

other strain of equal amount; and the principal type to which the last corresponds is that of a strain which is maintained by a less stress than any other strain of equal amount in the same body.

Prop. If a body be strained in the direction of which the concurrences with the principal strain-types are $l, m, n, \lambda, \mu, \nu$, and to an amount equal to r , the stress required to maintain it in this state will be equal to Ωr , where

$$\Omega = (A^2l^2 + B^2m^2 + C^2n^2 + F^2\lambda^2 + G^2\mu^2 + H^2\nu^2)^{\frac{1}{2}},$$

and will be of a type of which the concurrences with the principal types are respectively

$$\frac{Al}{\Omega}, \frac{Bm}{\Omega}, \frac{Cn}{\Omega}, \frac{F\lambda}{\Omega}, \frac{G\mu}{\Omega}, \frac{H\nu}{\Omega}.$$

Prop. A homogeneous elastic solid, crystalline or non-crystalline, subject to magnetic force or free from magnetic force, has neither any right-handed or left-handed, nor any dipolar, properties dependent on elastic forces simply proportional to strains.

Cor. The elastic forces concerned in the luminiferous vibrations of a solid or fluid medium possessing the right- or left-handed property, whether axial or rotatory, such as quartz crystal, or tartaric acid, or solution of sugar, either depend on the heterogeneity or on the magnitude of the strains experienced.

Hence as they do not depend on the magnitude of the strain, they do depend on its heterogeneity through the portion of a medium containing a wave.

Cor. There cannot possibly be any characteristic of elastic forces simply proportional to the strains in a homogeneous body, corresponding to certain peculiarities of crystalline form which have been observed,—for instance corresponding to the plagioclinal faces discovered by Sir John Herschel to indicate the optical character, whether right-handed or left-handed, in different specimens of quartz crystal, or corresponding to the distinguishing characteristics of the crystals of the right-handed and left-handed tartaric acids obtained by M. Pasteur from racemic acid, or corresponding to the dipolar characteristics of form said to have been discovered in electric crystals.

CHAPTER XVI.—Application of Conclusions to Natural Crystals.

It is easy to demonstrate that a body, homogeneous when regarded on a large scale, may be constructed to have twenty-one arbitrarily prescribed values for the coefficients in the expression for its potential energy in terms of any prescribed system of strain coordinates. This proposition was first enunciated in the paper on the Thermo-elastic Properties of Solids, published April 1855, in the Quarterly Mathematical Journal alluded to above. We may infer the following.

Prop. A solid may be constructed to have arbitrarily prescribed values for its six Principal Elasticities and an arbitrary orthogonal system of six strain-types, specified by fifteen independent elements, for its principal strains; for instance, five arbitrarily chosen systems of three rectangular axes, for the normal axes of five of the Principal Types; those of the sixth consequently in general distinct from all the others, and determinate; and the six times two ratios between the three stresses or strains of each type, also determinate. The fifteen equations expressing (Chap. VI.) the mutual orthogonality of the six types determine the twelve ratios for the six types, and the three quantities specifying the axes of the sixth type in the particular case here suggested; or generally the fifteen equations determine fifteen out of the thirty quantities (viz. twelve ratios and eighteen angular coordinates) specifying six Principal Types.

Cor. There is no reason for believing that natural crystals do not exist for which there are six unequal Principal Elasticities, and six distinct strain-types for which the three normal axes constitute six distinct sets of three principal rectangular axes of elasticity.

It is easy to give arbitrary illustrative examples regarding Principal Elasticities; also, to investigate the principal strain-types and the equations of elastic force referred to them or to other natural types, for a body possessing the kind of symmetry as to elastic forces that is possessed by a crystal of Iceland spar, or by a crystal of the "tesseral class," or of the included "cubical class." Such illustrations and developments, though proper for a student's text book of the subject, are unnecessary here.

For applications of the Mathematical Theory of Elasticity to the question of the earth's rigidity and elasticity as a whole, and to the equilibrium of elastic solids in general, which are beyond the scope of the present article, the reader is referred to Thomson and Tait's Natural Philosophy, §§ 588, 740, 832, 849, and Appendix C.

CHAPTER XVII.—Plane Waves in a Homogeneous Anisotropic Solid.

A plane wave in a homogeneous elastic solid is a motion in which every line of particles in a plane parallel to one fixed plane ex-

periences simply a motion of translation—but a motion differing from the motions of particles in planes parallel to the same. Let OX, OY, OZ be three fixed rectangular axes; OX perpendicular to the wave front (as any of the parallel planes of moving particles referred to in the definition is called), and OY, OZ in the wave front. Let $x+u, y+v, z+w$ be the coordinates at time t of a particle which, if the solid were free from strain, would be at (x, y, z) . The definition of wave motion amounts simply to this, that u, v, w are functions of x and t .

The strain of the solid (Chap. VII. above) is the resultant of a simple longitudinal strain in the direction OX, equal to $\frac{du}{dx}$, and

two differential slips $\frac{dv}{dx}, \frac{dw}{dx}$, parallel to OY and OZ, constituting simple distortions of which the numerical magnitudes (Chap. X.) are

$$\frac{dv}{dx}\sqrt{2}, \text{ and } \frac{dw}{dx}\sqrt{2}.$$

Put then

$$\frac{du}{dx} = \xi, \quad \frac{dv}{dx}\sqrt{2} = \eta, \quad \frac{dw}{dx}\sqrt{2} = \zeta \dots \dots (1),$$

and let W denote the work per unit of bulk required to produce the strain represented by this notation. We have (Chap. XV.)

$$W = \frac{1}{2}(A\xi^2 + B\eta^2 + C\zeta^2 + 2D\eta\xi + 2E\xi\zeta + 2F\xi\eta) \dots \dots (2),$$

where A, B, C, D, E, F denote moduli of elasticity of the solid. Let p, q, r denote the three components of the traction per unit area of the wave front. We have (Chap. XV.)

$$\left. \begin{aligned} p &= A\xi + F\eta + E\zeta \\ q &= \sqrt{2}(F\xi + B\eta + D\zeta) \\ r &= \sqrt{2}(E\xi + D\eta + C\zeta) \end{aligned} \right\} \dots \dots (3),$$

Now let ξ, η, ζ be taken such that

$$\left. \begin{aligned} A\xi + F\eta + E\zeta &= M\xi \\ F\xi + B\eta + D\zeta &= M\eta \\ E\xi + D\eta + C\zeta &= M\zeta \end{aligned} \right\} \dots \dots (4)$$

the determinantal cubic gives three real positive values for M, and with M equal to any one of these values, (4) determine the ratios $\xi : \eta : \zeta$. Hence when the solid is strained in any one of the three ways thus determined we have

$$p = M\frac{du}{dx}, \quad q = M\frac{dv}{dx}, \quad r = M\frac{dw}{dx} \dots \dots (5).$$

The three components of the whole force due to the tractions on the sides of an infinitely small parallelepiped $\delta x, \delta y, \delta z$ of the solid are clearly

$$\frac{dp}{dx}\delta x\delta y\delta z, \quad \frac{dq}{dx}\delta x\delta y\delta z, \quad \text{and } \frac{dr}{dx}\delta x\delta y\delta z \dots \dots (6),$$

and therefore, if ρ be its density, and consequently $\rho\delta x\delta y\delta z$ its mean, the equations of its motion are

$$\left. \begin{aligned} \rho\frac{d^2u}{dx^2} &= \frac{dp}{dx} \\ \rho\frac{d^2v}{dx^2} &= \frac{dq}{dx} \\ \rho\frac{d^2w}{dx^2} &= \frac{dr}{dx} \end{aligned} \right\} \dots \dots (7).$$

These, putting for p, q, r their values by (5), become

$$\left. \begin{aligned} \rho\frac{d^2u}{dx^2} &= M\frac{d^2u}{dx^2} \\ \rho\frac{d^2v}{dx^2} &= M\frac{d^2v}{dx^2} \\ \rho\frac{d^2w}{dx^2} &= M\frac{d^2w}{dx^2} \end{aligned} \right\} \dots \dots (8).$$

And by (4) and (1) we have

$$\left. \begin{aligned} Au + (Fv + Ew)\sqrt{2} &= Mu \\ Fu + (Bv + Dw)\sqrt{2} &= Mv \\ Eu + (Dv + Cw)\sqrt{2} &= Mw \end{aligned} \right\} \dots \dots (9).$$

Let M_1, M_2, M_3 be the three roots of the determinantal cubic, and $b_1, c_1; b_2, c_2; b_3, c_3$ the corresponding values of the ratios $\frac{v}{u}, \frac{w}{u}$ determined by (9). The complete solution of (8), subject to (9), is

$$\left. \begin{aligned} u &= u_1 + u_2 + u_3 \\ v &= b_1u_1 + b_2u_2 + b_3u_3 \\ w &= c_1u_1 + c_2u_2 + c_3u_3 \end{aligned} \right\} \dots \dots (10),$$

where

$f_1, F_1, f_2, F_2, f_3, F_3$ denoting arbitrary functions. Hence we conclude that there are three different wave-velocities,

$$\sqrt{\frac{M_1}{\rho}}, \sqrt{\frac{M_2}{\rho}}, \sqrt{\frac{M_3}{\rho}}$$

and three different modes of waves, determined by equations (9).

Waves in an Isotropic Solid.—If the solid be isotropic, we have

$$\left. \begin{aligned} B &= C \\ D &= E = F = 0 \\ M_1 &= A, \quad M_2 = M_3 = B \end{aligned} \right\} \dots \dots (11)$$

Hence, instead of three different waves with different velocities, we have just two,—a wave (like that of sound in air or other elastic fluid), in which the motions are perpendicular to the wave front, and the other (like the waves of light in an isotropic medium) in which the motions are parallel to the wave front.

Waves in an Incompressible Solid (Anisotropic or Isotropic).—If the solid be incompressible, we have $A = \infty$, and u must be zero. Hence

$$W = Bv^2 + Cw^2 + 2Dv\zeta$$

and by a determinantal quadratic, instead of cubic, we find two wave-velocities and two wave-modes, in each of which the motion is parallel to the wave front. In the case of isotropy the two wave velocities are equal.

It is to be noticed that M_1, M_2, M_3 in the preceding investigation are not generally true "principal moduli," but special moduli corresponding to the particular plane chosen for the wave front. In the particular case of isotropy, however, the equal moduli M_2, M_3 of (11) are principal moduli, being each equal to the modulus of rigidity, but M_1 is a mixed modulus of compressibility and rigidity—not a principal modulus. In the case of incompressibility, the two moduli found from the determinantal quadratic by the process indicated above are not principal moduli generally, because the distortions by the differential motions of planes of particles parallel to the wave front must generally give rise to tangential stresses orthogonal to them, which do not influence the wave motion. (W. TH.)

ELATERIUM, a drug consisting of a sediment deposited by the juice of the fruit of *Ecbalium Elaterium*, the squinting cucumber (see vol. vi. p. 688.) To prepare it, the fruit is sliced lengthwise and slightly pressed; the greenish and slightly turbid juice thus obtained is strained and set aside; and the deposit of elaterium formed after a few hours is collected on a linen filter, rapidly drained, and dried on porous tiles at a gentle heat. Elaterium is met with in commerce in light, thin, friable, flat or slightly incurved opaque cakes, of a greyish-green colour, bitter taste, and tea-like smell. The best kind is the English, prepared at Hitchin, Market Deeping, Mitcham, and elsewhere; the Maltese is generally very inferior. Elaterium is an exceedingly powerful hydragogue and drastic purgative, and not unfrequently produces vomiting. Its active principle is *elaterin*, a crystallizable body of the formula $C_{20}H_{28}O_8$.

ELBA, the *Albania* of the Greeks, and *Iva* of the Romans, is an island in the Mediterranean Sea, forming part of the Italian province of Livorno, and lying about 6 miles from the mainland of Italy, from which it is separated by the channel of Piombino, and about 34 miles E. of Corsica. It has a very irregular coast outline, is 18 miles long and 2½ to 10½ miles broad, and has a total area of nearly 90 square miles. It is throughout mountainous, and the highest point, Monte Capanne, is 2925 feet above sea-level. The western portion of the island is granitic, the eastern consists mainly of the sandstone locally known as *verrucano*, which in some places passes into a talc slate. In the vicinity of Porto Ferrajo the hills are cretaceous. The climate is mild, and, except at some spots on the coast, healthy. Springs are numerous, and the soil is not infertile; but agriculture and cattle-rearing are neglected, and there are no manufactures. Wine, wheat, aloes, dyer's lichen, and olives and other fruits are produced. The sardine and tunny fisheries, and the manufacture of sea-salt are of some importance; but the principal industry is mining. The iron mines are mostly in the vicinity of Rio Inferiore, and yield abundance of ore, chiefly hematite, of excellent quality. On account of the lack of fuel the ore is not smelted on the island, but is shipped direct to Follonica on the neighbouring coast of Italy, and to the ports of France and England. Marble, alabaster, sulphur, and ores of tin, lead, and silver are among the other mineral products. The principal places in Elba are the chief town Porto Ferrajo, with about 5000 inhabitants, the residence of Napoleon from May 4, 1814, to February 26, 1815, Rio Ferrajo, San Pietro, Porto Longone, and the village of Capoliveri. The population of the island in 1871 was 21,755.

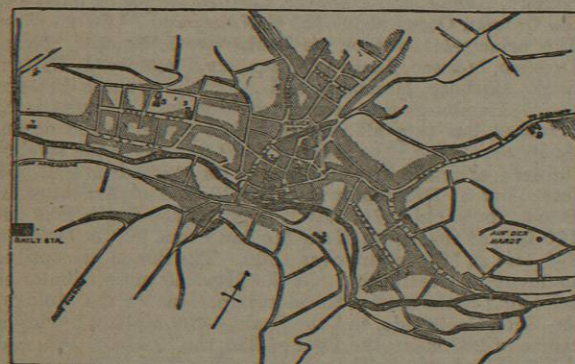
The Argonauts, in quest of Circe, are said to have landed at Portus Argous (*Αργαῖος λιμήν*), now Porto Ferrajo, in Elba. The island was early famous for the richness of its mines, alluded to by Virgil (*Æn.* x. 178). It was attacked by Phayllus with a Syracusan fleet, 453 B.C., and subsequently by Apelles, who is stated to have subjugated it. In the 10th century it became a possession of the Pisans, from whom it was taken by the Genoese in 1290. It fell

eventually into Spanish hands, came in 1736 under the jurisdiction of Naples, and in 1801 was ceded to the king of Etruria by the treaty of Lunéville. It was united to France in 1803, made over to Napoleon by the Treaty of Paris in 1814, restored to Tuscany in the following year, and in 1860 annexed to Italy.

ELBE, the Albis of the Romans and the Labe of the Bohemians, a large river of Germany, with a total length of 705 miles, and a drainage area of about 55,000 square miles. It rises in Bohemia not far from the frontiers of Silesia, on the southern side of the Riesengebirge or Giants' Mountains, in 50° 46' N. lat. and 15° 32' E. long. Of the numerous small streams (Seifen or Flessen, as they are named in the district) whose confluent waters compose the infant river, the most important are the Weisswasser, or White Water, and the Elbseifen; the former rises to the S.W. of the Schneekuppe in the White Meadow, and the latter in a stone fountain in the Elb Meadow. Augmented successively by the Adler, the Iser, the Moldau, and the Eger, it cuts its way through the Mittelgebirge of Bohemia, traverses the sandstone mountains of Saxony Switzerland, and with a general N.W. direction continues to meander through Saxony, Anhalt, and Hanover, until at length it falls into the German Ocean about 53° 5' N. lat. and 8° 50' E. long. The principal towns on its banks are Leitmeritz, Pirna, Dresden, Meissen, Torgau, Wittenberg, Magdeburg, Wittenberge, Harburg, Hamburg, and Altona. A short distance above Hamburg the stream divides into a number of branches, but they all reunite before reaching the ocean. At its source the Elbe is about 4600 feet above the level of the sea; after the first 40 miles of its course it is still 658 feet; but at Dresden it is only 279, and at Arneburg in Brandenburg only 176. At Königgratz the width is about 100 feet, at the mouth of the Moldau about 300, at Dresden 960, and at Magdeburg over 1000. The tide is perceptible as far up as Geesthacht. Of the fifty and more tributaries belonging to the system the most important are the Moldau, the Eger, the Mulde, and the Saale,—the Moldau having a course of 267 miles, the Eger of 235, the Mulde of 185, and the Saale of 220. Though the channel in some places, and especially in the estuary, is encumbered with sandbanks and shallows, the Elbe is of great importance as a means of communication, steamboats being able to ascend the main stream as far as Melnick, and to reach Prague by means of the Moldau. Some idea of the extent of its traffic may be obtained from the statement that in 1870 at Schandau 489 passenger-steamers and 2658 vessels and barges of various kinds passed up the stream, and 489 passenger steamers, 2865 ships, and 1505 rafts down the stream. By one line of canal it communicates with Lübeck, by another with Bremen, and by others with the great network of Mecklenburg and Brandenburg; and several new lines are projected, by which a direct way will be opened up to Hanover, Leipsic, and various other important cities.—For details see Dr Th. H. Schunke's "Die Schiffahrts-Kanäle im Deutschen Reiche," in *Fischer's Mittheil.*, 1877.

Formerly 3 entrepôts (Pirma, Dresden, and Magdeburg), 35 tolls, and numerous corporations of privileged watermen, opposed almost insurmountable obstacles to the navigation; the Austrians and the Saxons alone could navigate the Upper Elbe, that is, from Magdeburg to where it ceases to be navigable, and the Prussians and Hamburgers had the sole privilege of navigating the Lower Elbe. But new regulations were introduced by a convention concluded on the 13th June 1821 between all the bordering states, viz. Austria, Saxony, Prussia, Hanover, Denmark (for Holstein and Lauenburg), the grand duchy of Mecklenburg-Schwerin, and the three principalities of Anhalt. Every merchant, to whatever bordering state he might belong, was allowed with his own vessel and crew to navigate the whole course of the river without interruption; the 35 tolls were reduced to 14; the heavy dues which were levied upon goods of the first necessity were reduced to one for the cargo (*Elbe Toll*) and another for the ship (*Recognitionsgeld*); and each state was bound to watch over the portion of river which passed through their territories, and to preserve it from everything injurious to commerce or navigation. It was also arranged that a commission should meet from time to time for the revision of the tariff, &c., and the investigation of all matters connected with the utilization of the river. By the second of these commissions, which met at Dresden in 1842, an additional Navigation Act was published in 1844; in the third, at Magdeburg in 1850, it was proposed by Austria to remove the Elbe tolls altogether, but Hanover and some other states refused; in the fourth, at Hamburg, 1853, the same objections still carried the day; but in 1861 the fifth commission decided that only one common toll for all the riparian states should be left at Wittenberge; and after numerous difficulties, the federative council of the German empire succeeded in securing the complete freedom of the river in 1870. A compensation of 1,000,000 thalers was granted to Mecklenburg-Schwerin, and of 85,000 to Anhalt.

ELBERFELD, a manufacturing town of Rhenish Prussia in the government of Düsseldorf, situated in the narrow valley of the Wupper, about 19 miles E. of the town of Düsseldorf on the Berg and Mark railway. Though for the most part of modern erection, it has a large number of irregular and narrow streets, and altogether presents rather an unprepossessing appearance; the very river, polluted as it is with the refuse of dye-works and factories, rather



Plan of Elberfeld.

increasing the unseemliness. The newer quarters, however, must be excepted from this description, and many of the public buildings are large and handsome. Of these the most important are the town-house, in the modern Romanesque style, the provincial court, the exchange, the post office, the orphanage, the lunatic asylum, St Joseph's hospital, the infirmary, the Female Society's hospital, the railway company's offices, the gymnasium, and the technical school. The educational institutions include 27 popular schools where no fees are paid, and the whole system of relief for the poor is so well arranged that it has excited imitation in several towns in Germany. A great variety

of textile fabrics in cotton, wool, and silk are manufactured on an extensive scale; and besides dye-works and chemical works of proportionate importance, there may be mentioned button-factories, lace-factories, a brewery, a foundry, and soap-works. The town is the seat of a considerable number of industrial, philanthropic, intellectual, and religious institutions, among which the most noticeable are the public library, the museum, and the Berg Bible Society. The inhabitants are mainly Protestants, with a strong tendency towards pietism; but the Roman Catholics number upwards of 14,000, and the Jewish community has recently erected a new synagogue. The *Elberfelder Zeitung* and several other newspapers are published in the town. In 1840 the population was 31,514; in 1864, 63,300; and in 1875, 80,599.

The site of Elberfeld was marked in the 12th century by a castle belonging to the lords of Elverfeld, which was afterwards united with the Berg possessions, and held by the family of Nesselrode; but it was not till the 16th century that the nucleus of the present industrial development was formed by the establishment on the banks of the Wupper of a number of bleachers, who obtained a monopoly in 1532. Municipal rights were granted in 1610, a great increase of the manufactures effected in the beginning of the 18th century, silk-weaving introduced in 1760, and the dyeing of Turkey red commenced in 1780.

See Coustelle, *Elberfeld, topographisch-statistische Darstellung*, Elberfeld, 1853; Langewiesche, *Elberfeld und Barmen*, Barmen, 1862.

ELBEUF, a town of France in the department of Seine Inférieure, 13 miles S. of Rouen, on the left bank of the Seine, with a station on the railway between Oissel and Serquigny. It has three parish churches, a Protestant place of worship, a town-house with a natural history museum, a public library, a hospital, an industrial society, an archaeological society, and a chamber of arts and sciences. The churches of St Étienne and St Jean are both of some antiquity, and preserve stained glass of the 15th and 16th centuries. The town is one of the principal seats of the woollen manufacture in France: more than half of the inhabitants are directly maintained by the staple industry, and numbers more by the auxiliary crafts. As a river-port it has a brisk trade in the produce of the surrounding district as well as in the raw materials of its manufactures. A suspension bridge communicates with St Aubin, and steam-boats ply regularly to Rouen. The population, which was only about 4600 in the end of last century, amounted in 1831 to 10,258, and in 1872 to 22,563. If the quasi-suburban towns of Caudebec-lès-Elbeuf, Saint-Pierre-lès-Elbeuf, and St Aubin-jouxte-Boulleng be included, this great industrial congeries will comprise upwards of 39,000 inhabitants.

Elbeuf is an old town, and the site was probably occupied during the Roman period. In the 14th century it was made a countship, and in 1554 it passed by marriage to Duke René of Lorraine. By King Henry III. it was raised to the rank of a duchy in favour of Charles, grandson of Claude of Lorraine, but the dukes of Elbeuf made no figure in history, and in 1763 the title passed to the house of Harcourt. The town and its industries were greatly patronized by Colbert; but the revocation of the Edict of Nantes soon after neutralized the beneficial effects of his regulations, and it was not till 1814 that the removal of Belgian competition gave the new impetus which is still at work. In that year there were 80 factories producing goods to the value of 25 millions of francs; in 1840 the factories numbered 200, and the value of the goods amounted to 40 or 45 millions.

ELBING, a seaport town of Prussia, at the head of a circle in the government of Dantzig, 36 miles E.S.E. of the city of that name, on the Elbing, a small river which flows into the Frische Haff about four miles from the town, and is united with the Nogat or eastern arm of the Vistula by means of the Kraffohl canal. The old town was formerly surrounded by fortifications, but of these only a few fragments remain. There are seven Evangelical, one Roman Catholic, and two Mennonite churches, a synagogue, a gymnasium founded in 1536, with a public library of

22,000 volumes, an orphan-asylum, several hospitals, and numerous charitable institutions. Of these last a number owe their existence to the bequests of an Englishman, Richard Cowle, who settled in the town in 1810 and died at Dantzig in 1821. The manufacturing industry is extensive and varied, producing, among the rest, iron goods, iron ships, and machinery, sail-cloth, woollen cloth, leather, paper, tobacco, starch, vitriol, and vinegar; and the transit trade has received a considerable increase by the opening of the Overland canal (1846-1861).

The existence of Elbing is due to a colony of Lübeck traders who settled under the protection of the castle of the Teutonic Knights in 1237. Invested with the Lübeck rights, and afterwards admitted into the Hanseatic confederation, the settlement was highly prosperous, and in 1335 greatly extended its limits by laying out a New Town. In 1434 it paid allegiance to Poland, and in 1454 was made the seat of a waiwode; but in 1525 it was captured by Albert of Brandenburg, Grand Master of the Teutonic Order. After various vicissitudes, it came at last to Prussia in 1772—decadent and declining; and its present prosperity is of quite recent date. Population in 1875, 33,572.

ELCHE, a town of Spain, in the province of Alicante, six miles from the sea, on the river Vinalapo. It has three churches, as many monastic buildings, a hospital, barracks, and an old episcopal palace; but there is nothing of architectural interest except perhaps the portico of Santa Maria. The costume and physiognomy of the inhabitants, the narrow streets and flat-roofed white-washed houses, and more than all the thousands of palm-trees in its gardens and fields, give the place a strikingly Oriental aspect, and render it unique among the cities of Spain. The cultivation of the palm is indeed the principal occupation; and though the dates are inferior to those of Barbary, the annual value of the crop is about £14,000. The blanched fronds are also sold in large quantities for the processions of Palm-Sunday; and after they have received the blessing of the priest, they are regarded throughout Spain as certain defences against lightning.

Elche is identified with the ancient Illici or Illici of the Contestani, which under the Romans obtained the rank of a colony with the *ius Italicum*. In 1332 it was attacked by the Moors of Granada, who discharged against it "iron balls through fire." Population 18,734.

ELDAD BEN MALCHI, also surnamed Ha-Dani, Abu-Dani, Daud-Ha-Dani, or the Danite, a Jewish traveller of the 9th century of the Christian era, chiefly interesting on account of the light (or darkness) which his writings throw on the question of the Lost Tribes. The date and place of his birth are not accurately known; but he was a native either of South Arabia or of Media. About 860 he set out with a companion to visit his Jewish brethren in Africa and Asia. Their vessel was wrecked, and they fell into the hands of cannibals; but Eldad was saved from the inhuman fate of his comrade, first by his leanness and afterwards by the opportune invasion of a neighbouring tribe. He spent four years with his new captors, was ransomed by a fellow-countryman, continued his journey as far, according to one interpretation of his story, as Chlma, spent several years at Kairwan in Tunis, and died on a visit to Cordova in Spain. The work which goes under his name is written in Hebrew, and consists of six chapters, probably abbreviated from the original form of the narrative. It was first printed at Constantinople in 1518; and the same recension afterwards appeared at Venice in 1540 and 1605, and at Jessnitz in 1722. A Latin version by Genebrard was published at Paris in 1563, under the title of *Eldad Danius de Judæis clausis eorumque in Æthiopia imperio*, and was afterwards incorporated in the translator's *Chronographia Hebræorum*; a German version appeared at Prague in 1695, and another at Jessnitz in 1723. In 1838 M. Carmoly edited and translated a fuller recension which he had found in a MS. from the library of Eliezer Ben Hasan, forwarded to him

by Daud Zabach of Morocco. Both forms are printed by Dr Jelinek in his *Beth-Ha-Midrash*, vols. ii. and iii., Leipsic, 1853-55. One of the most curious passages in the work is the account of the Levites, who, says the author, were miraculously guided to the land of Havila, and are there protected from their enemies by the mystic river Sabbath, which on the Sabbath is calm and involved in delusive mists, and on the other days of the week runs with a fierce and fordless current.

See Bartolucci, *Bibliotheca Magna Rabbinnica*, vol. i.; Fürst, *Bibliotheca Judaica*; Graetz, *Geschichte der Juden*, vol. v.; Rossi, *Dizionario degli Ebrei*; and Kitto's *Biblical Cyclopædia*, 3d edition, *sub nomine*.

ELDER, the name of an office both in the Jewish and in the Christian church, which is used in modern times only by Presbyterians. As first applied, among the ancient Jews, for example, it had no doubt a literal fitness, indicating the responsibility and authority that naturally accrue in any community to those advanced in age. As the office gradually came to be fixed in its character and limited in the number of its occupants, the name lost something of its literal fitness, the responsibility and authority becoming attached to it without regard to the age of the occupant. In this respect the kindred terms alderman, senator, &c., have had a similar history. In the Old Testament usage of the word it is impossible to fix any exact point of time at which it passed from its primary or etymological to its secondary or official sense, as the process was a gradual one, and old age continued to be a leading qualification for the office long after it had ceased to be essential. In Exodus iii. 16 elders are mentioned as a recognized official body among the Israelites, and in subsequent notices (Ex. xix. 7; Ex. xxiv. 1; Deut. xxxi. 9) they appear as the representatives of the whole body of the people. In Numbers xi. 16, 17, seventy elders, to be chosen out of the entire body, were set apart "to bear the burden of the people" along with Moses. It is unnecessary to enter here into any discussion of the moot question of the connection of this Mosaic council of seventy with large though undefined legislative and executive powers with the Sanhedrim as it existed at the time of Christ. From the time of the institution of the Mosaic council the elders are mentioned at each successive stage of Jewish history. After the settlement in Canaan they acted as the administrators of the laws in every city (Deut. xix. 11-12; xxi. 3-9, 19; xxii. 15-21); and references to them are frequent during the period of the judges and the kings, during the captivity, and after the restoration. In the New Testament the word is used to denote both an order of the Jewish economy and an office of the Christian church. Its precise significance in the latter usage is the main subject in the standing controversy between Episcopalians and Presbyterians, and a statement of the arguments on either side belongs properly to the articles on Episcopacy and Presbytery respectively. Reference must also be made to the article on Presbytery for a full statement of the qualifications, duties, and powers of elders in a presbyterian church. It may be noted here that while the New Testament word *presbyteros* denotes, according to the admission of the adherents of all forms of church government, those especially set apart to the pastoral office, whatever else it may be held to include, its English equivalent *elder* is used as an official designation only in the presbyterian church. According to the presbyterian theory of church government there are two classes of elders, *teaching* elders, or those set apart specially to the pastoral office, and *ruling* elders, who are laymen, chosen generally by the congregation, and set apart by ordination to be associated with the pastor in the oversight and government of the church. When the word is used without any qualification, it is understood to apply to the latter class alone.

ELDER (Ang.-Sax. *ellarn*; Ger. *Holunder*; Fr. *sureau*), the popular designation of the deciduous shrubs and trees constituting the genus *Sambucus* of the natural order *Caprifoliaceae*. The Black-berried or Common Elder, *S. nigra*, the bourtree of Scotland, is found in Europe, the north of Africa, Western Asia, the Caucasus, and Southern Siberia; in sheltered spots it attains a height of over 20 feet. The bark is smooth; the shoots are stout and angular, and the leaves glabrous, pinnate, and generally oval or elliptical. The flowers, which form corymbose cymes, with five main branches, have a cream-coloured, gamopetalous, five-lobed corolla, five stamens, and three sessile stigmas; the berries are purplish-black, globular, and three- or four-seeded, and ripen about September. The elder thrives best in moist, well-drained situations, but can be grown in a great diversity of soils. It is propagated by young shoots, which after a year are fit for transplantation. It is found useful for making screen-fences in bleak, exposed situations, and also as a shelter for other shrubs in the outskirts of plantations. By clipping two or three times a year, it may be made close and compact in growth. The young trees furnish a brittle wood, containing much pith; the wood of old trees is white, hard, and close-grained, and polishes well, and is employed for shoemakers' pegs, combs, skewers, mathematical instruments, and turned articles. Young elder twigs deprived of pith have from very early times been in request for making whistles, popguns, and other toys.

The elder was known to the ancients for its medicinal properties, and in England the inner bark was formerly administered as a cathartic. The flowers (*sambuci flores*) contain a volatile oil, and are reputed to be diaphoretic in properties; they serve for the preparation of an ointment (*unguentum sambuci*), and for the distillation of elder-flower water (*aqua sambuci*), used in confectionery, perfumes, and lotions. The leaves of the elder are employed to impart a green colour to fat and oil (*unguentum sambuci foliorum* and *oleum viride*), and the berries for making wine, a common adulterant of port. The leaves and bark emit a sickly odour, believed to be repugnant to insects. Christopher Gullet (*Phil. Trans.*, 1772, lxii. p. 343) recommends that cabbages, turnips, wheat, and fruit trees, to preserve them from caterpillars, flies, and blight, should be whipped with twigs of young elder. According to German folk-lore, the hat must be doffed in the presence of the elder-tree; and in certain of the English midland counties a belief was once prevalent that the cross of Christ was made from its wood, which should therefore never be used as fuel, or treated with disrespect (see *Quart. Rev.*, cxiv. 233). It was, however, a common mediæval tradition, alluded to by Ben Jonson, Shakespeare, and other writers, that the elder was the tree on which Judas hanged himself; and on this account, probably, to be crowned with elder was in olden times accounted a disgrace. In *Cymbeline* (act iv. s. 2) "the stinking elder" is mentioned as a symbol of grief. In Denmark the tree is supposed by the superstitious to be under the protection of the "Elder-mother": its flowers may not be gathered without her leave; its wood must not be employed for any household furniture; and a child sleeping in an elder-wood cradle would certainly be strangled by the Elder-mother.

S. nigra virescens is a variety of *S. nigra* having white bark and green-coloured berries; some ornamental varieties have blotched leaves. The Scarlet-berried Elder, *S. racemosa*, is the handsomest species of its genus. It is a native of various parts of Europe, growing in Britain to a height of over 15 feet, but often producing no fruit. The Dwarf Elder or Danewort, *S. Ebulus*, a common European species, reaches a height of about 6 feet. Its cyme is hairy, has three principal branches, and is smaller than that of *S. nigra*; the flowers are of a dull purplish hue. All parts of the plant are cathartic and emetic.

ELDON, JOHN SCOTT, BARON, and afterwards **EARL OF** (1751-1838), lord high chancellor of England, was born at Newcastle on the 4th June 1751. His grandfather, William Scott, of Sandgate, a suburb of Newcastle, was clerk to a "fitter"—a sort of water-carrier and broker of coals. His father, whose name also was William, began life as an apprentice to a fitter, in which service he obtained the freedom of Newcastle, becoming a member of the guild of Hoastmen; later in life he became a principal in the business, and attained a respectable position as a merchant in

Newcastle, accumulating property worth nearly £20,000. He was twice married; his second wife, the mother of John Scott, says Lord Campbell (*Lord Chancellors*, vol. vii. p. 4), "was a woman of such superior understanding, that to her is traced the extraordinary talent which distinguished her two sons, William and John—Lord Stowell and Lord Eldon." It may be mentioned that William and John had each of them a twin sister.

The boys were educated at the grammar school of their native town, where, however, they scarcely gave promise of the splendid careers which they were destined to run. John Scott was not remarkable at school for application to his studies, though his wonderful memory enabled him to make good progress in them; he frequently played truant, and was whipped for it, robbed orchards, and indulged in other questionable school-boy freaks; nor did he always come out of his scrapes with honour and a character for truthfulness. When John had finished his education at the grammar school, his father thought of apprenticing him to his own business, to which an elder brother Henry had already devoted himself; and it was only through the interference of William, who had already obtained a fellowship at University College, Oxford, that it was ultimately resolved that he should continue the prosecution of his studies. Accordingly, on the 15th May 1766, John Scott entered University College as a commoner, with the view of entering the church, and obtaining a college living. In the year following he obtained a fellowship, graduated B.A. in 1770, and in 1771 won the prize for the English essay, the only university prize open in his time for general competition. It does not appear, however, that he distinguished himself at college any more than he had done at school by any severe application to study. It was not till after his marriage that he first concentrated his energies on the congenial study of law.

His wife was the eldest daughter of Mr Aubone Surtees, a Newcastle banker. John Scott first met her at Sedgfield Church, in the county of Durham, and a strong attachment sprang up between them. The Surtees family objected to the match, and attempted to prevent it; but the fire once kindled was not to be put out. On the 18th November 1772, Scott, with the aid of a ladder and an old friend, carried off the lady from her father's house in the Sandhill, across the border to Blackhills, in Scotland, where they were married. The father of the bridegroom objected not to his son's choice, but to the time he chose to marry; for it was a blight on his son's prospects, depriving him of his fellowship and his chance of church preferment. But while the bride's family refused to hold intercourse with the pair, Mr Scott, like a prudent man and an affectionate father, set himself to make the best of a bad matter, and received them kindly, settling on his son £2000. John returned with his wife to Oxford, and continued to hold his fellowship for what is called the year of grace given after marriage, and added to his income by acting as a private tutor. After a time Mr Surtees was reconciled with his daughter, and made a liberal settlement on her. John Scott's year of grace closed without any college living falling vacant; and with his fellowship he gave up the church, and turned to the study of law. He became a student at the Middle Temple in January 1773, and in February took his degree of M.A. at Oxford. In 1776 he was called to the bar, intending at first to establish himself as an advocate in his native town, a scheme which his early success led him to abandon, and he soon settled to the practice of his profession in London, and on the Northern Circuit. Thus, at last, had he started on the high road to the chancellorship, having narrowly escaped becoming a coal-fitter, a country parson, a provincial barrister, and, according to one account, a retailer of figs and raisins.

In the autumn of the year in which he was called to the bar his father died, leaving him a legacy of £1000 over and above the £2000 previously settled on him. He was already an excellent lawyer, and succeeded fairly well on his first circuit, though not so well as to satisfy him of the safety of attempting a London career. He therefore took a house in Newcastle, with the view of establishing himself there, but still delayed to leave London; and his prospects there suddenly improving, he assigned the Newcastle house to his brother Henry. In his second year at the bar his prospects began to brighten. His brother William, who by this time held the Camden professorship of ancient history, and enjoyed an extensive acquaintance with men of eminence in London, was in a position materially to advance his interests. Among his friends was the notorious Bowes of Gibside, to the patronage of whose house the rise of the Scott family was largely owing. Bowes having contested Newcastle and lost it, presented an election petition against the return of his opponent. Young Scott was retained as junior counsel in the case, and though he lost the petition he did not fail to improve the opportunity which it afforded for displaying his talents. This engagement, in the commencement of his second year at the bar, and the dropping in of occasional fees, must have raised his hopes; and he now abandoned the scheme of becoming a provincial barrister. A year or two of dull drudgery and few fees followed, and he began to be much depressed. But in 1780 we find his prospects suddenly improved, by his appearance in the case of Ackroyd v. Smithson, which became a leading case settling a rule of law; and young Scott, having lost his point in the inferior court, insisted on arguing it, on appeal, against the opinion of his clients, and carried it before Lord Thurlow, whose favourable consideration he won by his able argument. The same year Bowes again retained him in an election petition; and in the year following Scott greatly increased his reputation by his appearance as leading counsel in the Clitheroe election petition. From this time his success was certain. In two years he obtained a silk gown, and was so far cured of his early modesty that he declined accepting the king's counselship if precedence over him were given to his junior, Mr Erskine, though the latter was the son of a peer and a most accomplished orator. He was now on the high way to fortune. His health, which had hitherto been but indifferent, strengthened with the demands made upon it; his talents, his power of endurance, and his ambition all expanded together. He enjoyed a considerable practice in the northern part of his circuit, before parliamentary committees, and at the Chancery bar, and was in sight of the honours and emoluments of the solicitor and attorney generalships. By 1787 his practice at the Equity bar had so far increased that he was obliged to give up the eastern half of his circuit (which embraced six counties), and attend it only at Lancaster.

Shortly after taking the silk gown, he entered Parliament for Lord Weymouth's close borough of Weobley, which Lord Thurlow obtained for him without solicitation. In Parliament he gave a general and independent support to Pitt. His first parliamentary speeches were directed against Fox's India Bill. They were unsuccessful. In one he aimed at being brilliant; and becoming merely laboured and pedantic, he was covered with ridicule by Sheridan, from whom he received a lesson which he did not fail to turn to account. In 1788 Pitt conferred upon him the honour of knighthood and the office of solicitor-general; and at the close of this year he attracted attention by his speeches in support of Pitt's resolutions on the state of the king (George III., who then laboured under a mental malady) and the delegation of his authority. It is said that he drew the Regency Bill, which was introduced

in 1789. In 1793 Sir John Scott was promoted to the office of attorney-general, in which it fell to him to conduct the memorable prosecutions for high treason against British sympathizers with French republicanism,—amongst others, against the celebrated Horne Tooke. These prosecutions, in most cases, were no doubt instigated by Sir John Scott, and were the most important proceedings in which he was ever professionally engaged. He has left on record, in his *Anecdote Book*, a defence of his conduct in regard to them. A full account of the principal trials, and of the various legislative measures for repressing the expressions of popular opinion for which he was more or less responsible, will be found in Twiss's *Public and Private Life of the Lord Chancellor Eldon*, and in the *Lives of the Lord Chancellors*, by Lord Campbell. In 1799 the office of chief-justice of the Court of Common Pleas falling vacant, Sir John Scott's claim to it was not overlooked; and after seventeen years' service in the Lower House, he entered the House of Peers as Baron Eldon. In February 1801, the ministry of Pitt was succeeded by that of Addington, and the chief-justice now ascended the woolsack. The chancellorship was given to him professedly on account of his notorious anti-Catholic zeal. From the Peace of Amiens (1801) till 1804, Lord Eldon appears to have interfered little in politics. In the latter year we find him conducting the negotiations which resulted in the dismissal of Addington and the recall of Pitt to office as prime minister. Lord Eldon was continued in office as chancellor under Pitt; but the new administration was of short duration, for on the 23d of January 1806 Pitt died, worn out with the anxieties of office, and his ministry was succeeded by a coalition, under Lord Grenville. The death of Fox, who became foreign secretary and leader of the House of Commons, soon, however, broke up the Grenville administration; and in the spring of 1807, Lord Eldon once more, under Lord Liverpool's administration, returned to the woolsack, which, from that time, he continued to occupy for about twenty years, swaying the Cabinet, and being in all but name prime minister of England. It was not till April 1827, when the premier-ship, vacant through the paralysis of Lord Liverpool, fell to Mr Canning, the chief advocate of Roman Catholic emancipation, that Lord Eldon, in the seventy-sixth year of his age, finally resigned the chancellorship. When, after the two short administrations of Canning and Goderich, it fell to the duke of Wellington to construct a Cabinet, Lord Eldon expected to be included, if not as chancellor, at least in some important office, but he was overlooked, at which he was much chagrined. Notwithstanding his frequent protests that he did not covet power, but longed for retirement, we find him again, so late as 1835, within three years of his death, in hopes of office under Peel. He spoke in Parliament for the last time in July 1834.

In 1821 Lord Eldon had been created earl by George IV., whom he managed to conciliate, partly, no doubt, by espousing his cause against his wife, whose advocate he had formerly been, and partly through his reputation for zeal against the Roman Catholics. In the same year, his brother William, who from 1798 had filled the office of judge of the High Court of Admiralty, was raised to the peerage under the title of Lord Stowell.

Lord Eldon's wife, his dear "Bessy," his love for whom is a beautiful feature in his life, died before him, on the 28th June 1831. By nature she was of simple character, and by habits acquired during the early portion of her husband's career almost a recluse. Two of their sons reached maturity,—John, who died in 1805, and William Henry John, who died unmarried in 1832. Lord Eldon himself survived almost all his immediate relations. His brother William died in 1836. He him-