time there are portions of the work still incomplete. On the part of England the triangulation was, in 1862, carried through France into Belgium; and the difference of longitude of Greenwich and Valentia was determined by the Astronomer Royal by means of electric telegraph signals.

Although in theory the determination of differences of longitude by electric telegraph signals may appear extremely simple, yet practically there are very many sources of error which have to be sought out and eliminated by a proper arrangement of the observations. The system has now been brought to such perfection that the astronomical amplitude of arcs of longitude can be determined with nearly as much accuracy as those of latitude, and in a few years the data of the problem of the figure of the earth will thus receive many additions. As an example of the precision arrived at, the difference of longitude of Greenwich Observatory and Harvard Observatory, U.S.A., has been three times determined with the following results :—

	h.	m.	s.
1866 by Anglo-American Cable..............	4	44	31·00
1870 by French Cable to Duxbury............	4	44	30 99
1872 by French Cable to St Pierre...........	4	44	30·96

But the different determinations of the velocity of transmission of signals present great anomalies.

Pendulum Observations.

In Clairaut's theorem we have seen that if g' be gravity in the latitude of ϕ, g its value at the equator, then $g'=g(1+q\sin^2\phi)$. If the same pendulum be swung in different latitudes then the square of the number of vibrations will be proportional to gravity. Hence, if N be the number of vibrations of an invariable pendulum per diem at the equator, N′ the number in latitude ϕ, then $N'^2=N^2(1+q\sin^2\phi)$. Thus q can be obtained by observations on the same pendulum in different latitudes, and since $q=\frac{5}{2}m-e$ and m is known, e will at once follow. The pendulum which makes 86400 oscillations per diem in London is observed to lose 136 vibrations at the equator and gain 79 at Spitzbergen.

The limits of space at our disposal here prevent our going into the subject of pendulum experiments, and it seems unnecessary to repeat the investigations that have already been based upon the older pendulum observations. See Airy's *Figure of the Earth*, Baily's paper in the *Memoirs of the Royal Astronomical Society*, General Sabine's *Account of Experiments to determine the Figure of the Earth by means of the Pendulum vibrating seconds in Different Latitudes*, 1825, and a valuable paper in the *Cambridge Philosophical Transactions*, 1849, by Professor Stokes. The pendulum gives an ellipticity certainly somewhat greater than that resulting from arcs of meridian, viz., $\frac{1}{288\cdot5}$. An immense number of pendulum observations are now being made at the astronomical stations of geodesical surveys in Germany, Russia, and India, which, when fully published, will throw light more perhaps upon the local variations of gravity than on the figure of the earth. The observations made at the various stations of the Indian meridian arc bring to light a physical fact of the very highest importance and interest, namely, that the density of the strata of the earth's crust under and in the vicinity of the Himalayan Mountains is less than that under the plains to the south, the deficiency increasing as the stations of observation approach the Himalayas, and being a maximum when they are situated on the range itself. This accounts for the non-appearance of the large deflections which the Himalayas, according to Archdeacon Pratt's calculations, ought to produce. The Indian pendulum observations also throw some light on the relative variations of gravity at continental, coast, and island stations, showing that, without a single exception, gravity at the coast stations is greater than at the corresponding continental stations, and greater at island stations than at coast stations. The ellipticity of the earth has also been deduced from the motion of the moon, the quantity $e-\frac{1}{2}m$ entering as a coefficient in the expression for the moon's latitude. The resulting value of the ellipticity is $\frac{1}{297}$th (Airy's *Tracts*, p. 188). A value of the ellipticity may also be derived from the precession of the equinoxes, but as this depends on the assumed law of density in the interior of the earth it is not of much importance.

Elements of the Figure as a Solid of Revolution.

$$a=20926062 : b=20855121\,.$$

If ρ be the radius of curvature of the meridian in latitude ϕ, ρ' that perpendicular to the meridian, D the length of a degree of the meridian, D′ the length of a degree of longitude, r the radius drawn from the centre of the earth, V the angle of the vertical, then

$$\begin{array}{lllll}
 & \text{Feet.} & & & \\
\rho & =20890606\cdot6 & -106411\cdot5\ \cos 2\phi & +225\cdot8\ \cos 4\phi & \\
\rho' & =20961607\cdot3 & -\ 35590\cdot9\ \cos 2\phi & +\ 45\cdot2\ \cos 4\phi & \\
\text{D} & =\ \ 364609\cdot87 & -\ \ 1857\cdot14\ \cos 2\phi & +\ \ 3\cdot94\ \cos 4\phi & \\
\text{D}' & =\ \ 365538\cdot43\ \cos\phi & -\ \ 310\cdot17\ \cos 3\phi & +\ \ 0\cdot39\ \cos 5\phi & \\
\text{Log}\,\frac{r}{a} & =9\cdot9992645 & +\ \cdot0007374\ \cos 2\phi & -\ \cdot0000019\ \cos 4\phi & \\
\text{V} & =700''\cdot44\ \sin 2\phi-1''\cdot19\ \sin 4\phi\,. & & &
\end{array}$$

(A. R. C.)

EARTHQUAKE. Although the terrible effects which are often produced by earthquakes have in all ages forced themselves upon the attention of man, it is nevertheless only within the last thirty years that the phenomena have been subjected to exact investigation. A new science has been thus established under the name of *seismology* (σεισμὸς, an earthquake). This branch of knowledge, however, has hitherto attracted but few students, and its development in England has been almost exclusively due to the researches of Mr Robert Mallet. References to his principal works will be given at the end of this article.

Accounts of earthquakes are to be found scattered through the writings of many ancient authors, but they are, for the most part, of little value to the seismologist. There is a natural tendency to exaggeration in describing such phenomena, sometimes indeed to the extent of importing a supernatural element into the description. It is true that attempts were made by some ancient writers on natural philosophy to offer a rational explanation of earthquake phenomena, but the hypotheses which their explanations involved are, as a rule, too fanciful to be worth reproducing at the present day. It is therefore unnecessary to dwell upon the references to seismic phenomena which have come down to us in the writings of such historians and philosophers as Thucydides, Aristotle, and Strabo, Seneca, Livy, and Pliny. Nor is much to be gleaned from the pages of mediæval and later writers on earthquakes, of whom the most notable are Fromondi (1527), Maggio (1571), and Travagini (1679). In this country, the earliest work worthy of mention is Dr Robert Hooke's *Discourse on Earthquakes*, written in 1668, and read at a later date before the Royal Society. This discourse, though containing many passages of considerable merit, tended but little to a correct interpretation of the phenomena in question. Equally unsatisfactory were the attempts of Priestley and some other scientific writers of the last century to connect the cause of earthquakes with electrical phenomena. The great earthquake of Lisbon in 1755 led the Rev. John Michell, professor of mineralogy at Cambridge, to turn his attention to the subject; and in 1760 he published in the *Philosophical Transactions* a remarkable essay on the Cause and Phenomena of Earthquakes. Regarding the earth as having a liquid interior covered by a comparatively thin crust, he conceived that waves might be generated in this subterranean liquid, and that such waves by shaking the flexible crust would produce the shocks of an earthquake.

His illustration of the movement of the ground is that of a loose carpet thrown into undulations by being shaken at one corner. Although Michell's hypothesis is still accepted, in a modified form, by some geologists, it should be remembered that many arguments of considerable weight have been urged by modern physicists against the doctrine of a liquid nucleus and a thin crust. Whatever the merits of Michell's theory, he failed to understand the true nature of wave-motion, and the way in which it is transmitted during an earthquake shock. Modern seismologists believe that an earthquake is a vibratory motion propagated through the solid materials of the earth, much in the same way that sound is propagated by vibrations in the atmosphere. It appears that this view was first suggested by Dr Thomas Young in his *Lectures on Natural Philosophy*, published in 1807. The development of this view, especially in its quantitative results, lies at the very base of seismology. In 1846 Mr Mallet communicated to the Royal Irish Academy his first paper "On the Dynamics of Earthquakes;" and in the following year the late Mr Hopkins, of Cambridge, presented to the British Association a valuable report in which earthquake-phenomena are discussed in some detail. Since that date the great advances in this country have been made by Mr Mallet, assisted occasionally by the Rev. Professor Haughton and other mathematicians.

Even at the present day, after all that has been written on the subject, but little is really known as to the origin of earthquakes. Probably several distinct causes should be recognized, for it is hardly to be supposed that all subterranean disturbances, differing as they do so widely in intensity and in duration, should be referable to one common mechanism. Any great concussion, even upon the surface, is competent to produce tremors which may be regarded as diminutive earthquakes; thus the great landslip at the Rossberg in Switzerland in 1806 was accompanied by a local quaking of the ground. Volger and Mohr have suggested that some of the small earthquakes which have been felt in Germany may be referred to the falling-in of the roof of enormous subterranean cavities formed by the long-continued solvent action of water on deposits of rock-salt, limestone, and gypsum. Such causes, however, can have given rise to only very petty shocks, and must be quite subordinate to subterranean disturbances of a more general character. The late Mr Poulett Scrope was led to refer most earthquakes to "the snap and jar occasioned by the sudden and violent rupture of solid rock-masses, and perhaps the instantaneous injection into them of intumescent molten matter from beneath." He believed that the rupture of the rocks was due to expansion of deeply seated masses of mineral matter, consequent upon either increased temperature or diminished temperature. It is argued, however, by Mr Mallet, on mechanical principles, that such fractures could produce only very weak impulses; but he believes that some earthquakes, especially those marked by long continued tremors, may be due to the movement and crushing of rock masses by tangential pressures produced by secular cooling of the earth. Steam has always been a favourite agent with seismologists, since it is clearly competent to produce great effects by its sudden generation or by its sudden condensation. It has been suggested that water, finding its way through fissures in the earth's crust, might reach highly-heated rocks and remain quietly, in the spheroidal condition, until a local reduction of temperature suddenly caused it to flash into steam. After all, the origin of earthquakes is probably to be regarded as part only of a much wider question. Whatever causes are competent to produce volcanic action are, in all likelihood, equally competent to produce the ordinary manifestations of seismic energy. A relation is clearly traceable between the geographical distribution of volcanoes and the chief earthquake-areas; and although it is not for a moment to be supposed that the volcano and the earthquake stand to each other in the relation of cause and effect, it is nevertheless highly probable that they represent merely different expressions of the same subterranean forces.

Whatever may be the real origin of the earthquake shock, it is convenient to regard its effects as proceeding from a concussion or sudden blow delivered underground at some definite centre. This centre of impulse is called the *seismic focus*. It must be borne in mind, however, that such a centre, so far from being anything like a mathematical point, is in nature a subterranean region, which in many cases is no doubt of very large dimensions, measuring perhaps some miles in diameter.

From the seismic centre waves are propagated in all directions through the solid materials of the earth's crust; and if the focus be situated beneath the sea, the vibrations of the ground will be accompanied by undulations of the water. Those waves which pass through the elastic materials of the earth consist, for the most part, of *longitudinal* vibrations, like those of atmospheric sound-waves, and consequently not like ordinary water-waves. In the sound-wave the air is alternately condensed and rarefied, the molecules advancing and retreating in the line of direction in which the wave is travelling. In a water-wave, on the contrary, the molecules of liquid rise and fall, or rather describe closed curves in planes which are transverse to the direction in which the undulation or wave-form advances. According to Mr Hopkins, both orders of vibration—longitudinal and transversal—coexist in the earthquake-wave, and call for investigation. When, for example, the molecules of an iron bar are disturbed by a blow delivered at one end, both kinds of vibration are generally excited, and hence two waves are sent through the bar,—the longitudinal, however, having a much greater velocity than the transversal wave. But it may be doubted whether the seismologist need concern himself with any but longitudinal vibrations. For, admitting that small transversal vibrations are generated at the seismic focus, it is probable that they would be cut off to a great extent during transmission from stratum to stratum. Indeed, the planes of junction between the several beds in stratified deposits would hinder the transmission of transversal vibrations travelling in a direction normal to the strata. Hence Mr Mallet maintains, that in studying the effects of an earthquake, attention may be restricted, without danger of error, to the longitudinal or normal vibrations, the transversal or tangential vibrations being neglected.

Around the seismic centre, or mean focal point, the molecules of the rock will first be squeezed together by the concussion, and then separated by virtue of the elasticity of the solid medium; the onward motion is then rapidly taken up by the next set of molecules, which in like manner are pushed against each other, and then spring apart. In this way the pulse, or form of the wave, may be propagated to an enormous distance, whilst the excursions of the individual particles are confined within very narrow limits. It is therefore of great importance to distinguish between the transit of the wave and the movement of the material particles. Each molecule may move only through a few inches, but the undulation may travel for hundreds of miles. The distance through which the individual particles oscillate is called the *amplitude* of the wave. After the Neapolitan earthquake of 1857 Mr Mallet found from actual observation at a place called Polla, situated nearly above the seismic centre, that the amplitude of a wave which caused certain fractures in masonry could not have been more than 2½ inches. He is thus led to believe, contrary to the opinion of most geologists, that earthquakes are not great agents of permanent elevation. That elevation has been frequently observed after an earthquake is a fact beyond question; thus, Captain Fitzroy found, after the South American earthquake of 1835, that a part of the isle of Santa Maria, in the Bay of Concepcion, had been raised upwards of 10 feet, and, although this elevation was followed by a slow subsidence, it is believed that the land was permanently left considerably higher than its level before the occurrence of the catastrophe. Mr Mallet, however, would refer such alteration of level to the action of elevatory forces accompanying the earthquake, but not to the direct transit of the earth-wave.

From the density and the modulus of elasticity of a given rock, it is possible to calculate the velocity with which a vibration would travel through such a medium. But the rate deduced by calculation usually exceeds very greatly that actually observed in an earthquake. To determine the rate of transit through various rocks, Mr Mallet and his son Dr J. W. Mallet conducted many years ago a series of experiments, at the instance of the British Association. A mile was carefully levelled and measured on sand in Killiney Bay, near Dublin, and by explosion of gunpowder the velocity of transmission through this damp sand was observed. This sand was selected as a medium likely to give a minimum velocity, whilst an assumed maximum velocity was observed by experiments on the granite of Killiney Hill. The velocity in sand was about 825 feet, and in solid granite 1665 feet per second. These figures are much lower than those obtained from theoretical considerations, and it is believed that the difference is due to loss of speed occasioned by the discontinuity of the rock, even the solid granite being always more or less affected by joints. The velocity deduced from these experiments accords tolerably well, however, with that observed during earthquake-shocks. Thus the velocity of shock during the Lisbon earthquake of 1755 is computed to have been about 20 miles per minute, or 1760 feet per second. This velocity of the vibration, or wave of shock, is of course to be carefully distinguished from the velocity of the oscillating particles. The mischief of the shock depends in fact on the rate at which the earth-molecules are moving, and this is vastly inferior to that of the wave. Thus Mr Mallet calculated from his observations in Naples that the shock of the great earthquake of 1857 had a mean velocity at the surface of 788 feet per second, whilst the greatest velocity of the wave-particles was never more than 15 feet per second, and in many places was very much less. Yet this low velocity is quite sufficient to produce effects of the most disastrous kind upon solid objects exposed to the shock.

If the earth were a homogeneous solid, perfectly isotropic —that is to say, possessing equal elasticity in all directions —the waves of alternate compression and expansion would take the form of a series of concentric spherical shells around the seismic focus as a common centre. As a matter of fact, however, the crust of the earth is made up of rocks varying greatly in physical properties, each having its own density and elasticity, whilst the rocks themselves are fissured in all directions. Symmetry of wave-surface is therefore hardly to be expected; for the waves will necessarily have greater velocity in one direction than in another, whilst the transit of the wave may be interrupted by breach of continuity in the transmitting medium. The points at which a wave-shell reaches the surface form a curve which is conveniently called a *coseismal line.* It is obviously the line along which an earthquake shock will be simultaneously felt, and where the waves will emerge at the same angle. Since the wave-shells are not concentric spheres, the coseismal curves cannot be concentric circles.

It may readily be supposed that the greatest effect of an earthquake, at least in shaking a building up and down, will be felt at that point of the surface which is situated vertically over the centre of impulse. A line joining this point with the earthquake-focus is termed the *seismic vertical*, and the wave travelling to the surface along this vertical has a shorter path than that of a wave emerging at any other point. Just as the seismic focus is, in nature, not a single point, but a considerable space, so the seismic vertical is not a single line, but rather a succession of parallel lines drawn vertically from every point of the focal area to the surface. The mean of these lines may be taken as the seismic vertical. In the neighbourhood of this line the waves emerge at very steep angles, and indeed for a considerable area may be regarded as practically vertical in direction. As the distance from the seismic vertical increases, the angle of emergence becomes less and less; but it is evident that since the focus is seated beneath the surface, the path of an emergent wave can never be perfectly horizontal, unless indeed it be that of a reflected wave.

Almost any object which has been overthrown or projected by an earthquake-shock may afford direct information as to the path of the wave along the surface. For when the vibration is transmitted to such a solid body as an upright column, the particles are pushed together and then pulled apart in the line of wave-transit. It is clear too that half the excursion of each particle is executed in the same direction as that in which the wave is travelling, and half in the opposite direction. Each particle of the object when first disturbed moves with the wave, and its velocity increases from zero to the maximum, this maximum being reached at one quarter of the total vibration; then the velocity diminishes from the maximum to zero, which it attains at the end of half the oscillation. During this first semi-phase, therefore, the vibration has been in the direction in which the wave moves. After the first half oscillation has been executed, movement begins afresh, but this time in the contrary direction, attaining its maximum at the end of the third quarter, and then falling again to zero when the vibration is completed. Hence during the first semi-phase, the motion of the particles is in the same sense or direction as that of the wave, and during the second semi-phase in the opposite direction. But in consequence of the inertia of the body its apparent movement if free, will be in a direction contrary to that of the wave during the first semi-phase. Whatever the direction of overthrow, however, it will always be in the *line* of wave-transit. Hence the azimuthal direction of the wave is easily found.

Whenever any two wave-paths, not in the same right line, can be thus traced on the surface, the position of the seismic vertical may be immediately determined. For this line must pass through the point of their intersection. If, for example, it is found by observation on bodies displaced by the shock that one wave moved in the direction AB (fig. 1), whilst another had a path along CD, it is only necessary to mark on the surface the point O, at which these azimuths meet, and the seismic focus will be vertically beneath such a point. The point indicates, in fact, the centre on the surface from which the waves radiated. Practically it is found that the several wave-paths of an earthquake do not diverge from a single point, for reasons already indicated; but intersections of the paths are crowded together in the neighbourhood of the mean vertical.

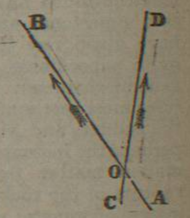

Fig. 1.

It is easy to understand that the greatest amount of mechanical damage is not to be expected immediately above the focus, although this is the point nearest to the origin of impulse. It is true, the shock passing directly upwards along the seismic vertical might destroy the roof or floor of a building, but it would not tend directly to overturn the walls or produce lateral disturbance. In fact, the side-thrust will be greatest in waves which reach the surface at small angles, and are therefore necessarily at great distances from the seismic vertical. But the energy of the wave diminishes as the square of the distance along the normal increases. Hence there must be some definite position upon the surface beyond which advantage of direction is counterbalanced by loss of energy. Indeed it is generally possible after an earthquake to trace a zone of maximum disturbance, where the damage to the shaken country has been greatest. The line indicating this maximum is termed the *meizoseismic curve*, whilst lines along which the overthrow of objects may be regarded as practically the same are known as *isoseismic curves*. After what has been already said, it is hardly necessary to remark that these lines are not true circles, nor indeed are they in all cases regular closed curves.

Fractures and fissures in walls which have been rent by an earthquake, are of great value to the seismologist, since they often indicate the direction in which the waves emerge at the surface. The interpretation of such phenomena, in some cases very complicated, has been ably discussed by Mr Mallet, who applied the results with excellent effect to his observations on the Neapolitan earthquake. If it is possible to find, from such indications, the direction in which any two waves emerged at the surface, the depth of the seismic focus is easily determined. For since the waves radiate from this focus, any two wave-paths when produced backwards will meet at the seismic centre. It has already been shown how easily the vertical is found, and when this is known the determination of the focus is simplified, for as the vertical itself represents one-wave path it is necessary to find only one other. Let O (fig. 2) be the seismic focus, and OA the seismic vertical; if a wave, OB, emerge at the surface B, at an angle θ, it is evident that

$$AO = AB \,.\, \tan\theta.$$

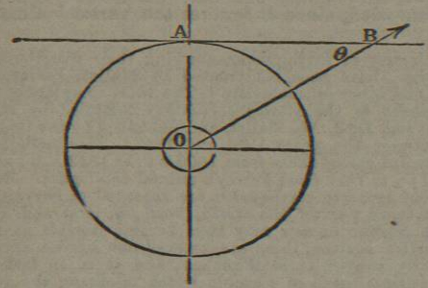

Fig. 2.

To find the depth of the focus, it is consequently only necessary to know the angle of emergence of a wave at a given station, and the distance of this station from the seismic vertical. As the stations A and B are comparatively near each other, the earth's sphericity may be neglected, and the surface between the two regarded as practically a horizontal plane.

Where several wave-paths are known, several values of AO will be obtained, and as the seismic centre is not a point, like O, but a cavity of determinate magnitude, the average of these different values must be taken to represent the *mean focal depth*. After the great Neapolitan earthquake of 1857, Mr Mallet, aided by the Royal Society, spent some months in carefully examining the country which had been visited by the shock; and in 1862 he published an elaborate report in which his observations were fully discussed. By determining the wave-paths at twenty-six stations in every azimuth around the seismic vertical, he was enabled to deduce the important fact that the mean focal depth of the earthquake was about 5¾ geographical miles. Similar principles have since been applied by Dr Oldham to an examination of the results of an earthquake which occurred in Cachar in India, on January 10, 1869; and he has found that the seismic focus there must have had a depth of about 30 miles. This coincides very nearly with the depth which Mr Mallet believes to be the maximum at which any earthquake is likely to originate in our planet.

When the centre of disturbance is seated beneath the sea, as appears to have been the case with that which produced the great earthquake of Lisbon in 1755, a water-wave is generated; but since this has less velocity than the earth-wave, it does not roll in upon the shore until after the shock has been felt on land. The height of the sea-wave depends on the depth of the water. During the Lisbon earthquake the wave at Cadiz was as much as sixty feet in height. It is this great sea-wave which, breaking upon the shore after the earthquake-shock, generally completes the work of devastation. At first the water retires from the land, but in a few moments the gigantic wave rolls in, and sweeps all before it. The earthquakes which are so frequently felt on the western coast of South America are generally terminated in this manner; and the great tidal wave which accompanied the earthquake of May 1877, wrought dreadful havoc at Arica, Iquique, and other towns on the coast.

In addition to the waves propagated through earth and sea, it commonly happens that waves are transmitted through the air and thus produce sound. These sound-waves, travelling at the rate of about 1100 feet per second, may reach the observer either simultaneously with the shock or before it or even after it. They probably result from sudden fracture and dislocation of rock-masses, or from subterranean explosions.

Almost every object disturbed by an earthquake may be made to yield, when properly questioned, more or less information with respect to the direction and intensity of shock. Special instruments termed *seismometers* have, however, been constructed for this purpose, and have assumed considerable variety of form. Perhaps the simplest seismometer is that suggested by Mr Babbage, consisting merely of a bowl of some viscid liquid like treacle. On the passage of a shock the liquid rises up one side of the vessel, leaving its mark to indicate rudely the direction and extent of motion. As a modification of this simple instrument Mr Mallet proposed the use of a common wooden tub having its inside rubbed with chalk, and half filled with coloured water. An apparatus devised by Professor Cacciatore, of Palermo, and much used in Italy, is constructed with a shallow dish having eight notches in the side, and containing mercury up to the level of the lips. When any oscillation occurs, the liquid is spilt into a series of cups placed under the notches; and the quantity ejected, which may be readily weighed, gives some notion of the intensity of the shock. Since the notches face the four cardinal points and bisecting rhumbs, the direction in azimuth is approximately obtained. Mr Mallet suggested a convenient form of seismometer in the shape of a system of four L-shaped glass tubes having the upper ends closed and the horizontal limbs directed to the cardinal points. The tubes are partially filled with mercury, and the horizontal component of any shock causes the mercury to move in the lower limbs; whilst the vertical component is determined by the motion of quicksilver in a U-shaped tube. In both cases, the movement of the liquid column is registered by means of indexes.

All these instruments depend for their indications on the displacement of liquids by the shock of the earthquake. But it is obvious that the oscillations of solid bodies may be equally well employed in seismometry. Thus a pendulum free to move in all directions will be set vibrating by a shock, and may be made to record the direction and extent of its vibration by means of a stile below the bob, which moves over a bed of fine sand in a properly-shaped dish. Two pendulums are sometimes used, as proposed by Santi. One pendulum vibrates in a vertical plane directed north and south, and the other in one striking east and west,—the arcs traversed in these planes being registered by means of a tracing-stile affixed to the bob. Professor J. Forbes employed an inverted pendulum, or rod fixed at its base and weighted above, carrying at its free end a pencil or tracer by which any oscillation could be recorded. A modification of the inverted pendulum was proposed by Mr Budge of Valparaiso, in which the pendulum when moved by the first shock was kept in position at the end of a semioscillation, by means of a pawl working in a ratchet on the base of the vibrating body.

Such seismometers as those previously noticed require to have their indications observed after each shock. Several ingenious instruments have, however, been constructed on self-registering principles, so that however often they are disturbed, each movement leaves a permanent record. The first of these self-registering seismometers was devised by Mr Mallet, and described in 1846. Both the horizontal and the vertical element of a shock are recorded by the movement of mercury in a system of glass tubes, the tubes being placed in a galvanic circuit so arranged that contact is broken by displacement of the liquid. As long as the circuit remains complete, a pencil traces a line on ruled paper wound round a cylinder rotated by clock-work, but the motion of the mercury intercepts the current and thus breaks the line. Two forms of "bull seismometer" are also due to the ingenuity of the same investigator. In one of these instruments, two heavy metal balls are placed on slightly inclined planes supported by a cast-iron table, the axis of which passes through a vertical spiral spring. During the passage of an earthquake wave the spring is compressed and the balls displaced,—their displacement breaking contact in an electric circuit which had previously been completed through the balls. That ball which first moves gives the time at which the shock commences, whilst the other gives the elements of the shock. Two such instruments are necessary to form one seismometer, the two being placed at right angles to each other.

An elaborate electro-magnetic seismograph has been constructed by Professor Palmieri, and has done good service in the observatory on Mount Vesuvius. The vertical movements are recorded by a helix of copper wire, the lower end of which is caused by even the slightest shock to dip into a basin of mercury, and thus complete a galvanic circuit. An electro-magnet, brought into action when the connections are completed, strikes an alarm bell which calls an attendant, and also stops a clock, so that the instant at which the shock occurs is permanently marked. At the same time a second electro-magnet releases the pendulum of another clock, which being thus set in motion unrolls a band of paper, while a pencil continues to mark upon the paper as long as the shock lasts. To record the vertical element a system of four U-shaped tubes is employed, the tubes being placed in different azimuths. Each limb is partly filled with mercury, and any oscillation in the level of the liquid is indicated by movement of a little float connected with an index. The oscillation of the quicksilver also completes a galvanic circuit, and brings into action the electro-magnets already described.

Although the limits of this article forbid reference to some other seismometers, such as that of Kreil of Vienna, mention should certainly be made of one instrument which is marked by its extreme simplicity. Its construction, which is due to Mr Mallet, will be understood by reference to fig. 3. Two sets of right cylinders are turned in some hard material, such as boxwood. The cylinders are all of the same height, but vary in diameter. Two planks of wood are fixed to a level floor, one having its length in a north-and-south, and the other in an east-and-west direction. The cylinders stand upright on the planks in the order of their size, with a space between each pair greater than their height, so that when one pillar falls it does not strike its neighbour. The surrounding floor is covered up to the level of the planks with dry sand. When a shock passes, some of the cylinders are overturned, the number depending on the velocity of the wave. Suppose the shock knocks over the narrow-based cylinders 4, 5, 6, leaving Nos. 1, 2, 3 standing; then the velocity of the horizontal component must have been greater than that needed to overturn No. 4, but not great enough to overturn No. 3. Hence the velocity (V) can be approximately obtained by using a formula due to Professor Haughton, viz. :

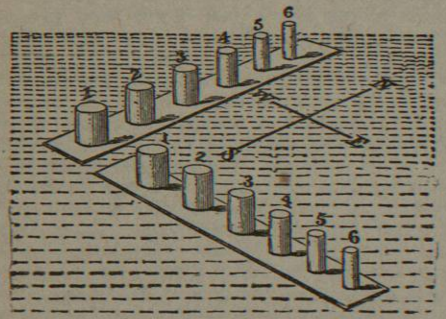

Fig. 3.

$$V^2=\frac{15b^2+16a^2}{12a^2}\cdot g\sqrt{a^2+b^2}(1-\cos\theta);$$

where a is the altitude of the column, b the diameter of its base, and θ the angle formed by the side and a line drawn through the centre of gravity to the extremity of the base. The direction in azimuth is indicated by the position in which the overturned pillars are found, since the bed of sand prevents rolling. It is possible to obtain the exact time at which the shock commences by connecting the narrowest-based pillar with the pendulum of a clock so as to stop it at the instant of overthrow. Where the angle of wave-emergence is very steep, this instrument is not to be recommended, since it ignores the vertical element of the shock.

Catalogues of earthquakes, showing their distribution in time and space, have been constructed by Mallet, Perrey, Von Hoff, Cotte, and other seismologists. The most complete of these statistical works is the *catalogue raisonné* compiled by Mr R. Mallet and his son, Dr J. W. Mallet, and published by the British Association between the years 1854 and 1858. This includes notices of all recorded earthquakes from 1606 B.C. to 1842 A.D., and is thence carried on to 1850 from Perrey's annual catalogues. Between 6000 and 7000 separate earthquakes are recorded as having occurred in almost every part of the world, both on land and at sea. But though seismic energy may thus become sensible at any point of the earth's surface, there are, as everyone knows, certain regions peculiarly subject to earthquakes, and it is, in fact, possible to trace seismic bands of variable width following the great lines of elevation which divide the oceanic basins.

It is now several years since Professor Alexis Perrey, of Dijon, sought to trace a relation between the occurrence of earthquakes and the age of the moon. By careful analysis of his catalogue he believed that he had established the facts—that earthquakes occur more frequently at the syzygies than at the quadratures, that their frequency increases at the perigee and diminishes at the apogee of the moon, and that shocks are more frequent when the moon is on the meridian than when 90° from it. Such a connection between seismic phenomena and the phases of the moon would accord with Zantedeschi's views on the existence of a terrestrial or terrene tide, views which were based, however, on the old hypothesis of a liquid nucleus in the earth, covered by a thin crust.

From Mallet's discussion of his catalogue for three centuries, he was led to detect definite periods of maximum energy. Thus it is found that the greatest number of earthquakes are recorded about the middle of each century; whilst a second epoch, less powerful than the first, occurs towards the close of the century. According to Perrey there is a preponderance of earthquake-shocks at particular seasons, the equinoxes and solstices, which he terms "critical epochs." Mallet's analysis of a large catalogue showed a decided maximum about the winter solstice, but Perrey's other epochs were less marked. In the present state of our knowledge it would be rash to regard seismic force, whatever it may be, as a distinctly periodic force, or to insist upon any of those relations between earthquakes and meteorological phenomena which have sometimes been discussed.

Annual reports on earthquakes have been published for many years by Professor Fuchs. During the year 1876 he recorded 104 earthquakes, which were distributed among the months as follows:—In January 10, February 10, March 14, April 8, May 7, June 7, July 8, August 5, September 7, October 14, November 5, December 9. In the preceding year 97 earthquakes were noticed, occurring as follows:—In January 15, February 7, March 12, April 7, May 9, June 10, July 6, August 5, September 3, October 2, November 9, December 12.

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EARWIG, a name, sanctioned by common error, applied under various modifications in different languages (*e.g.*, Auricularia, Perce-oreille, Ohr-wurm, Oorblazer, Ormask, Oerentvist, Gusano del oido, &c.) to the somewhat osculant insects comprised in the old Linnean genus *Forficula*,—an error arising in the first instance probably from their invariable habit of secreting themselves in any cavity, of which they always endeavour to reach the innermost recess (instances being known of the common species hiding itself in the ear of a person sleeping in the open air), and strengthened by the popular exaggerated idea of the strength and attributes of the anal forceps peculiar to these insects.

Earwigs have been for some time of uncertain position in classification. having been even considered as worthy of the rank of a special separate order (*Labidoures*, Duméril: *Dermaptera*, corrected to *Dermatoptera*, Leach; and *Euplexoptera*, corrected to *Euplectoptera*, Westwood), but they are now generally recognized as forming a family, *Forficulidæ* or *Forficulariæ*, of the *Orthoptera* (the Locusts, Grasshoppers. Crickets. Cockroaches. Mantis. &c.) They have much the facies of the *Brachelytra* or *Staphylinidæ* in the *Coleoptera* (Beetles), from which order they differ in their pupa being active, resembling the perfect insect except in possessing only rudimentary wings, &c.; also in the method of folding and neuration of the hinder wings, the possession of an anal forceps, and, as in the other *Orthoptera*, in the additional external lobe to their maxillæ. From all the other *Orthoptera*, apart from the anal forceps, they differ in having horizontal elytra covering the wings in repose as in beetles, and in the female not possessing a corneous ovipositor, and from most of them in the hind legs being not formed for jumping.

Of distinct species 250 are recognized, comprised in 34 genera (of which some are apparently needless); but it is highly probable that this represents a mere outline of the group, as scarcely any naturalists make them an object of study, and their geographical distribution is very extended. There are about 200 species in the collection of the British Museum alone, mostly unnamed, and not specially collected. They are found in the whole of Europe, in Syria and Asia Minor, Central Asia, Hindustan, Ceylon, Indo-China, China and Formosa, the Malay Archipelago, the Philippines, North, West, and South Africa to the Cape itself, Egypt, Zanzibar, Mauritius, Kamtchatka, Newfoundland, the North American States from New York to California (but comparatively rare, according to Packard), Mexico, Florida, Central America and the West Indies, South America from Columbia to Chili, New Guinea, North Australia, Tasmania, and New Zealand; and species occur in such isolated localities as Madeira, the Canaries, St. Helena, Woodlark Island, the Solomon and Sandwich Isles, and Kerguelen's Island. As regards pre-historic times, a few fossil species have been found in the territories of Solenhofen, Œningen, and Italy in the Old World; and of the Rocky Mountains (Colorado) in the New. Seven species have been recorded from Great Britain, of which two are universally common, viz., *Forficula auricularia*, the typical earwig, and the smaller *Labia minor*. The former of these is found all over Europe, in Armenia, the Caucasus, and other parts of Asia, and in the eastern United States, being also recorded from Japan; and the latter occurs in Europe, Western Asia, and North America. Another species, *Labidura riparia*, extends over the entire Old World.

All are of comparatively small size, and nearly all of obscure colours, mostly various shades of brown or dull yellows and reds: one South American species is white; another, from the Amazon, has blue metallic elytra, which are metallic also in another from Penang; a fourth exotic species is yellow, with black stripe; and several have opaline or iridescent wings. Eccentricity of development is shown chiefly in the forceps, which in a Nicaraguan species are as long as the rest of the body; in another South American form the abdomen is laterally toothed; a third has very long legs, being almost tipuliform; *Apachys* has the body as thin as cardboard.

Sexual differences are shown in the male by the greater development and armature of the forceps, or the tuberculated abdomen, which is composed of nine distinct segments, whereas only seven are evident in the female. The forceps have been observed to be used in arranging the wings and are also supposed to be used as weapons of offence and defence, though it is difficult to understand how they could be of any practical assistance for either purpose. The lower wings have long attracted attention from their unexpectedly large size and fan-like structure; in the accompanying figure, *a* is the magnified open wing of the common earwig, *b* the same of the natural size, and *c* the wing closed, also of natural size. Although possessed of such ample organs of flight, *Forficula auricularia* has seldom, if ever, been observed to make use of them, though there is evidence that it does fly; but the other common British species, *Labia minor*, is frequently seen on the wing, being often mistaken for a brachelytrous beetle. It may be observed, that the possession of wings is apparently sexual in some cases, and that some species are entirely apterous.

Wing of Earwig.

Some few instances have been recorded of earwigs being carnivorous, devouring the larvæ and pupæ of wild bees and even their own species; but the majority are in a normal state certainly eaters of vegetable matter, congregating under bark, and destroying flowers, fruit, &c., often to a considerable extent. An instance of their adaptability to circumstances is afforded by Mr H. W. Bates's discovery of a large *white* species (above referred to) very common on white sandy beaches of the Brazilian river Pará, at Caripí, with a white *Tetracha* and a white mole cricket; this whiteness was permanent, and must not be confused with the light colour of recently disclosed individuals.

The female of the common earwig has long been noted for an exhibition of remarkable maternal instinct in defending her progeny, not only brooding over her eggs, but caring for her newly hatched young.

The chief writers on *Forficulidæ* are Dohrn, in the *Stettiner entomologische Zeitung* for 1862 and following years, and quite recently, S. H. Scudder, in the *Proceedings of the Boston Natural History Society*, vol. xviii., the latter being the first to discuss these insects in a collective form. (E. C. R.)

EASEMENT, in English law, is a species of servitude or limited right of use over land belonging to another. It is distinguished from a *profit*, which is a right to take the soil of another; while an easement is a right to use the soil or the produce of the soil in a way tending to the more convenient enjoyment of another piece of land. Thus a right of way is an easement, a right of common is a profit. Besides rights of way the most important easements are *water-courses* (as where a person has a right to divert a flow of water), the right to discharge water, &c., upon a neighbour's land, and the right to restrain such a use of land as would obstruct the access of light and air to an ancient window.

EASTBOURNE, a watering-place on the Sussex coast, 66 miles from London by railway. It is situated about three miles to the east of Beachy Head, the loftiest headland on the English Channel. It once consisted of three parts:—the old village of East Bourne, a mile inland; South Bourne, lying back from the shore; and Seahouses, facing the beach; but these distinctions are now almost obliterated, and numerous handsome terraces and detached houses have more or less united the three old hamlets into one town. Besides the parish church of St Mary's, a building of some antiquity there are four chapels of ease in Eastbourne. A pier was erected in 1868. The population, which is rapidly increasing, was 10,361 in 1871.

EASTER, the annual festival observed throughout Christendom in commemoration of the Resurrection of our Lord Jesus Christ. The word *Easter*—Anglo-Saxon, *Eastre*, *Eoster*; German, *Ostern*—like the names of the days of the week, is a survival from the old Teutonic mythology. According to Bede (*De Temp. Rat.*, c. xv.) it is derived from *Eostre*, or *Ostâra*, the Anglo-Saxon goddess of spring, to whom the fourth month, answering to our April—thence called *Eostur-monath*—was dedicated. This month, Bede informs us, was the same as the "Mensis Paschalis," when "the old festival was observed with the gladness of a new solemnity."

The name by which Easter is known among the Romance nations— French *pâques ;* Italian, *pasqua ;* Spanish, *pascua*—is derived through the Latin *pascha*, and the Greek *πάσχα*, from the Chaldee or Aramæan form, פַּסְחָא *pascha'*, of the Hebrew name of the Passover festival, פֶּסַח, *pesach*, from פָּסַח, "he passed over," in memory of the great deliverance when the destroying angel "passed over the houses of the children of Israel in Egypt when he smote the Egyptians," Exod. xii. 27. An erroneous derivation of *pascha* is given by some of the early fathers of the church, *e.g.*, Irenæus, Tertullian, &c., to whom Hebrew was an unknown tongue, from the Greek *πάσχειν*, "to suffer," as being the period of our Lord's sufferings. St Augustine (*in Joann. Tract.* 55) notices this false etymology, and shows how similarity of sound had led to the error, and gives the true derivation.

There is no trace of the celebration of Easter as a Christian festival in the New Testament or in the writings of the apostolic fathers. The sanctity of special times or places was an idea quite alien from the early Christian mind, too profoundly absorbed in the events themselves to think of their external accidents. "The whole of time is a festival unto Christians because of the excellency of the good things which have been given," writes Chrysostom, commenting on the passage 1 Cor. v. 7, which has been erroneously supposed to refer to an apostolic observance of Easter. Origen also in the same spirit (*Contr. Celsum*, viii. 22) urges that the Christian who dwells on the truths of Christ as our Passover and the gift of the Holy Ghost, is every day keeping an Easter and Pentecostal feast. The ecclesiastical historian Socrates (*Hist. Eccl.*, v. 22) states with perfect truth that neither Christ nor his apostles enjoined the keeping of this or any other festival. "The apostles," he writes, "had no thought of appointing festival days, but of promoting a life of blamelessness and piety;" and he attributes the introduction of the festival of Easter into the church to the perpetuation of an old usage, "just as many other customs have been established." This is doubtless the true statement of the case. The first Christians, being derived from, or intimately connected with, the Jewish Church, naturally continued to observe the Jewish festivals, though in a new spirit, as commemorations of events of which these had been the shadows. The Passover, ennobled by the thought of Christ the true Paschal Lamb, the first-fruits from the dead, continued to be celebrated, and became the Christian Easter. Thus the human instinct which everywhere craves for the commemoration of marked epochs in the personal, social, ecclesiastical, or national life, found its legitimate gratification in the public celebration of the events which are the foundation of the Christian faith.

But though the observance of the Paschal festival at a very early period became the rule in the Christian church, a difference as to the time of its observance speedily sprang up between Christians of Jewish and Gentile descent, which led to a long-continued and bitter controversy, and an unhappy severance of Christian union. No rule as to the date of the Easter festivals having been laid down by authority, Christians were left to follow their own instincts. These were naturally different in the Jewish and Gentile churches. The point at issue really was the date of the termination of the Paschal fast. With the Jewish Christians, whose leading thought would be the death of Christ as the true Paschal Lamb, this fast would end at the same time as that of the Jews, on the 14th day of the moon, at evening, and the Easter festival would immediately follow, entirely *irrespective of the day of the week.* With the Gentile Christians, on the other hand, unfettered by Jewish traditions, the first day of the week would be identified with the Resurrection festival, and the preceding Friday would be kept as the commemoration of the Crucifixion, *irrespective of the day of the month*, the fast continuing with increasing strictness till the midnight of Saturday. With the one, therefore, the observance of the day of the month, with the other the observance of the day of the week, was the ruling principle. The chief point was the "keeping" or "not keeping" the 14th day of the moon corresponding to that of the month Nisan. Those who, adopting the Jewish rule, did so keep the 14th day were called Τετραδεκάτιται, Τετράδιται, *Quartodecimani*, and were stigmatized as heretics. In the absence of any authoritative decision as to the day to be observed and the proper mode of calculating it, other discrepancies arose, which led to controversies and dissensions which, in the words of Epiphanius (*Panar.*, Hær. lxx.), distracted the church, and became a source of mockery and ridicule to the unbelievers. "Some," he writes, "began the festival before the week, some after the week, some at the beginning, some at the middle, some at the end, thus creating a wonderful and laborious confusion."

This diversity of usage was gradually brought to an end by the verdict of the Church of Rome. The Roman Christians adopted the ordinary Gentile usage, which, within certain limits, placed the observance of the Crucifixion on a Friday, and that of the Resurrection on the following Sunday. A decretal of Pope Pius I., c. 147—the genuineness of which, however, is by no means established—pronounces that "the Pasch should be celebrated on the Lord's Day by all." His successor Anicetus was equally firm upon the point. Polycarp, the venerable and sainted bishop of Smyrna, who, according to Irenæus (*apud* Euseb., *H. E.*, v. 24), visited Rome in 159 with this object, failed to induce Anicetus to conform to the Quartodeciman usage, which Polycarp had inherited from his master, the Apostle John. Anicetus declined to permit the Jewish custom in the churches under his jurisdiction, but made no scruple of communicating with those who adopted it, and allowed Polycarp to celebrate the Eucharist at Rome. Between thirty and forty years after this visit (197) the same question was controverted in a very different spirit between Victor, bishop of Rome, and Polycrates, bishop of Ephesus, the aged metropolitan of proconsular Asia. This province was the only portion of Christendom that still maintained the Quartodeciman usage, which had been dropt even by the churches of Palestine and Alexandria. Victor's despotic demand that the Asiatic churches should adopt the Roman system having been met by Polycrates with a courteous but firm refusal, Victor proceeded to excommunicate him and all who held with him. So sweeping a measure shocked the Christian world. Irenæus remonstrated with the bishop of Rome, and ultimately the Asiatic churches were allowed to retain their usage unmolested. (Euseb., *H. E.*, v. 23–25.) We still find the Quartodeciman usage springing up from time to time in various places, but it never took permanent root, and at the time of the Council of Nicæa (325) the Syrians and the Antiochenes were the solitary champions of the Jewish rule. The settlement of this controversy was one among the causes which led the emperor Constantine to summon that council. The consent of the assembled prelates was unanimous. All agreed that Easter should be kept on one and the same day throughout the world, and that none should hereafter follow the blindness of the Jews (Socr., *H. E.*, i. 9). Nothing, however, was said as to the determination of the day. This was practically left to be calculated at Alexandria, the home of astronomical science, and the bishop of that see was to announce it annually to the churches under his jurisdiction and to the bishop of Rome, by whom it was to be communicated to the Western churches.

But although measures had thus been apparently taken to secure uniformity of observance, some centuries elapsed before all discrepancy ceased. A more intricate question remained to be solved, viz., how the full moon on which Easter depended was to be predicted. The Nicene decrees had effectually crushed the feeble remnants of the Quartodeciman usage. It was established as a rule that Easter must be kept on a Sunday, but there was no general agreement as to the cycle by which the festival was to be calculated,—some churches adopting one rule, some another. We learn from St Ambrose (*Epist.* 23) that in 387 the churches of Gaul kept Easter on March 21, while the churches of Italy postponed it to April 18, and those of Egypt a week later still, to April 25; and it appears from an epistle of Leo the Great (*Epist.* 64 *ad Marcian.*) that in 455 there was eight days' difference between the Roman and Alexandrine Easter. Similar discrepancies are mentioned by Gregory of Tours in the year 577, nor did they disappear from the Gallican Church till the 8th century, although by a canon of the fourth Council of Orleans (541) it had been ordained that the Easter festival should be kept at the same time by all, according to the tables of Victorius. The ancient British Church observed the 84 years' cycle which they had originally received from Rome, and their stubborn refusal to give it up caused much bitter controversy between the fathers of Iona and the Latin missionaries. These latter unfairly attempted to fix the stigma of the Quartodeciman heresy on their opponents, and they are sometimes even now spoken of as adopting the Asiatic mode of calculation, and false inferences are thence drawn as to the Eastern origin of the British Church. This, however, is quite erroneous. The early British and Irish Church always commemorated the Crucifixion on a Friday and the Resurrection on a Sunday. The only difference between them and the Romish Church was in the cycle adopted for the computation of the festival,—the British Church really adhering to the cycle originally adopted by the Romish Church itself, which had been superseded by the more accurate calculations of Victorius of Aquitaine (457), and of Dionysius Exiguus (525). This led to a double Easter being observed by the adherents of the two churches. Thus, as we learn from Bede (*Eccl. Hist.*, iii. 25), in 651 Queen Eanfleda, adopting the Roman rule, was fasting and keeping Palm Sunday while her husband Oswy, king of Northumbria, was celebrating the Easter festival. This diversity of usage was put an end to in the kingdom of Northumbria in the council of Streaneshalch, or Whitby (654); and the Roman rule was finally established in England by Archbishop Theodore in 669. This rule may be thus briefly stated. Easter day is the first Sunday after the 14th day (not the full moon) of the calendar moon which happens on or next after March 21. This calendar moon, however, is not the moon of the heavens, nor the mean moon of the astronomers, but an imaginary moon created for ecclesiastical convenience in advance of the real moon (see Prof. De Morgan's article in *Companion to the Almanac*, 1845). After nine centuries a fresh discrepancy in the observance of Easter between the Roman and the English Church was caused by the refusal in England to adopt the Gregorian reformation of the calendar, 1582, apparently for no other reason than that the alteration had originated at Rome. This difference was happily put an end to in 1752, when the "New Style" was adopted in the United Kingdom. The churches of Russia and Greece, and the Oriental churches generally, still observe the unreformed calendar, their Easter falling sometimes before sometimes after that of the Western church; very rarely, as in 1865, the two coincide.

The rules on which the calculation of Easter is based are given in the article CALENDAR (vol. iv. p. 675).

Easter day, as commemorating the central fact of our religion, has always been regarded as the chief festival of the Christian year, and has been from the earliest times observed with a stately and elaborate ceremonial. It is not, however, the purpose of this article to enter on the ritual observances of Easter, nor on the many curious and interesting popular customs—of which the sending of Pasch eggs, or Easter eggs, is one of the most wide-spread—with which it is connected in all Christian nations. For these last the reader may consult Brand's *Popular Antiquities*, Hone's *Every Day Book*, and Chambers's *Book of Days.* (E. V.)

EASTLAKE, SIR CHARLES LOCK (1793–1865), an eminent painter who became president of the Royal Academy in London, was born on 17th November 1793 in Plymouth, where his father, a man of uncommon gifts but of indolent temperament, was solicitor to the Admiralty and judge advocate of the Admiralty Court. Charles was educated (like Sir Joshua Reynolds) at the Plympton grammar-school, and in London at the Charterhouse. Towards 1809, partly through the influence of his fellow-Devonian Haydon, of whom he became a pupil, he determined to be a painter; he also studied in the Royal Academy school. In 1813 he exhibited in the British Institution his first picture, a work of considerable size, Christ restoring life to the Daughter of Jairus. In 1814 he was commissioned to copy some of the paintings collected by Napoleon in the Louvre; he returned to England in 1815, and practised portrait-painting at Plymouth. Here he saw Napoleon a captive on the "Bellerophon;" from a boat he made some sketches of the emperor, and he afterwards painted, from these sketches and from memory, a life-sized full-length portrait of him, which was pronounced a good likeness; it belongs to the marquis of Lansdowne. In 1817 Eastlake went to Italy; in 1819 to Greece; in 1820 back to Italy, where he remained altogether fourteen years, sojourning chiefly in Rome and in Ferrara. Subjects of banditti and peasant-life engaged his pencil mostly from 1820 onwards. In 1827 he exhibited at the Royal Academy his picture of the Spartan Isidas—who (as narrated by Plutarch in the life of Agesilaus), rushing naked out of his bath, performed prodigies of valour against the Theban host. This was the first work that attracted much notice to the name of Eastlake, who in consequence obtained his election as A.R.A.; in 1830, when he returned to England, as R.A. In 1850 he succeeded Shee as P.R.A. (his only worthy competitor being Landseer, with the elder Pickersgill and George Jones besides, to mark the poor estate of British art, or of its official representatives), and, as usual, he was knighted. Prior to this, in 1841, he had been appointed secretary to the Royal Commission for decorating the Houses of Parliament, and he retained this post until the commission was dissolved in 1862. In 1843 he was made keeper of the National Gallery, a post which he resigned in 1847 in consequence of an unfortunate purchase that roused much animadversion; in 1855, director of the same institution, with more extended powers. During his directorship he purchased for the gallery 155 pictures, mostly of the Italian schools. He became also a D.C.L. of Oxford, F.R.S., Chevalier of the Legion of Honour, and member of various foreign academies. In 1849 he married Miss Elizabeth Rigby, a lady of some literary distinction. In 1865 he fell ill at Milan; he died at Pisa on 24th December in the same year, and lies buried at Kensal Green.

As a painter, Eastlake was gentle, harmonious, diligent, and correct; lacking fire of invention or of execution; eclectic, without being exactly imitative; influenced rather by a love of ideal grace and beauty than by any marked bent of individual power or vigorous originality. Among