exact moment for reading off being indicated by a chronograph. The relative intensities transmitted by radiation from the centre and from the border of the solar disc, first claim our attention. Fig. 6 represents the solar disc covered by a circular screen 145·25 millimetres in diameter, excluding the rays excepting from a narrow zone, the mean width of which is situated 49″ from the border of the photosphere. Fig. 7 shows a screen excluding the solar rays excepting from the central portion, *the area of which is precisely equal to the area of the narrow zone in* Fig. 6. The following table shows the intensities transmitted to the actinometers during an observation, August 25, 1875, the radiation from the solar disc being then excluded in the manner shown in Figs. 6 and 7:—

Time.	Central portion. Cent.	Border. Cent.	Rate of difference.
4′	3°·28	2°·19	$\frac{2·19}{3·28} = 0·667$
5′	3°·56	2°·37	$\frac{2·37}{3·56} = 0·665$
6′	3°·73	2°·49	$\frac{2·49}{3·73} = 0·667$
7′	3°·88	2°·60	$\frac{2·60}{3·88} = 0·669$
			Mean = 0·667

It should be particularly observed that this table records the result of four distinct observations; nor should it be overlooked that although the intensities vary greatly for each observation in consequence of the continued exposure to the sun, yet the rates showing the difference of the intensity of the rays transmitted from the border, inserted in the last column, is practically the same for each observation, the discrepancy between the highest and the lowest rate being only 0·004.* Persons practically acquainted with the difficulty of ascertaining the intensity of solar radiation will be surprised at the exactness and consistency of the indications of our actinometers. This desirable exactness has been attained by surrounding the actinometers with water-jackets, which communicate with each other by connecting pipes, through which a steady stream of water is circulated. By this expedient the chambers containing the bulbs of the several thermometers are maintained with critical nicety at equal temperature, an inexorable condition when the object is to determine differential temperature with great exactness. Apart from this, the chambers which contain the bulbs of the thermometers are air-tight, the radiant heat being admitted through a small aperture at the top of the chamber, covered by a thin crystal.

Referring to the preceding table, it will be seen that the intensity transmitted by radiation from the sun's border, represented in Fig. 6, is 0·667 of the intensity transmitted from the central region represented in Fig. 7, the area of each being precisely alike. From the stated intensity must be deducted the heat imparted to the actinometer by the inflection of the calorific rays. The circumference of the perforation of the screen shown in Fig. 7 being exactly one-half of the circumference of the screen in Fig. 6, while the central region radiates more powerfully than the border, fully one-half of the inflected radiation from the border will be balanced by the inflected radiation emanating from the central region. Agreeable to the previous demonstration relating to Figs. 2 and 3, it will be seen that the unbalanced inflection amounts to 0·029; hence the radiation transmitted from the border zone will be 0·667 − 0·029 = 0·638 of the intensity of radiation transmitted from the central region. We have thus shown by a reliable method that the intensity of the rays directed towards the earth from the border zone suffers a diminution of 1·000 − 0·638 = 0·362 of the intensity of the radiation emanating from the central region. But the mean depth of the solar atmosphere of the border zone, in the direction of the earth, is 2·551 greater than the vertical depth, while the mean depth over the central region referred to is only 0·036 greater than the vertical depth of the solar atmosphere. Consequently, if we accept the assumption that the retardation is as the depth, the absorption by the solar atmosphere cannot exceed $\frac{0·362}{2·551 - 0·036} = 0·144$ of the radiant heat emanating from the photosphere.* It will be found, on referring to the revised edition of "Le Soleil," vol. i. p. 212, that Père Secchi makes the following statements regarding the absorptive power of the solar atmosphere. (1) "At the centre of the disc, that is to say perpendicularly to the surface of the photosphere, the absorption arrests about $\frac{2}{3}$ or more exactly $\frac{62}{100}$ of the total force." (2) "The total action of the absorbing envelope on the hemisphere visible from the sun is so great that it allows only $\frac{12}{100}$ of the total radiation to pass, the remainder, namely, $\frac{88}{100}$, being absorbed." It is unnecessary to criticise these figures presented by the Roman astronomer, as a cursory inspection of our table and diagrams is sufficient to show the fallacy of his computations. Apart from determining the absorptive power of the solar atmosphere, the most important problem which may be solved by accurately measuring the intensity of the radiation emanating from various parts of the disc, is that relating to the sun's emissive power in different directions. In order to decide this question, I have adopted the plan of measuring the energy of the radiant heat transmitted from zones crossing the solar disc at right angles, as shown in Figs. 10 and 11. Should it be found that our actinometers are equally affected by the radiation from these zones, each of which occupies an arc of 30 deg. containing one-third of the area of the disc, the inference will be irresistible that the sun emits heat of equal intensity in all directions. It should be borne in mind that, agreeable to our method, the radiations from these zones are observed simultaneously. The arrangement exhibited in Figs. 10 and 11 hardly needs explanation. Referring to Fig. 10, it will be seen that two segmental screens are employed excluding the radiant heat, excepting from the zone, which is parallel with the sun's equator. Similar screens are employed (see Fig. 11) for excluding the rays excepting from the zone parallel with the sun's polar axis. The curvatures of the segmental screens, it should be observed, have been struck to a radius of ninety millimetres, in order to cut off effectually the inflected radiation from the sun's border. Obviously diffraction has not called for any correction of our observations relating to this part of the investigation, since the inflected radiation from the equatorial zone exactly balances the inflected radiation from the polar zone. It only remains to be stated that repeated observations show that the radiant energies transmitted to the actinometers from the two zones are identical. The result of observations relating to the radiation emanating from the polar regions, represented in Figs. 8 and 9, together with other observations, will be discussed in future communications.

J. ERICSSON

* All my instruments for measuring radiant heat have been graduated to the Fahrenheit scale, which practically is more exact than the Centigrade, owing to its finer divisions. For the benefit of the Continental readers of NATURE, and in order to satisfy English and American advocates of the course Centigrade, the observed temperatures have been reduced to that cale before being entered in our tables.

* In the first edition of "Le Soleil," p. 264, the author assumes that the absorption of the calorific rays by the atmosphere "augments in proportion to the secant of the zenith distance;" in other words, as the depth of the atmosphere penetrated by the rays.

SOME LECTURE NOTES ON METEORITES †

III.

AMONG the mineral constituents of meteorites the unstable sulphides, it is hardly necessary to observe, could with difficulty be conceived as continuing permanently undecomposed, or as being even formed under the ordinary conditions of rock formation on our globe; and the same remark may be extended, though with some limitation, to the metallic iron that is so characteristic and ubiquitous a constituent of almost every, if, indeed, not (as maintained by Dr. Lawrence Smith) of every meteorite. On the other hand, it is to be remembered that the rocks that we are acquainted with on our globe are only those composing its outer crust; rocks which represent the results of the corrosive action of the atmospheric agencies, oxygen, carbonic acid, and water, and their counterpart the ocean, on whatever material the consolidated surface of our planet offered for their action. The endless cycle of mechanical and chemical disintegration, decomposition, and reconstruction would be limited to a shallow shell, and even the fresh matter forced out to the surface in volcanoes, through the contraction of the cooling globe, would consist in all likelihood only of the lower-lying layers of an already to a certain degree metamorphosed material. Whether the inner core of this planet is still in the meteoric condition—that is to say, still may contain such minerals as native iron, associated with nickel, not to say magnesium or calcium sulphides, is a question not to be lost sight of in explaining the high specific gravity of our globe as compared with that of the rocks that form its crust.

† Concluded from p. 507.

That the silicates contained in meteorites should be identical, or nearly so, with corresponding minerals in our globe seems only the natural consequence of the identity in the elements that constitute both. They are essentially magnesium silicates—namely, olivine the basic, and enstatite (or bronzite) the neutral silicate, the latter taking the form of augite to an amount corresponding to the calcium present, where this latter element is a constituent of the meteorite. Where, at the first production of the meteoric minerals by the union of their elements, the oxygen was in sufficient amount to allow of a portion of the iron present being in the state of an oxide, ferrous oxide is combined in the silicate, and the meteoric olivines are from this cause generally ferriferous, and the enstatite also assumes one of the varieties of that mineral which the mineralogist has termed bronzite. The silicic acid is rarely in excess of the amount requisite to form an enstatite or augite; usually the contrary condition is evidenced by the presence of some olivine. The case of the occurrence of free silica in the Breitenbach meteorite, at present exceptional, may, however, hereafter prove to be characteristic of a type, and its occurrence, not as quartz, nor even as tridymite (the crystallised silica discovered by von Rath), but in the form to which I gave the name asmanite, in crystals belonging to the orthorhombic system with the specific gravity of fused quartz, seems to point to conditions, probably involving an enormous temperature, as those under which such meteorites have been formed, and such as have not been realised in the production of any of the acid or super-siliceous silicates of our globe. The felspathic ingredients of meteorites are for the most part basic, chiefly consisting of anorthite, the most basic of terrestrial felspars, known as a crystallised mineral in volcanic rocks. Crystals of meteoric anorthite were measured by Viktor von Lang at the British Museum, with results quite concordant with those yielded by the crystals from the volcanoes of our planet. A felspar with a composition corresponding to that of labradorite, on the other hand, in the only meteorite in which its presence has been established beyond doubt, is proved by Tschermak to crystallise in the cubic system, instead of the anorthic system to which terrestrial labradorite belongs.

Attempts have been made to classify meteorites according to their mineralogical constitution. As a provisional method, such a classification has its uses; but while we find that the same meteorite may contain distinct portions which severally would authorise its being placed in different classes, such a classification must necessarily be very imperfect.

The best general divisions are those of Gustav Rose; and in the following table are classed the various groups of Aërolites, with a statement of the minerals that are met with in them:—

Aërolites.

CHONDRITIC	Olivine. Bronzite. Augite. Nickel-Iron. Troilite.
EUKRITIC...	Augite. Anorthite. Nickel-Iron.
CHLADNITIC	Bronzite or Enstatite. Augite (occasional). Nickel-Iron. Troilite Oldhamite (occasional). Osbornite. Chromite.
CHASSIGNITIC... ...	Olivine. Chromite.
CARBONACEOUS ...	Olivine. Enstatite. Nickel-Iron. Sulphur. Carbon. Troilite. Chromite. Hydrocarbons.

The great division of meteorites into iron masses or siderites, mixed masses or siderolites (the pallasites and mesosiderites of Rose), and aërolites or stony meteorites; and the sub-division of the latter into chondritic and non-chondritic varieties, seems to be a sufficiently logical division. And among the non-chondritic aërolites, those designated in Gustav Rose's classification as Eukrites form one well-marked group. They consist of anorthite mingled sometimes with augite in a crystallogranular admixture, with nickel-iron, troilite, magnetic pyrites, a little olivine, and small amounts of other minerals. The crystals of anorthite and the augite in the eukritic meteorite of Juvinas have afforded satisfactory goniometrical measurements, and been identified as regards their crystalline forms—the former, as before mentioned by V. von Lang, and the augite by Gustav Rose—with the corresponding terrestrial minerals; and it is the eukritic aërolites which most closely resemble some of our volcanic rocks.

The carbonaceous meteorites form another remarkable though not a distinct group. In these we meet with minerals which, if occurring in a terrestrial rock, would lead us to ascribe to that rock an igneous origin; they are the same minerals that occur in other meteorites (olivine, enstatite, &c.), but are associated with carbon and with a minute amount of a white or a yellowish crystallisable matter, soluble in ether and partly so in alcohol, and exhibiting the characters and the composition of one or more hydrocarbonous bodies with high melting points. Such an ingredient permeating a rock on our globe would assuredly be accepted as a product resulting indirectly from animal or vegetable existence. We must be cautious, however, in the extending of this generalisation to celestial hydrocarbons. It seems not at all improbable that this singular ingredient of these otherwise stony and fire-formed meteoric rocks may have been taken up by the mass subsequently to its formation; perhaps while passing through an atmosphere of these hydrocarbonous substances in the form of a vapour. The probability of this is enhanced by the smallness in the amount (about 0·25 per cent. only) of the white soluble bodies contained in the aërolite, and by the fact that the whole of it may be dissolved out from a mass of considerable size by the direct treatment of the solid aërolite by the boiling solvent, even without previous pulverisation; the substance, in short, mechanically fills the pores of the aërolite, but does not appear to be otherwise contained or entangled in the interior of the silicates or of the compacter aggregations of these within the meteorite.

The remaining divisions into which aërolites have been grouped are less distinctly marked, and their boundaries less fixed than those we have considered. In fact, a more comprehensive knowledge of all the varieties of meteorites and the modes in which their constituent minerals may be associated is needed for our forming a complete classification of them, and it is only necessary to make one observation in order to indicate the importance of our being able thus to arrange together these meteorites which are strictly comparable, and may be supposed to have had a common or at least a similar origin and history.

Such a classification is in fact a necessary preliminary to our ever successfully dealing with the problem of the periodically recurrent visitation to our earth of any particular class or group of meteorites. And it is here that the great collections of meteorites brought together in the National European Museums already are, and promise in a far higher degree in the future to be, so valuable. They offer the opportunities for the most complete comparison and the widest induction that our limited material admits of.

It may thus be possible hereafter by their aid to trace such a periodicity in the falls of meteorites of particular kinds as has been established in the cases of several meteor showers; or again the accumulation of observations recording the directions from which these bodies fall to the earth may enable us to connect those of a particular class with some definite direction that may indicate for these a common source in space. It may be feared, however, that owing to the species of refraction which their paths must undergo on entering the atmosphere, and the great difficulty, if not impossibility, of obtaining very accurate comparable parallactic observations of their paths, it will be impossible to rely on any calculated elements of their orbits before approaching our planet.

One of the difficulties confronting us in any endeavour to trace them to their sources, lies in the near similarity of composition of very large groups of them, such for instance as the entire group of the chondritic aërolites, or again that of the siderites, a similarity so close in each case as to render it difficult at first to suppose that the masses belonging to either of these groups originated under dissimilar conditions, or in widely sundered regions of space.

A difficulty of a similar kind further presents itself in the relative importance of nickel as an ingredient in the iron element of meteorites. One cannot indeed institute a comparison in this respect with the iron of our globe, which cannot be said to exist within the scope of our knowledge in the native state, while on the other hand the silicates composing meteorites, and those constituting the mass of our terrestrial rocks, are alike almost devoid of nickel; and a process that would reduce the iron in such rocks (*e.g.* serpentine or lherzolite) as contain traces of this element would simultaneously reduce the nickel also to the metallic condition, as has been shown by Daubrée.

Among those who have sought to throw light on the part of our problem which deals with the chemical history of meteorites, M. Daubrée, the distinguished Director of the Ecole des Mines, stands forward. He has subjected both meteorites and certain terrestrial rocks in some respects mineralogically allied to them to fusion under special conditions. He has, further, reviewed in a valuable article in the *Comptes Rendus* of the French Academy, the two opposite chemical conditions under which aërolitic matter may be supposed to have assumed its present form; those namely, first, of the oxidation with a limited supply of oxygen of the elements composing a meteorite assumed as combined *inter se*; and secondly, a condition under which a basic ferruginous silicate may be supposed to be converted into a neutral silicate with the emancipation of free iron by the operation of reducing agents, such as hydrogen or carbon, acting on the ferrous silicate at a high temperature.

In this way an olivine, rich in diferrous silicate, would become a bronzite poor in ferrous silicate, or become an enstatite without any iron in it at all, the iron lost in either case by the olivine being separated as metallic iron; and M. Daubrée performed transformations of this kind.

Now, the remarkable discovery by the late Prof. Graham of hydrogen in the Lenarto iron, and that recently made by Wöhler of carbonic oxide in the iron of Ovifak (due, however, probably in this case to the action of magnetic iron-oxide on the carbon of the meteorite), and also by Prof. Mallet of the same gas in a meteoric iron from Virginia, lend some probability to the view of M. Daubrée.

Still the existence of great masses of siderolites like those of Pallas and from Atacama, rich in ferruginous olivine, and presenting, so far as the analyses may be trusted, no trace of enstatite, or even bronzite, offers a great obstacle to the view that the iron in these cases was the result of a reduction from olivine. So again the Breitenbach siderolite, notwithstanding its large ingredient of free silica (as asmanite) consists largely of a bronzite very rich in ferrous monosilicate. This bronzite, however, it is to be said, resists the reducing action of hydrogen at a considerable temperature.

The similarity, not to say the peculiarity, as well in their chemical nature as in their mechanical condition that I have alluded to as characterising so many meteorites would seem to impose some restrictions on our freedom in tracing the origin of these bodies to distant and dissevered regions of interstellar space. And, indeed, though a great unity and simplicity in condition and in material would seem to rule throughout the stellar universe, as viewed by our present means of knowledge, and so far would justify our treating lightly the sameness of the meteoric material that reaches us as a check on our reasonings; yet it is to be borne in mind that the prism has only begun to interpret for us the language of the stars, and that further research may introduce complexity, and narrow the limits of our problem. On the other hand, we can only reason legitimately from the standing-point of the present; and it is equally probable, nay, almost certain, that the stellar spectra, in which, for instance, the lines characterising nickel have not yet been found, will, on direct search for them, yield those lines, and then the arguments otherwise converging on the probability of meteorites coming to us from interstellar space will acquire an almost conclusive character; for the difficulties in the way of our confining their origin to our own solar system are almost insuperable. Their high proper velocity, often far greater than that of the earth in her orbit, the directions of their motion, sometimes direct, often retrograde, and continually at high angles to the ecliptic, are not consistent with their being portions of asteroidal matter sporadically dispersed, while they are still less so with any explanation of meteorites as resulting from lunar volcanoes or from any lost telluric satellite, or from satellitic matter that had escaped the centralising influence of gravitation.

Whether any of the meteorites are intercepted by our earth while passing nodes common to our orbit, and to long cometary orbits described by innumerable meteoric groups around the sun, is a question we cannot answer in the present condition of our knowledge.

But reasoning by analogy from the movements of the meteor-swarms that we are acquainted with, this is rendered highly probable by the identification beyond a question of the orbits of periodic meteor-swarms with those of known comets, and the statement of Leverrier that these meteor-swarms are probably vast cosmical clouds consisting of sparsely-spread particles; and that some of them entering our solar system from interstellar space have been drawn aside by planetary attraction, and have assumed a circum-solar orbit. When the curve is an ellipse, they of course remain in our system, and are seen now as comets, or also again in certain very rare instances, where their orbit intersects with our own, as star-showers, which recur annually, or at the long intervals separating their approach to their perihelia, according as they have or have not been long enough members of our system for the meteoric dust to have become more or less equally distributed along their orbit in a ring, or have still only the form of a prolonged cloud continually becoming more and more annular in the distribution of its ingredient particles.

Four cases of unquestionable accordance between comets and meteor showers are established in—

The Lyriad meteoric shower (April 20–21) and Comet I. of 1861 (Galle and Weiss).
The Perseids meteoric shower (August 10–11) and Comet III. of 1862 (Schiaparelli).
The Leonids meteoric shower (November 13–14) and Comet I. of 1866 (Oppolzer, Peters, and Schiaparelli).
The Andromedes meteoric shower (November 27–28) and Biela's Comet (Galle and Weiss).

If we imagine meteorites to have a similar history, but with the difference that the meteor-particles are assembled into larger masses or clusters of them, and that these consequently are separated from each other by far vaster distances than is the case with the even widely-spread units that compose a meteor-swarm, we may comprehend why the meteorite is such a rare visitant as compared with the meteors proper, of which thousands must pass into our atmosphere every hour. Indeed, when we consider what has been before alluded to, touching the comparatively loose condition of aggregation of so many meteorites, and when we remember that the fine dust and little particles of a meteoric cloud are separated by no such atmosphere, gaseous or vaporous, as prevents actual contact between surfaces on a terraqueous globe, we may perhaps go so far as to suppose that if groups of the individual particular units of a meteor cloud once should approach each other to a distance small enough to give their mutual gravitation a sensible influence, they might gradually collect into masses, and acquire a cohesion more or less compact according to the conditions imposed on such masses during their subsequent history. Such is possibly the case with the nuclei of the comets, which would thus possess the character of a cluster of meteorites, while the coma is composed of meteoritic particles of the character of ordinary meteors.

There is one respect in which the comparison of the smaller meteors with those of greater magnitude and with meteorites may seem to point to a difference of some importance in the character of the objects themselves. The velocities usually ascribed to the former class of bodies are in many cases very much higher than that belonging to the larger objects. Thus, a velocity of 140 miles per second has been ascribed to some of the smaller meteors. Mr. Hind, however, gives the perihelion velocity of the August swarm at 26 miles per second, which, added to the motion of the earth (as the meteors are retrograde), would give a velocity of about 40 miles at a point so near their perihelion as that in which our earth meets them. On the other hand, a velocity of from 13 to 40 miles per second is that usually ascribed to the larger meteoric masses, and to meteorites of which the actual fall has been witnessed.

Furthermore, we have to consider, on the one hand, the very great difficulty in determining the parallax of a body moving so rapidly in the absence of accurate instrumental means of observing it, and on the other hand, the fact that a large meteoric mass is sure to be observed best, and by daylight almost exclusively, during the more brilliant and imposing, and therefore the nearer and more slowly traversed, portion of its track. Thus the small particles represented by the ordinary meteor are kindled and extinguished almost instantaneously in the upper part of the atmosphere, while the meteoroid masses of larger volume are observed and reasoned upon almost entirely during the more imposing part of their course, namely, their passage through its lower and denser regions.

While, then, we are restrained by the facts, as they at present stand, from separating into different classes of cosmical phenomena the meteors and the meteoroid bodies known as fireballs and meteorites, and I must add the comets, so are we constrained to recognise for all of these bodies—whether on encountering the earth they had become actually members of the solar family or not—an ultimately extra-solar origin; that, in fact, whether they, some or all of them, had become temporarily or permanently imprisoned, as it were, in the vortex of solar attraction, the probability is that they originally entered our system from the interstellar spaces beyond it. And it may further be said, that the tendency of scientific conviction is in the direction of recognising the collection towards and concentration in definite centres of the matter of the universe, as a cosmical law, rather than the opposite supposition of such centres being the sources whence matter is dispersed into space.

In the meteorites that fall on our earth (certainly in considerable numbers) we have to acknowledge the evidence of a vast and perpetual movement in space of matter otherwise unseen, about which we can only reason as part of a great feature in the universe, which we have every ground for not supposing to be confined within the limits of the solar system.

That this matter, whether intercepted or not by the planets and the sun, should to an ever-increasing amount become entangled in the web of solar and planetary attraction, and that the same operation should be collecting round other stars and in distant systems, such moving clouds of meteoric particles as have been treated by Schiaparelli, Leverrier, and other astronomers, whether as indivi luals or in clusters widely separated, of wandering stone or iron, is a necessary deduction from the view that we have assumed regarding the tendency of cosmical matter to collect towards centres.

But in order to trace the previous stages of the history of any meteorite, and in particular to determine the conditions under which its present constitution as a rock took its origin, we have only for our guide the actual record written on the meteoric mass itself; and it is in this direction that the mineralogist is now working.

But the process is necessarily a gradual one. We may indeed assert that the meteorites we know have, probably all of them, been originally formed under conditions from which the presence of water or of free oxygen to the amount requisite to oxidise entirely the elements present were excluded; for this is proved by the nature of the minerals constituting the meteorites, and by the way in which the metallic iron is distributed through them.

The progress of solar physics and the reflex light it is likely to shed on the condition of the primeval chaos of nebular matter, and the stages by which suns and planets were evolved, will no doubt help to explain the origin of meteorites; and possibly they in turn will be found to offer some not unimportant evidence on those cosmogenic questions which still belong to the more speculative region of Science.

N. S. Maskelyne

A CITY OF HEALTH.*

It is my object to put forward a theoretical outline of a community so circumstanced and so maintained by the exercise of its own free will, guided by scientific knowledge, that in it the perfection of sanitary results will be approached, if not actually realised, in the co-existence of the lowest possible general mortality with the highest possible individual longevity. I shall try to show a working community in which death, if I may apply so common and expressive a phrase on so solemn a subject—in which death is kept as nearly as possible in its proper or natural place in the scheme of life.

Before I proceed to this task, it is right I should ask of the past what hope there is of any such advancement of human progress. For as my Lord of Verulam quaintly teaches, "The past ever deserves that men should stand upon it for awhile to see which way they should go, but when they have made up their minds they should hesitate no longer, but proceed with cheerfulness." For a moment, then, we will stand on the past.

From this vantage-ground we gather the fact, that onward with the simple progress of true civilisation the value of life has increased. Ere yet the words "Sanitary Science" had been written; ere yet the heralds of that science, some of whom, in the persons of our illustrious colleagues Edwin Chadwick and William Farr, are with us in this place at this moment; ere yet these heralds had summoned the world to answer for its profligacy of life, the health and strength of mankind was undergoing improvement. One or two striking facts must be sufficient in the brief space at my disposal to demonstrate this truth. In England, from 1790 to 1810, Heberden calculated that the general mortality diminished one-fourth. In France, during the same period, the same favourable returns were made. The deaths in France, Berard calculated, were 1 in 30 in the year 1780, and during the eight years from 1817 to 1828, 1 in 40, or a fourth less. In 1780, out of 100 new-born infants in France, 50 died in the two first years; in the later period, extending from the time of the census that was taken in 1817 to 1827, only 38 of the same age died, an augmentation of infant life equal to 25 per cent. In 1780 as many as 55 per cent. died before reaching the age of ten years; in the later period 43, or about a fifth less. In 1780 only 21 persons per cent. attained the age of 50 years; in the later period 32, or eleven more, reached that term. In 1780 but 15 persons per cent. arrived at 60 years; in the later period 24 arrived at that age.

Side by side with these facts of the statist we detect other facts which show that in the progress of civilisation the actual organic strength and build of the man and woman increases. Just as in the highest developments of the fine arts the sculptor and painter place before us the finest imaginative types of strength, grace, and beauty, so the silent artist, civilisation, approaches nearer and nearer to perfection, and by evolution of form and mind develops what is practically a new order of physical and mental build. Peron—who first used, if he did not invent, the little instrument the dynamometer, or muscular strength measurer—subjected specimens of different stages of civilisation to the test of his gauge, and discovered that the strength of the limbs of the natives of Van Dieman's Land and New Holland was as 50 degrees of power, while that of the Frenchmen was 69, and of the Englishmen 71. The same order of facts are maintained in respect to the size of body. The stalwart Englishman of to-day can neither get into the armour nor be placed in the sarcophagus of those sons of men who were accounted the heroes of the infantile life of the human world.

We discover, moreover, from our view of the past, that the developments of tenacity of life and of vital power have been comparatively rapid in their course when they have once commenced. There is nothing discoverable to us that would lead to the conception of a human civilisation extending back over two hundred generations; and when in these generations we survey the actual effect of civilisation—so fragmentary, and overshadowed by persistent barbarism—in influencing disease and mortality, we are reduced to the observation of at most twelve generations, including our own, engaged indirectly or directly in the work of sanitary progress. During this comparatively brief period, the labour of which, until within a century, has had no systematic direction, the changes for good that have been effected are amongst the most startling of historical facts. Pestilences which decimated populations, and which, like the great plague of London, destroyed 7,165 people in a single week, have lost their virulence; gaol fever has disappeared, and our gaols, once each a plague-spot, have become, by a strange perversion of civilisation, the health spots of, at least, one kingdom. The term Black Death is heard no more; and ague, from which the London physician once made a fortune, is now a rare tax even on the skill of the hard-worked Union Medical Officer.

From the study of the past we are warranted, then, in assuming that civilisation, unaided by special scientific knowledge, reduces disease and lessens mortality, and that the hope of doing still more by systematic scientific art is fully justified.

I might hereupon proceed to my project straightway. I perceive, however, that it may be urged, that as mere civilising influences can of themselves effect so much, they might safely be left to themselves to complete, through the necessity of their demands, the whole sanitary code. If this were so, a formula for a city of health were practically useless. The city would come without the special call for it.

I think it probable the city would come in the manner described, but how long it would be coming is hard to say, for whatever great results have followed civilisation, the most that has occurred has been an unexpected, unexplained, and therefore uncertain arrest of the spread of the grand physical scourges of mankind. The phenomena have been suppressed, but the root of not one of them has been touched. Still in our midst are thousands of enfeebled human organisms which only are comparable with the savage. Still are left amongst us the bases of every disease that, up to the present hour, has afflicted humanity.

The existing calendar of diseases, studied in connection with the classical history of them, written for us by the longest unbroken line of authorities in the world of letters, shows, in un-

* An Address by Dr. B. W. Richardson, F.R.S., at the Brighton meeting of the Social Science Association. Revised by the author.