correspond with a more advanced stage of the spot-cycle than was indicated by numerical data alone.

Signor Tacchini concludes his memoir with a survey of the vicissitudes of spot-formation during eight years—from January 1, 1877, to December 31, 1884. The results are graphically exhibited in a set of curves variously derived. No. 1 is constructed from the daily numbers of spots with their accompanying pores; No. 2 from the record of spots alone; No. 3 shows the frequency of groups; No. 4 follows the fluctuations of spotted area; No. 5 those of facular extension. All the first four methods agree in fixing the absolute minimum in March 1879; Nos 1, 2, and 3 display secondary maxima in September 1880, March and July 1881, and March 1882: the absolute maximum was reached, judging by the statistics of spots and groups (curves 2 and 3) in February 1884; but in November 1883, according to those of spots with pores, and spotted area (curves 1 and 4). It is noticeable that the preliminary maxima are largely exaggerated in proportion to the true maximum, when pores are admitted into the account with spots; while the curve resulting from the simple enumeration of groups is very slightly indented. This last method is regarded by our author as that which should invariably be followed when recent have to be compared with ancient records of sunspots; but no system of observation with the eye can any longer compete with the simpler and surer one of photographic registration.

The curve of facular extension for 1877-84 is somewhat anomalous. It touched its lowest point in November 1878, five months previous to the spot-minimum, then sprang up to an absolute maximum in October 1880. This was followed by a secondary but very considerable rise in September 1881, after which, during two years, a tolerably high average level was maintained. The definitive decline which set in in September 1883 was only partially arrested in May 1884. The coincidence between the maximum of faculæ in September 1880, and a large and abrupt increase in the formation of pores, just a month earlier, should not be overlooked. It is also remarkable that a maximum of prominences, but slightly inferior to that of 1884, occurred in 1881.

The condition of the sun in 1885 is epitomised in the note by Signor Tacchini already referred to. That year was, in his opinion, distinguished as one of continued agitation by the persistent abundance of its various symptoms in the neighbourhood of the equator. A zone of 40° north and south covered all the spots, and (save one example of each kind) all the faculæ and metallic eruptions observed. The tranquil or "hydrogenic" description of prominences, on the other hand, figured indifferently in all latitudes. Their general equality of diffusion was but slightly infringed by a southern preponderance; while the frequency in the same hemisphere of spots, faculæ, and eruptions was, in each class, almost double that of its northern occurrence. The alternating activity of the solar hemispheres, thus exemplified in one of its most conspicuous phases, is one of the many enigmatical features of solar disturbance.

SEISMOLOGY IN JAPAN[1]

FOUNDED only in 1879, the Seismological Society of Japan is already able to point to a good record of accomplished work. The Society was happy in the time and the place of its birth. No home could be more fitted to nurse the enthusiasm of the seismologist than one whose foundations are shaken, on the average, a little oftener than once a week. One may take a rather half-hearted interest in other natural phenomena, but, while it lasts, an earthquake certainly commands undivided attention. And the Society came into being just when a few zealous investigators were striving who should be first to solve the problem of obtaining an accurate record of how the ground moves in an earthquake. Lord Byron has described a thunderstorm in the Alps as the joy of the hills "o'er a young earthquake's birth;" but the joy of the hills, if more loudly expressed, was nothing like so deep as the joy with which the inventor of a new "earthquake machine" felt the first convulsion that came to test its powers. In these congenial conditions it is not surprising that the Society's early volumes record the history of what is nothing less than a new departure in observational seismology. Of late the Society has suffered by the removal from Japan of some of its more active members; but this latest volume of its *Transactions* gives satisfactory evidence that, while it has not yet lost all its foreign supporters, some of the Japanese themselves are ready to step forward and continue the work. So long as Prof. Milne remains, the Society will not lack material for publication; the present volume, like many of its predecessors, is largely the work of his pen.

The first paper, on "Seismic Experiments," is by Mr. Milne, and contains an account of eight series of experiments on artificial earthquakes, as well as some laboratory work. Part of this work was done in conjunction with Mr. T. Gray, and much of it has already been described in other papers. The vibrations of the ground were produced in some instances by letting fall heavy weights, in others by the use of dynamite. Several observing-stations were selected, at various distances from the source of disturbance, and generally in one straight line with it. At these stations seismographs of various kinds were placed, and Prof. Milne seems to have preferred the horizontal pendulum seismograph of the present writer as an instrument for recording separately two rectangular components of the horizontal motion of the ground. By placing the pair of pendulums so that one recorded vibrations in the direction of the line joining the station with the source, while the other recorded vibrations at right angles to this, Prof. Milne was able to separate without difficulty the normal from the transverse constituents of the disturbance, and to see the normal vibrations arrive sooner than the transverse vibrations at each station, as the theory of waves in elastic solids requires. In this instrument the two components of horizontal motion are separately recorded on a moving plate of smoked glass. Another instrument was used to record the whole horizontal movement on a fixed plate, and, as might be expected, the diagrams it gave showed first a movement in the line of the source, quickly followed by a confused wriggle of vibrations in all azimuths. By telegraphically connecting the moving plates of the horizontal pendulum seismographs, Prof. Milne endeavoured to determine the interval of time between the arrival of the disturbance at successive stations, and so to infer the velocity of transit. From the results he has concluded that the velocity decreases as the disturbance travels away from the origin, but the figures on which this conclusion is based seem to the present writer to furnish very insufficient evidence. In one series of experiments there is, in the average of three pairs of observations, a loss of about 6 per cent. in the velocity between the second and third stations as compared with the velocity between the first and second stations; but, when we examine the individual observations, we find in one case a gain of velocity amounting to 14 per cent. And, on turning to what is apparently the most complete series of automatically-recorded diagrams (which are reproduced in lithographed plates), it is clear that the time-intervals cannot have been measured with the precision necessary to establish this result, still less to justify the further conclusion that the velocities of normal and transverse waves become more nearly equal as the disturbance spreads. The velocity of transit is, in fact, a term of very vague meaning, unless we can follow an individual wave along its course. As Mr. Milne's

[1] *Transactions* of the Seismological Society of Japan, vol. viii. (Tokio: Published by the Society, 1885.)

own observations show, the shock loses much of its individuality as it travels further from the source. It becomes more and more preceded by a vanguard of small waves, and, for this reason, seismoscopes of different degrees of sensibility will differ in the time at which they chronicle the arrival of the group. Mr. Milne's results, as summarised by him at the end of the paper, are too numerous to be taken up in detail. The assiduity with which he has pursued these experiments deserves the greatest praise, especially as the experiments themselves are of a very high order of difficulty. It is perhaps to be regretted that Mr. Milne has not given his attention more to perfecting a single series than to multiplying results which, as he himself remarks, are often "most discordant." Seismographs will not tell the truth unless they are very well made and very carefully tended. Some of the jagged outlines of the curves are much more likely to be due to friction and shakiness and want of rigidity in the instruments than to any characteristic in the motion of the ground; and unless the lithographer has done Mr. Milne a serious injustice, there are cases where the ground suffers a considerable displacement in a good deal less than no time. He has himself observed this in one instance, and ascribes it to what must (if his explanation be correct) be called a faulty mode of setting the seismographs. It is not impossible to get results free from these defects; and a single really good set of diagrams would do much to remove the uncertainty which now attaches to many of Mr. Milne's results.

Besides the experiments with artificial earthquakes, the paper describes a laboratory investigation of the stability of cylindrical columns standing on a platform which vibrates horizontally, and of the velocity of projection of detached bodies. The projected bodies were balls, held in L-shaped notches at the top of a vertical wooden post; the post, bent slightly to begin with, was allowed to spring; the velocity of projection of the ball was determined from its trajectory, while the greatest velocity of the post-head was measured by means of a revolving plate of smoked glass. The two agreed fairly well, and with a nearly frictionless ball supported in this manner no other result was to be expected. The late Mr. Mallet used to calculate the velocity of the ground's motion from observation of the horizontal distance traversed by projected bodies, but the velocity with which a body is projected depends too largely on the mode of support, and on the amount of adhesion between the body and the support, to allow the result to be, in general, of the slightest value. With regard to the overthrow of columns, it would seem that the author falls into the error of supposing that when the resultant force got by compounding the weight of the column with its resistance to acceleration passes outside the base, the column will fall. But since the disturbing force is of short duration, all that necessarily happens in such a case is that the column will rock; whether it will fall or not is a question of much greater difficulty.

The second paper is a note by Mr. S. Sekiya, "On Prof. Ewing's Duplex Pendulum Seismometer, with Earthquake Records obtained by it." The paper is a brief but very clearly written account of a form of the duplex pendulum seismograph designed by the present writer in 1883, and now in constant use under Mr. Sekiya's care. An earlier form of the instrument has already been described in NATURE (vol. xxx. p. 152): the latest modification of it was exhibited to the British Association at Aberdeen, and will shortly be illustrated in this journal. Its function is to draw on a fixed plate a magnified diagram of the ground's horizontal motion; the figures, which are generally of great complexity, are given by Mr. Sekiya for a number of recent Japanese earthquakes.

A short paper follows by Mr. E. Knipping, "On the Meteorology of Japan," gathered from observations made at twenty-three stations during the year 1883. It mentions that the annual variation of temperature for that year in Japan was more than double that of Britain, and that changes of 14° C. or 15° C. at one station in twenty-four hours are not unfrequent in the spring and autumn.

A paper by Father Faura, S.J., of Manila, describes the Cecchi seismograph—an instrument belonging so decidedly to the old school of seismology that, by allowing its description to appear without criticism, the Society at least shows its catholicity of spirit.

Dr. Dubois contributes some notes on the earthquakes of Ischia, and refers to the effects—or rather absence of effects—of the earthquakes in excavations there, in support of the fact that seismic shocks which do much damage on the surface may pass unperceived at a certain distance beneath.

The volume concludes with a catalogue of earthquakes registered in the meteorological observatory of Tokio by Palmieri's recording seismoscopes. The list for 1884 shows the respectable total of seventy distinct disturbances, and twenty-eight were registered in the first four months of 1885. J. A. EWING

RECENT ADVANCES IN SANITARY SCIENCE

"HYGIENE," in the words of the late Professor Parkes, "is the art of preserving health; that is, of obtaining the most perfect action of body and mind during as long a period as is consistent with the laws of life. In other words, it aims at rendering growth more perfect, decay less rapid, life more vigorous, death more remote." The art of preserving health is correlative with the science of prevention of disease, since perfect health means the absence of disease and of tendencies to disease. Hygiene is thus the art of preserving health and the science of preventing disease; and in taking into account recent advances in sanitary science we must consider recent acquisitions in our knowledge of the origin, causes, and spread of disease, more especially of those diseases known as "preventable," as well as the methods of improving the natural conditions or social relations surrounding us, which are instrumental in preserving health and counteracting disease.

The etiological relations of all diseases are a subject of interest to the sanitarian, but those which have received the most attention of recent years, and in which the most striking advances of knowledge have either already been made, or are imminent in the near future, are perhaps Asiatic cholera, typhoid or enteric fever, diphtheria, and phthisis or tubercular disease of the lungs. The mode of origin and spread of Asiatic cholera has attracted great popular attention, both on account of its possible introduction into this country from infected districts of the Continent, and from the alleged discovery by Koch of a *Spirillum* or *comma-Bacillus* asserted to be the specific cause of this terrible disease. The Report of the Government Commission consisting of Drs. Klein and Heneage Gibbes, who visited India in 1884 with the object of undertaking researches into the etiology of Asiatic cholera, has lately appeared, and in this Report the conclusions arrived at by Koch from his own researches are very directly traversed. This Report, too, has received a very cordial support from a Committee consisting of many eminent physicians and physiologists, which was convened by the Secretary of State for India for the purpose of taking it into consideration. It must be apparent, however, to any one who makes an impartial study of the literature of the subject, that, if Koch's organism has not yet been proved to be the actual cause of the disease, it has been proved to differ from all other organisms asserted to be identical with it, from the fact that its growth in various nutrient media is characteristic, and serves to distinguish it from all other organisms. As far as our knowledge at present extends, difference in manner of