1867.1, that is, if I mistake not, early in each year ; so that nearly two of each of the three years taken come after the epoch, while only one of them precedes it. By taking 1849, therefore, as a middle maximum year, we come nearer to the conditions observed with respect to the other epochs than we should do by taking 1848.

Before proceeding to deduce a few results from Mr. Rawson's valuable "Report upon the Rainfall of Barbados," from 1843 to

1871, with a copy of which he has favoured me, I would remark that he has made apparently some oversights in his letter. For example, he says, with reference to a comparison of the rainfalls at Fairfield and Halton, "but the rainfall at Fairfield during the last three years . . . is 13.33 per cent. below that of Halton. Therefore 21.7 in. have to be added to the minimum average of 1843-45, which would increase the above excess of 10.6 in." But if the minimum average be increased by a percentage, would it not be well to increase also the maximum average of 1847-49 by the same percentage ? If this be done, the excess is not altered in the least.

The earliest rainfall observations at Barbados, given by Mr. Rawson, were those taken at Fairfield from 1843 to 1850, after which there is a long blank. Now, the rainfall there during that period gives the following results:—

Min. years.	Rain.	Max. years.	Rain.
1843-45.....	163.7	1848-50.....	179.7

showing an excess of 16 inches in the maximum period.

The next earliest and most complete observations are those taken at Husbands ; they commence with 1847, and have been continued without interruption. From them we get:—

Max. years.	Rain.	Min. years.	Rain.
1848-50.....	182.3	1855-57.....	188.1
1859-61.....	183.3	1866-68.....	162.8

365.6 | 350.9

which gives an excess of 14.7 inches on the maximum side.

The greatest number of inter-comparable observations for the longest period are those taken at the eight stations, Binfield, Henly, Husbands, Grand View, Oughtersons, Halton, Edgcombe, and St. Ann's, from 1855 to 1868 ; and I find that they give a mean excess of 56.9 inches on the side of the years of maximum sun-spot.

I do not think that these results are opposed to the hypothesis which Mr. Lockyer and myself have put forward. As a matter of fact, the rainfall of Barbados, as given by Mr. Rawson from 1843 to 1868, bears out the hypothesis if we take 1849 as a middle maximum in place of 1848 ; and it is for others to judge whether the reasons that have been assigned for the change from 1848 to 1849 (not for Barbados alone, but generally) are valid.

But it may be said that the rainfall of 1871-73 was opposed to the hypothesis. I have not the rainfall for those years before me. Granting, however, that they show a very considerable diminution, the question arises whether the favourable result of twenty-six years (1843-68) are to be upset by the unfavourable results of three years (1871-73) ? Have we not in meteorology many such exceptions to well-established laws ?

The rainfall at 250 stations in different parts of the world has now been examined, and the results are so decidedly favourable that it is practically of no consequence whether the experience of Barbados is for or against the theory. I think the more the subject is examined, the more clearly will the law come out ; but we must be guided by facts, and not hesitate to discard this or any other theory when unsupported by facts.

Mauritius, Oct. 15

C. MELDRUM

Ice-Caves

THE occurrence of snow and ice in an old mine during the month of June, mentioned by Mr. J. Clifton Ward in his interesting paper in NATURE, vol. xi. p. 309—to the accuracy of the greater part of which I can bear personal testimony—has a more exact parallel in the Alps than "a Swiss glacier," namely, a *glacière*. These remarkable caverns have been fully described by Mr. G. F. Browne in his able and pleasant work, "Ice-Caves of Switzerland and France ;" and briefly by myself in "The Alpine Regions." Since the publication of that book I have seen others ; and as one of these has never, I think, been described in any English work, I venture to take the opportunity of sending you a short account of it. It is in the Val d'Hérens, a short distance from Evolena, on the way to the Pic d'Arzinol, and is called the Pertuis Freiss. A slip or subsidence of part of a cliff appears to have cracked the rock and opened two joints, into one of which fissures one can descend. This is about four feet wide and generally some four yards high, the floor being a little below the level of the ground outside. The crevice comes to an end in about a dozen yards. Against the slightly sloping wall of rock rested some pendent sheets of ice, whose thickness rarely appeared to exceed three inches, and irregular patches of ice lay about the floor. The temperature of the air appeared to be a little above the freezing (unfortunately, I had