stronger. Thus, excluding insignificant decimals from the sunspot figures, and taking the mean of three and a half cycles for the Ceylon dates from 1854 to 1891, and from 1864 to 1885 for the sunspots in pairs of years from Wolf's tables (the only sunspot data I have available) we get the following comparison :—

		Ceylon[1] monsoon dates. Mean abnormals.	Sunspots. Mean abnormals.
1856	1867–'78	− 7·5 min.	− 38 min.
1857	,,	− 3·2 ,,	− 34 ,,
1858	,,	− 1·0 ,,	− 15 ,,
1859	,,	− 4·0 ,,	+ 27 ,,
1860	,,	+ 2·0 ,,	+ 44 max.
1861	,,	+ 10·0 max.	+ 37 ,,
1862	,,	+ 4·0 ,,	+ 26 ,,
1863	,,	+ 3·0 ,,	+ 9 ,,
1864	,,	+ 1·0 ,,	− 9 ,,
1865	,,	− 4·0 ,,	− 21 ,,
1866	,,	± 0·0 ,,	− 30 ,,

Better sunspot data would certainly not invalidate the connection. The lag behind the maximum sunspot data and the apparent tendency to precede the minimum has always been noticed in other phenomena. Moreover, from the analogy between the abnormals of the two elements compared both in quantity as well as sign the same remarks as to the reality of the cycle made by Mr. Blanford in his work (cited ante) p. 254 apply *pari passu* to that in the Ceylon dates.

A similar relation holds good for the little monsoon which may be put into words as early dates in years with increasing sunspot numbers and late dates in years with diminishing sunspot numbers, with a decided maximum of twelve days early in the year immediately succeeding that of maximum sunspots. Even the period between the two bursts shows symptoms of a similar relation to the sun's condition, the mean maximum interval, forty-three days, corresponding to the year of minimum sunspots, and the minimum twenty days occurring two years after that of maximum sunspots. The relation, however, is clearest in the figures for the burst of the big monsoon and seems to show that apart from all indirect influences such as accumulation of snows on the Himalayan outer ranges, and unusual winter rainfall on the plains or the reverse, there is a real fluctuation in the dates of the burst of the big monsoon or burra barsât connected with the sun's condition which appears to be more direct than that exhibited by the amount of rain which falls during its continuance and appears to indicate, as indeed is borne out by what we know from other sources, that in years of many spots the conditions which usher in the summer monsoon rains are earlier developed, and, as the amounts show, probably continue more regularly than in years of few spots.

Granting this as a working hypothesis two important results follow.

(1) The parallel march of the Ceylon dates and the rainfall of the Carnatic shows that the former could be employed to forecast the probable amount of monsoon rainfall about to be enjoyed in the latter district.

(2) That by using the mean abnormal of the year in its position in the sunspot cycle as the true mean instead of the mean of the whole period, the true abnormal for the year can be better estimated and the probable general character of the weather foretold.

As an example let us take the well-known diurnal variation of barometric pressure, whose amplitude in the tropics is so large that it bears a sensible ratio to the abnormal fluctuation produced by a passing disturbance.

In estimating the true abnormal at some particular hour of the day we must evidently compare the value with reference to the normal *at that hour*.

Similarly for the sunspot period in the case under consideration. If there is reason to believe that the period exists we ought to treat it as a reality, and in constructing graphic abnormals take the curve of the progressive cyclic normal as our abscissa axis instead of a straight line representing an endless repetition of the mean of the whole period. The principle is adopted as regards varying locality in drawing synoptic abnormal charts. It should be equally imperative in cases where the element of time is considered.

Thus in 1894, if the monsoon burst in Colombo twelve days before its time it would be abnormal to the extent of + 2. On the other hand, if it were twelve days late, it would be abnormal to the existing mean to the extent of − 22, and even to the new mean formed by incorporating this fresh value, to the extent of − 16, and we might in such a case infer that some unusual cause was in operation which would certainly bode ill for the Madras agriculturists.

I have put these facts and considerations forward simply as a preliminary inspection of two phenomena which not only occur in Ceylon, but are more or less common to the Indian peninsula, and to show how conditions, the relations between which can at present only be exhibited in an empirical form, may yet be employed as a means of forecasting the character of a season, and also ultimately by further investigation help to elucidate the whole machinery by which the grand weather changes are produced by terrestrial physical conditions in conjunction with alterations in the state of the sun's surface as well as its varying declination. A large field on either side of the equator, embracing one-fourth of the entire area of the world, exists, from which observations are very much wanted to complete our knowledge of the causes of phenomena which, while they are evidently closely related to action-centres (using Teisserenc de Bort's significant expression) at some distance from the equator, are yet, probably to some considerable extent, dependent upon conditions prevailing over the entire equatorial belt, which may, for all we know, fluctuate in stricter unison with solar changes than those which occur in higher latitudes. E. DOUGLAS ARCHIBALD.

[1] These figures are simple means *unsmoothed*.

Singular Swarms of Flies.

WITH the writer's permission I send you herewith a letter which I have received concerning the subject of my letter which appeared in your issue of June 1.

During the week following the date of my letter I repeatedly saw swarms of similar kind; but smaller and less marked, seldom visible much more than fifty yards away; always under similar atmospheric conditions, which were chronic during the period in question. The swarms always showed much the same slant from vertical (some 30° or so), the direction of the slope in plan being towards such slight draft of air as was perceptible. R. E. FROUDE.

Gosport, June 12.

I FIND in NATURE, June 1, an inquiry you make about flies forming clouds, resembling smoke.

They are usually produced by the gnats called scientifically *Chironomus*, and have been often mentioned in entomological literature.

I give below several references I can lay my hand on, but there are probably many more recent ones, which I have not noticed—

German, Magazin für Entomologie (in German), vol. i. p. 134–140, 1813.

Clapton, J. C. Dale, in Magaz. Nat. Hist., 1833, p. 544. (In Ireland and England.)

Patterson, Ann. and Mag. of Nat. Hist., vol. x. 1842, p. 6–9.

I have seen such clouds myself more than once. Cases have occurred when the smoke-like appearance has caused a fire alarm to be sounded. C. R. OSTEN SACKEN.

Heidelberg, Germany, June 4.

OFFICIAL CATALOGUE OF THE EXHIBITION OF THE GERMAN EMPIRE AT THE COLUMBIAN UNIVERSAL EXHIBITION IN CHICAGO.

GERMANY, not unmindful that America is her best customer, will be worthily represented at Chicago. An elaborate catalogue, in the German language, has already appeared, and an English translation will shortly be published. We have been favoured with an advance copy of the latter, which is by no means a mere enumeration of exhibits. It contains a general introduction, and a number of original articles by leading experts, "intended to supply for each department a concisely descriptive survey of its development and present condition." There is also, in German and English, a special Guide to the collective exhibition of the German chemical

industry, containing historical and statistical notices of every exhibiting firm. Generally the effort of the editor, and the commission which he represents, has been to convey to the American people and to the world a faithful picture of a state of development of the industrial arts in Germany, which may well inspire,in the English reader, impressions of a mixed order, pleasure in the contemplation of a great national growth, based upon a true conception of the right methods, and regret that in our own country a similiar consummation still appears a great way off. The selection, as editor of this publication, of the eminent chemist, Dr. Otto N. Witt, professor of technology at the great Berlin Polytechnicum, is in itself a forecast of its scope and purpose, and an evidence of the position which the man of pure science occupies in official Germany. To summarise in the briefest manner the work which he and his collaborators have given to the world would carry us far beyond the limits of this article. There are two points, however, of paramount interest, to which we desire to call attention, the one social-political, not to say socialistic, the other industrial—both of national importance.

Among the provisions made and establishments created by the newly-founded empire avowedly in the interest of national industry and commerce, such as the Imperial Post Office, the Imperial Bank, the Imperial Patent Office, none bear the stamp of originality in the same degree as the great system of compulsory insurance, "the object being to secure for that portion of the population which is dependent upon the work of its hands, and is rarely in a position to save money or properly to administer its savings, a provision for the days when through accident, sickness, or advancing age the worker is incapacitated from further earnings. Insurance is applicable in three different forms. In assurance against illness, introduced in 1883, the means are provided, two-thirds by the insured and one-third by their employers, in weekly contributions, to an amount not exceeeding 3 per cent. of the average wage. It entitles the insured to free medical treatment and a fixed allowance over a given period. It includes 7,000,000 persons in more than 20,000 clubs, and involves an annual expenditure of more than 100 million marks. The system of insurance against accident, which came into existence in 1884, is intended *to transform the personal liability of the employer, in case of accident during the execution of work into an economical charge upon the entire trade concerned*, to secure to the worker an indemnity *in all cases*, and to put an end to troublesome lawsuits between employer and employed. At the present time 15 millions of persons are insured, and 10 millions of marks have been paid in indemnities. The insurance against incapacity for work, and the old-age pension fund, inaugurated in 1891, complete this system of workers' insurances. It insures an income to those unable to earn a living, without reference to age, and an old-age pension to septuagenarians, without reference to any capacity for earning which they may still retain. The necessary means, in addition to a yearly Imperial contribution of 50 marks per income, are supplied in equal proportions by the insured and their employers. This form of insurance includes 12 millions of persons, and has, up to the present time, involved an outlay of 30 millions of marks. On the whole, there has been, in connection with the objects of the operatives' insurance, an expenditure of well-nigh half a milliard of marks, which has exclusively benefited the working-classes."

Thus, in the course of eight years, the German Government and people have given practical form to these grave social problems, which, in our own country, are still waiting for solution. Whether the German system is based on sound principles it is not for the present writer to decide. It is admitted that it imposes a heavy burden upon industry, and yet most of the exhibiting firms appear to bear it with equanimity. Nay, it is refreshing to note that the obligations imposed upon manufacturers by the Legislature have not in any way dried up the springs of voluntary charitable effort. Most of the large firms, in addition to the requirements of the law, make generous provision for their workpeople in the shape of baths, refreshment-rooms, dormitories, supplies of fuel at cost price, model cottages at low rent, allotments, and various funds in cases of sickness and death, funds for widows and orphans, &c., &c. It must be borne in mind, as a set-off to all this benevolence, that wages are low. The average remuneration in chemical factories, for example, is something less than £1 per week for a ten hours day.

The other point suggested by a perusal of the catalogue is the rapid and, in some cases, triumphant progress of German industry. For our present purpose it will be sufficient to consider two departments of chemical manufacture—namely, the industry of general and fine chemicals and that of artificial colouring matters. They are typical of the spirit which pervades every branch of technical activity in Germany. The former, we are told, has developed to an extent unknown in any other country in the world. Imperial statistics show that in 1891 there were in Germany 521 factories engaged in the manufacture of chemico-pharmaceutical preparations, their 14,842 workpeople drawing 12,615,700 marks in wages. The exports in 1890 of chemical preparations, not specially named, exceeded the imports by 5000 tons, valued at more than 15,000,000 marks. If to these are added the chemicals quoted by name in the official list, we obtain a total excess of exports over imports amounting to 25,690,000 marks; and as the home consumption must at least be equal, we arrive at a grand total of 52,000,000 marks annually.

More remarkable still is the history of the great dye industry, which, as is well known, originated in England with the labours of Hofmann, Mansfield, and Perkin, closely followed in France by those of Verguin and Girard and de Laire. What has become of it? The chemical catalogue tells us that nine-tenths of the production of artificial dye-stuffs in the world must be credited to Germany.

There are altogether some 20 factories belonging to this industry in Germany, nearly all of which can claim to be important. Three of the largest are represented at Chicago. One of them, with a capital of 6,000,000 marks, employs 600 men and 90 women; another, with a capital of 12,000,000 marks, occupies 1600 men with a technical staff of 300, and produces nearly every known dye stuff, the alizarine dyes included. A third, with a capital of 16½ million marks, is said to be the largest chemical factory in the world. It began twenty-eight years ago with a staff of 30 men, and now employs 4000. These three factories have played a conspicuous part in the building up of the industry of artificial colouring matters.

To what causes must these great results be traced? Many minor causes are mentioned in the catalogue. Let us, however, go at once to the root of the matter. The two main factors are organisation and the consequent intimate connection between pure science and manufacture. When, at the beginning of the century, Germany lay crushed at the feet of Napoleon, it was felt by German patriots that nothing but the complete reorganisation of the country could lead to its emancipation. Since those days, side by side with the military forces, the scientific forces of the country have been carefully and patiently organised. At the instigation of Liebig, great State laboratories for pure scientific research were erected all over the country, and from these have issued an army of highly-trained workers, whose services manufacturers have vied with each other in securing. Nothing is more striking, in the special notices of the exhibiting firms, than the large number of competent and

often distinguished chemists employed in all the factories at all connected with the chemical trade.

Firms with 40 workmen sometimes employ as many as 5 or 6 chemists, and the three great colour firms referred to above employ together 178. In the words of Dr. Witt: "In chemical research the chemical industry of Germany possesses a never-failing helpmeet, and such is the intimacy between chemical research and chemical manufacture, that the periods of most rapid development of the one have always been epochs of prosperity with the other." And again: "It may be asserted that not only is the strength and productive power of German chemical industry based upon the intimate connection between science and practice above described, but that in that intimacy lies the surest safeguard that German industry will long continue to hold the prominent position which, with such strenuous exertion, it has ultimately achieved. When the question is asked why the chemical industry of other lands, still more favoured perhaps by nature, has in the end been surpassed by the German, the answer is that Germany has had the good fortune to call her own a number of the greatest intellects in the domain of pure scientific research, who have quickened the pace of theoretical chemistry. But, as before stated, it is the latter which constitutes the vital element of chemical manufacture. Only the country which, at any period, shall assume the leadership in pure scientific chemical investigation, will also be in a position to wrest from German chemical industry the palm to which it is at present entitled."

We do not shut our eyes to the fact that nations, like individuals, must work out their own character and destiny, nor do we for a moment inculcate a slavish copying of the German model. We have in this country a great deal of science and a great deal of industry, and many attempts have been made to bring about an effective cooperation of these two cardinal elements of productive energy. We cordially recognise that particular industries and individual firms have, by private enterprise, developed themselves upon a thoroughly scientific basis, and we also welcome the fact that substantial additions have been made in recent years to the laboratories and institutions where a scientific training can be obtained. At the same time we cannot escape from the admission that, in the friendly struggle for industrial supremacy, Germany has not only made astonishing progress both in the development of industries of long standing, and in the inception of new ones of enormous fruitfulness, but that she has been the first as a nation to solve the great problem of the cooperation of science and manufacture. We leave it to more competent hands to point out the course which now lies before us. In our own humble opinion the days of *laisser faire* have gone never to return, and the time has come when the Government of the country, backed by the country, must take—as is the case in Germany—a larger share than it has done hitherto in the systematic organisation of our scientific and industrial forces. A nobler and a more patriotic task could hardly be attempted.

THE REDE LECTURE.

AT Cambridge, on June 14, the Rede lecture was delivered by Prof. Michael Foster, Sec. R.S., his subject being "Weariness." The lecture was illustrated by experiments, conducted by Dr. Shore, with the assistance of Mr. Hardy. The following report of the lecture is from the *Times*:—

Prof. Foster said that among the many shortcomings which limited the power, and so the usefulness, of the machine which we call the human body, two stood out prominent among the rest: these were, on the one hand, inertia or laziness, the unwillingness to stir, and, on the other hand, weariness, the getting tired. He proposed to lay before his audience some account of such knowledge as the physiologists of to-day possessed, and it was but little, concerning the physical basis of this weariness, which so greatly shortened the power of man. He began with a simple yet illustrative case—the weariness which comes from the much repetition of a simple movement, a simple muscular act, as when a man lifts a weight with his hand. Analysing the act physiologically, he showed the changes which took place in the brain, the nerve, and the muscle. Taking the muscle first, he showed that weariness of muscle comes, in the first place, from too rapid expenditure of capital; secondly, from the accumulation in the muscle of the products of the muscle's own activity. There were many reasons for thinking that this latter cause of weariness was at least as potent as the former. The brute force of our food was the measure of our muscular strength, but the one could become the other only through the aid of many other things which might be wholly empty of energy, and the failure of these, no less than the absence of the former, entailed at first premature weariness, afterwards failure and death. The nerves and the brain shared in even the simplest and rudest muscular work. The nerves themselves, the mere bundles of fibres which carried the nervous impulses from the brain to the muscles, were never tired. Coming to the brain, the lecturer showed by a simple experiment a case of fatigue, demonstrating that the fatigue was in the brain and not in the muscle; a weariness of the particular part of the nervous system which was called into play.

By an illustration in colours he showed also how weariness not only lessened work but bred error. The study of the central nervous system had led, and was leading, physiologists to the conclusion that the material changes on which its activity depended were very analogous to those taking place in a muscle, only, of course, from a chemical point of view, not so massive. And all they knew went to show that in the brain, as in muscle, weariness was the result on the one hand of an expenditure of capital disproportionate to the accumulation, and on the other hand to a clogging of the machinery with the products of activity. The simple apparatus he had used might be successfully employed to illustrate general conditions as affecting weariness. If, taking always the same weight, they counted the number of times the weight was lifted and measured the height to which it was raised each time in succession before the movement was stopped by weariness, they could ascertain how much work had been done before the machine was so stopped. Proceeding in this way some interesting results as to what hastened or retarded fatigue had been obtained. Practice and habit, it was needless to say, were of prime influence. The depressing effects of a damp, muggy day, or the exhilarating effects of a bright, clear day, might in this way be measured in foot-pounds of power lost or gained, as might also the lowering influence of a cigar and the heightening effect of a glass of beer. One point perhaps he might dwell upon, and that was the influence of that part of the brain which was more immediately concerned with what was spoken of as mental work. An Italian professor determined, by means of the apparatus of which they were speaking, the amount of work which he could on a certain morning do before he was stopped by weariness. He then set himself to two hours' hard mental work, and the form of work he chose was that of examining candidates for their degree. The professor, as soon as the two hours' examination was over, went back to his apparatus and found that his power of bending his finger was enormously cut down. The nervous system was a candle which could not profitably be burnt at two ends at once. When the work done involved the activity, simultaneous or successive, of many muscles of many parts of the nervous system, the several