have become geographical); and, as mentioned above, there are a few scattered species, representing the South African flora, in extra-tropical South America. There are, however, two offshoots in a northern direction. The remarkable West European flora, already referred to, possesses species of *Erica*, shrubby *Leguminosæ*, *Lobelia*, *Gladiolus*, &c., "more nearly added to corresponding Cape species than they are to each other." The other extension is to Eastern Africa. The sub-alpine vegetation of Kilima Njaro is distinctly South African, and Hooker suggests "the probability of the South African flora being represented all along the highlands of Eastern Africa, from Natal to Abyssinia; and further, seeing that most of the South African plants found in the Cameroons are also natives of Abyssinia, it would appear probable that the migration of these to the Cameroons was by and through Abyssinia."[1] The further suggestion that this may have been the path travelled by the West European extension of the South African flora is sufficiently obvious.

The amount of agreement amongst these scattered fragments of a great flora points necessarily to a state of things when the lands they now occupy were at one time or other in more or less of intimate connection. The amount of differentiation between the floras, and the fact that agreement has to be sought in groups of high rather than of small rank, points equally to the fact that such connections must have been far from recent.[2] The detailed study of separate groups leads by another path to the same result, and, as a good instance of the new phase into which taxonomic botany is entering in the light of the study of geographical distribution, reference may be particularly made to Bentham's important investigation into the vast history and migrations of the *Campanulaceæ*.[3]

III. THE TROPICAL FLORA.—This is still perhaps too imperfectly known to admit of any very plausible generalization. It obviously presents three great subdivisions.

1. The *Indo-Malayan* extends from the Himalayas to north-east Australia and Japan. In the latter country it meets the northern temperate flora, from which in India it is sharply divided by the Himalayas.

2. The *American* is still a perfect mine of unexplored botanical wealth. Bentham remarks—"No general comparison of Asiatic and American tropical vegetation can therefore be made without immense labour of detail. As far as we know, however, the resemblance between them is only in some of the races of a higher grade, natural orders and comprehensive genera; the smaller genera and species, and many even of the higher ones, are totally different; or if a few species are identical, they are generally, if woody or arborescent such as *Entada*, *Gyrocarpus*, &c., wholly or partially maritime, and may have traversed the ocean during its present configuration, or if herbaceous widely, spread weeds still more likely to be spread all round the tropics under existing conditions."[4] There are, however, some extraordinary points of connection between the tropical floras of the Old and New Worlds, to which there is at present scarcely any clue. Thus *Ternstrœmia emarginata*, endemic to Ceylon, so closely resembles the Brazilian *Ternstrœmia cuneifolia* as to be barely distinguishable.

3. The *African* tropical flora is probably the most imperfectly known of any. Bentham considers it as of great antiquity, and as having preserved large numbers of persistent types from which races "have widely diverged in Asia or America, or in both." He further remarks that "as our knowledge of the vegetation of tropical Africa has increased, we have discovered a greater number of Asiatic types; but still there are, even in the interior, a certain number of American ones, offering a problem the solution of which has scarcely been attempted."[5]

In *Compositæ* American genera are represented in east tropical Africa, and Bentham is led on various grounds to regard this as the principal area of preservation of the most ancient tropical flora of the Old World.[6] A well-marked eastern element in the African tropical flora is generally accepted. Madagascar, whose flora bears the marks of long isolation, contains Malayan and even Australian types; and it is a problem worth future inquiry whether the connection between the floras of tropical America and Africa may not have taken place south of the tropics, and by similar (though more northern) paths to those which once united the scattered members of the great Southern flora.

As might have been expected, during the Tertiary period the tropical flora extended much beyond its present limits. De Saporta, who has studied with great caution the fossil flora of the gypseous beds (Eocene) of Aix in Provence, arrives at the following conclusions:[7]—The principal families were such as characterize tropical vegetation, especially Indian—*Ebenaceæ*, *Anacardiaceæ*, *Sapindaceæ*, *Sterculiaceæ*, *Leguminosæ*. The affinities of the ancient vegetation of Aix in respect of generic types, general facies, and composition with that of India and the Indian archipelago, China, the Philippines, and Japan at the present day, are in perfect accordance with the theory that these regions formed the shores of our ancient nummulitic sea, extending from Morocco to Japan, and entirely comprised in the tropical zone of the Eocene world, which extended to the 55th parallel. Besides its relation to South-Eastern Asia, the Aix flora exhibits, according to De Saporta, a strong affinity with that of Africa, lying between Abyssinia and the Cape, of which, however, it must be confessed, but little is as yet known.

Here this outline of the present state of a most important and rapidly developing branch of biological science must be concluded. The writer has availed himself very freely of the kind permission of Mr Bentham—perhaps the greatest living master of the subject—to make use of his scattered but invaluable papers, not scrupling to borrow from them all that seemed most important and suggestive, but has generally thought it fairer both to the subject and to Mr Bentham to do so in his own words. For two heads of the subject it must suffice merely to give references. On the remarkable phenomena of insular floras, the reader should consult Sir Joseph Hooker's well-known lecture delivered before the British Association in 1866, and printed in the *Gardener's Chronicle* for January 1867, or, in default of this, the summary given in Lyell's *Principles of Geology*, 10th ed., vol. ii. pp. 417–421. On the means of dispersion of plants, reference may also be made to Lyell's work already quoted, vol. ii. pp. 386–400; Darwin's *Origin of Species*, 4th ed., pp. 425–442; Bentham, Presidential Address, 1869, pp. 7, 8. (W. T. T. D.)

[1] *Cf.* also Darwin, *Origin of Species*, 4th ed. p. 474.
[2] *Journ. Linn. Soc. Bot.*, xiv. p. 145.
[3] *Journ. Linn. Soc. Bot.*, xv. p. 11. Presidential address, 1869, p. 24.
[4] *Journ. Linn. Soc. Bot.*, xiii. 545.
[5] Bentham, *l. c.* p. 24.
[6] *Annales des Sciences Naturelles*, Sept. 1, 1872.

DITHMARSCHEN, or DITMARSH, in the oldest form of the name *Thiatmaresgaho*, Dietmar's Gau, a territory between the Eider and the Elbe, forming the western part of the old duchy of Holstein, and now included in the Prussian province of Schleswig-Holstein. It was originally colonized mainly from Friesland and Saxony,—the Frisian kindred of the Vogdemans settling on the coast and giving rise to the two marks of Norderstrand and Süderstrand, and the Saxon kindred of the Woldersmen settling inland and forming the two marks of Norderhamme and Süderhamme. The district was subjugated and Christianized by Charlemagne in 804, and ranked as a separate *Gau*, included perhaps in the countship of Strade, or *Comitatus utriusque ripæ*. From the same century, according to one opinion, or from the year 1180, when the countship was incorporated with their see, according to another, the archbishops of Bremen claimed supremacy over the land; but the inhabitants, who had developed and consolidated a systematic organism for self-government, made obstinate resistance, and rather attached themselves to the bishop of Schleswig. The Danish king Björn Svendsön succeeded in defeating them; and Ditmarsken, to use the Scandinavian form of the name, continued part of the Danish dominions till the disastrous battle of Bornhöved in 1227, when its former independence was regained. The claims of the archbishop of Bremen were now so far recognized that he exercised the royal rights of *Heerbann* and *Blutbann*,[1] enjoyed the consequent emoluments, and was represented first by a single *advocatus*, or *vogt*, and afterwards by one for each of the five Döffts, or marks, into which the land was divided after the establishment of Meldorp. The community was governed by a landrath of forty-eight elective consuls, or twelve from each of the four marks; and even in the 14th century the power of the episcopal vogts was so slight that a chronicler of that date, quoted by Maurer, says, *De Ditmarschen leven sunder Heren und Hovedt unde dohn wadt se willen*, "the Ditmarschen live without lord and head, and do what they will." In 1319 and in 1404 they succeeded in defeating the invasions of the Holstein nobles; and though in 1474 the land was nominally incorporated with the duchy by the emperor Frederick III., the attempt of the Danish king Hans and the duke of Gottorp to enforce the decree in 1500 resulted only in their complete rout in the marshes of the Dussend-Düwels-Warf. During the early part of the century which began with such prestige for Ditmarsh, it was the scene of violent internal conflict in regard to the religious questions of the time; and, thus weakened, it was obliged in 1559 to submit to partition among its three conquerors—King Frederick II. of Denmark and Dukes John and Adolphus. A new division took place on Duke John's death in 1581, by which Frederick obtained South Ditmarsh, with its chief town of Meldorp, and Adolphus obtained North Ditmarsh, with its chief town of Heide; and this arrangement continued till 1773, when all the Gottorp possessions were incorporated with the Danish crown.

See Dahlmann's edition of Neocorus, *Chronik von Dithmarsen*, Kiel, 1827, and *Geschichte Dänemarks*, 1840–44; Michelsen, *Urkundenbuch zur Geschichte des Landes Dithmarschen*, 1834, *Sammlung alldithmarscher Rechtsquellen*, 1842, and *Dithmarschen im Verhältnis zum Bremischen Erzstift*; C. L. von Maurer, *Einleitung zur Geschichte der Mark-, Hof-, Dorf-, und Stadt-Verfassung*, 1854; Nitzsch, *Das alte Dithmarschen*, 1862; Kolster, *Geschichte Dithmarschens, nach F. R. Dahlmanns Vorlesungen*, 1873.

DITTON, HUMPHRY (1675–1715), an eminent mathematician, was born at Salisbury, May 29, 1675. In compliance with the wishes of his father rather than by his own inclination he entered on the study of theology, and was for some years a dissenting minister at Tunbridge, where he married. On the death of his father, however, he was induced to relinquish the clerical profession; and at the persuasion of Whiston and Dr Harris he devoted himself to the more congenial study of mathematics. Through the influence of Sir Isaac Newton, he was elected mathematical master in Christ's Hospital, where he continued till his death in 1715.

Ditton was the author of the following treatises:—*Of the Tangents of Curves*, &c., *Phil. Trans.* vol. xxiii.; *A Treatise on Spherical Catoptrics*, published in the *Phil. Trans.* for 1705, from which it was copied and reprinted in the *Acta Eruditorum*, 1707, and also in the Memoirs of the Academy of Sciences at Paris; *General Laws of Nature and Motion*, 8vo, 1705, a work which is commended by Wolfius as illustrating and rendering easy the writings of Galileo and Huyghens, and the *Principia* of Newton; *An Institution of Fluxions, containing the First Principles, Operations, and Applications of that admirable method, as invented by Sir Isaac Newton*, 8vo, 1706. In 1709 he published the *Synopsis Algebraica* of John Alexander, with many additions and corrections. In his *Treatise on Perspective*, published in 1712, he explained the mathematical principles of that art; and anticipated the method afterwards elaborated by Dr Brook Taylor. In 1714 Ditton published his *Discourse on the Resurrection of Jesus Christ*; and *The New Law of Fluids, or a Discourse concerning the Ascent of Liquids in exact Geometrical Figures, between two nearly contiguous Surfaces*. To this was annexed a tract to demonstrate the impossibility of thinking or perception being the result of any combination of the parts of matter and motion,—a subject much agitated about that time. There was also added an advertisement from him and Whiston concerning a method for discovering the longitude, which it seems they had published about half a year before. Although the method had been approved by Sir Isaac Newton before being presented to the Board of Longitude, and successfully practised in finding the longitude between Paris and Vienna, the board determined against it. This disappointment, aggravated as it was by certain unquotable lines written by Dean Swift, affected Ditton's health to such a degree that he died in the following year

DIU, an island and small seaport on the south coast of the Káthiáwár peninsula, in the province of Guzerat, in India. The Portuguese obtained possession of the island in 1515, and have held it ever since. Diu town is situated at the eastern extremity of the island, in 20° 42′ N. lat and 71° 0′ E. long. The anchorage is fairly protected from the sea, but the depth of water is only 3 to 4 fathoms, and is said to be decreasing. The channel between the island of Diu and the mainland is navigable only by fishing boats and small craft. The town is well fortified on the old system, being surrounded by a wall with towers at regular intervals.

DIURETICS (from διά, through, and οὐρέω, to pass urine) are remedies which, under certain conditions, produce an increased flow of urine. Their mode of action is various. Some, as turpentine and cantharides, are absorbed into the blood, are carried to the secretory organs (the kidneys), and stimulate them directly, causing an increased flow of blood to them; others act as stimulants through the nervous system. A second class act in congested conditions of the kidneys by diminishing the congestion; this is supposed to be one of the modes of action of digitalis. Another class, such as the saline diuretics, are effectual by virtue of their osmotic action. A fourth class are diuretic by increasing the blood pressure within the vessels in general, and the Malpighian tufts in particular,—some, as digitalis, by increasing the strength of the heart's contractions, and others, as water, by increasing the amount of fluid circulating in the vessels. Some remedies, as mercury, although not diuretic themselves, when prescribed along with those which have this action, increase their effect. The same remedy may act in more than one way, *e.g.*, alcohol, besides stimulating the secretory organs directly, is a stimulant to the circulation, and thus increases the pressure within the vessels. It is stated above that remedies have a diuretic action under "certain conditions." These relate to—1st, the state of the kidneys themselves; 2d, the condition of other organs; 3d, the surroundings of

[1] That is, the right of claiming military service, and the right of bringing capital offenders to justice.

the patient; 4th, the dose and mode of administration of the remedy. In illustration of each of these—1st, a dose of cantharides, which in a patient with the kidneys healthy would be diuretic, would in one with the kidneys acutely congested have the reverse effect; 2d, if there were much irritation of the gastro-intestinal tract, acid tartrate of potash, instead of producing diuresis, would probably cause diarrhœa, squills would induce vomiting, digitalis either diarrhœa or vomiting; 3d, Mindererus spirit, if taken by one exposed to an elevated temperature, would probably produce sweating, but if the temperature were low and the patient cool its action would be diuretic; 4th, many salines which in small doses are diuretic in larger doses are laxative; digitalis if too long continued diminishes the flow of urine, irritant diuretics in too large doses diminish or altogether arrest it. Diuretics are indicated when the quantity of urine is much diminished, or when, although the quantity may be normal, it is wished to relieve some other organ or set of organs of part of their ordinary work, or to aid in carrying off some morbid product circulating in the blood, or to hasten the removal of inflammatory serous exudations, or of dropsical collections of fluid.

DIVAN, or DÍWÁN. See MOHAMMEDANISM.

DIVER, a name that when applied to a bird is commonly used in a sense even more vague than that of LOOM (*q.v.*), several of the Sea-Ducks or *Fuligulinæ* (see DUCK) and MERGANSERS (*q.v.*) being frequently so called, to say nothing of certain of the Auks or *Alcidæ* and GREBES (*q.v.*); but in English ornithological works the term Diver is generally restricted to the Family known as *Colymbidæ*, a very well-marked group of aquatic birds, possessing great, though not exceptional, powers of submergence, and consisting of a single genus *Colymbus* (or *Eudytes* of some writers)[1] which is composed of three, or at most four, species, all confined to the northern hemisphere. This Family belongs to the *Cecomorphæ* of Professor Huxley, and is usually supposed to occupy a place between the *Alcidæ* and *Podicipedidæ*; but to which of those groups it is most closely related is at present undecided. Professor Brandt in 1837 (*Beitr. Naturgesch. Vögel*, pp. 124–132) pointed out the osteological differences of the Grebes and the Divers, urging the affinity of the latter to the Auks; while, thirty years later, Professor Alph. Milne-Edwards (*Ois. foss. France*, i. pp. 279–283) inclined to the opposite view, chiefly relying on the similarity of a peculiar formation of the *tibia* in the Grebes and Divers,[2] which indeed is very remarkable, and, in the latter group, attracted the attention of Willughby more than two hundred years since. On the other hand Professor Brandt, and Rudolph Wagner shortly after (Naumann's *Vögel Deutschlands*, ix. p. 683, xii. p. 395), had already shewn that the structure of the knee-joint in the Grebes and Divers differs in that the former have a distinct and singularly-formed *patella* (which is undeveloped in the latter) in addition to the prolonged, pyramidally-formed, procnemial process—which last may, from its exaggeration, be regarded as a character almost peculiar to these two groups.[3] The evidence furnished by oology and the newly-hatched young seems to favour Prof. Brandt's views; and, without according too much weight to such evidence, it certainly ought to be considered before a decision is reached. The abortion of the *rectrices* in the Grebes, while these feathers are fairly developed in the Divers, is another point that helps to separate the two Families; but until their morphology has been worked out nothing can be safely averred on the subject.

The commonest species of *Colymbus* is *C. septentrionalis*, known as the Red-throated Diver from an elongated patch of dark bay which distinguishes the throat of the adult in summer-dress. Immature birds want the bay patch, and have the back so much more spotted that they are commonly known as "Speckled Divers." Next in size is the Black-throated Diver, *C. arcticus*, having a light grey head and a gular patch of purplish-black, above which is a semicollar of white striped vertically with black. Still bigger is the Great Northern Diver, *C. glacialis* or *torquatus*, with a glossy black head and neck, two semicollars of white and black vertical stripes, and nearly the whole of the black back and upper surface of the wings beautifully marked with white spots, varying in size and arranged in belts.[4] Closely resembling this bird, so as to be most easily distinguished from it by its yellow bill, is *C. adamsi*, the specific validity of which is not yet fully established. The Divers live chiefly on fish, and are of eminently marine habit, though invariably resorting for the purpose of breeding to freshwater lakes, where they lay two dark brown eggs on the very brink; but they are not unfrequently found far from the sea, being either driven inland by stress of weather, or exhausted in their migrations. Like most birds of their build, they chiefly trust to swimming, whether submerged or on the surface, as a means of progress, but once on the wing their flight is strong and they can mount to a great height. In winter their range is too extensive and varied to be here defined, though it is believed never to pass, and in few directions to approach, the northern tropic; but the geographical distribution of the several forms in summer requires mention. While *C. septentrionalis* inhabits the north temperate zone of both hemispheres, *C. arcticus* breeds in suitable places from the Hebrides to Scandinavia, and across the Russian empire, it would seem, to Japan, reappearing in the north-west of North America,[5] though its eastern limit on that continent cannot yet be laid down; but it is not found in Greenland, Iceland, Shetland, or Orkney. *C. glacialis*, on the contrary, breeds throughout the north-eastern part of Canada, in Greenland, and in Iceland. It has been said to do so in Scotland as well as in Norway, but the assertion seems to await positive proof, and it may be doubted whether, with the exception of Iceland, it is indigenous to the Old World,[6] since the form observed in North-eastern Asia is evidently that which has been called *C. adamsi*, and is also found in North-western America; but it may be remarked that one example of this form has been taken in England (*Proc. Zool. Society*, 1859, p. 206) and at least one in Norway (*Nyt Mag. for Naturvidenskaberne*, 1877, p. 134). (A. N.)

DIVIDIVI, the commercial name for the astringent pods of *Cæsalpinia coriaria*, a leguminous shrub of the sub-order *Cæsalpiniæ*, which grows in low marshy tracts in the West Indies and the north of South America. The plant is between 20 and 30 feet in height, and bears white flowers. The pods are flattened, and curl up in praying; they are about ¾ inch broad, from 2 to 3 inches long, and of a rich brown colour. Dividivi was first brought to Europe from Caracas in 1768. Its value in the manufacture of leather is due to the large amount of tannin contained in the yellow resinous matter exterior to the seed husks. It may be employed in dyeing as a substitute for galls or sumach. Maracaibo, Rio Hacha, and Sabanilla are the ports from which it is principally shipped.

DIVINATION. This term is used to mean the obtaining knowledge of secret or future things by revelation from oracles or omens. The derivation of the word points to *divine* influence communicated through the soothsayer, much as the equivalent Greek term *mantike* refers to the utterances of the spiritually inspired or possessed seer, *mantis*. It is well seen from Cicero's treatise *De Divinatione* that in classic times theology not only included in its system all revelation by oracles, which clearly belongs to it, but also claimed possession of a variety of diviner's arts, such as augury and astrology, on the ground that their signs were sent by the gods. On the side of the Stoics, it is there argued that if divination is a real art, then there must be gods who gave it to mankind, which proposition is met by the counter-suggestions that signs of future events may be given by nature without any god, or that there may be gods and yet they not have bestowed on man any such art as divination. The real point of the relation of divination to religion is touched in the division of it into two kinds, —*artificial divination*, by haruspication, prodigies, lightning, augury, astrology, and lots, as contrasted with *natural divination*, by dreams and prophetic oracles. On a general survey of such arts among mankind, it appears that oracles, &c., being taken as revelations made directly by spiritual beings, fall to be considered under headings treating of religion (see, *e.g.*, DEMONOLOGY); but divining by such signs as the flight of birds or the falling of lots does not necessarily depend on the notion of intervening demons or deities. One part of its position is well stated in the argument by which Cicero makes his Stoic defend it:—If frogs by croaking, and oxen by snuffing the air, can give us signs to foretell the weather, why should there not be omens in the fibres of a victim's entrails, or in thunderstorms? But the religious view which regards omens as divine signs seems to have been from very early ages blended with the naturalistic view, so that in a great part of the cases it is impossible to disentangle them, or even to say which is the original one. This will appear in the following brief summary of the principal methods of divination. Now that the diviner's art has all but perished, we moderns are able to look back upon its history, to see how its futile proceedings were suggested by mistaken analogy, and how the experience of ages, which ratifies true inferences and destroys false fancies, is now reducing them to curious antiquarian relics.

The various "artificial" modes of divination for the most part rest evidently on the association of ideas in analogy and symbolism (see evidence in Tylor, *Early Hist. of Mankind*, p. 132; *Primitive Culture*, vol. i. p. 117, &c., 78.) A tree planted at a child's birth, or any other plant mentally associated with a person, gives a sign by its flourishing or withering as to that person's health or death (Ploss, *Das Kind*, vol. i. p. 71.) So with the sticks set up by Polynesians to see if the warriors they stand for will fall in battle, or with the cocoa-nut that is spun like a teetotum to point out a thief (Polack, *New Zealanders*, vol. i. p. 270; Mariner's *Tonga Islands*, ch. xx.) This kind of fanciful association appears in *sortilege*, or casting of lots, a proceeding remarkable not only for its antiquity but for the frequency with which religions have adopted it as a means of obtaining divine guidance, from the ages when classic poets sang of Homeric heroes praying to the gods when they cast lots in Agamemnon's leather cap, or of Mopsus the soothsayer divining with sacred lots when the Argonauts embarked on their voyage (Homer, *Il.*, vii. 175; Pindar, *Pyth.*, iv. 338), and on until modern times, when the Moravians still resorted to solemn religious lots to determine difficult questions, such as the choice of wives. Dice or astragali (bucklebones) have been used for the purposes of sortilege (see Suetonius, *Tiberius*); and *cartomancy*, or fortune-telling by means of playing-cards, is still common. In ancient times omens were drawn from poets' verses, fixed on by chance, a practice well known as *Sortes Virgilianæ*, from Virgil being often so consulted (see Smith's *Dic. Gr. and Rom. Antiq.*, art. "Sortes"); and the Bible came to be afterwards so used for drawing texts, or "pricking for texts;" this practice is still very usual in Germany (see Wuttke, *Deutsche Volksaberglaube*, 2 ed., p. 227.) The *haruspication*, or examination of entrails, by which Roman statesmen were (or pretended to be) guided in public affairs (see Cicero, *De Div.*, ii. 12; Plin. *H. N.*, xi. 73); and *scapulimancy*, or the Tatar mode of divining by the cracks and lines in a shoulder blade (Lubbock, *Origin of Civilization*, p. 230), formerly known in England as "reading the speal-bone" (Brand, *Popular Antiquities*, vol. iii. p. 339), depended on imaginary symbolic associations, such as that cracks in opposite directions meant good and ill fortune, that the course of particular lines indicated the course of the consulter's life, &c. This sort of false analogy may be well understood by any one who will have the similar art of *palmistry*, or divining by the lines of the hand, applied to his own future by a fortune-teller at a fair. Omens obtained by *augury*, or divining by the sight and cries of animals, especially birds (as the name indicates), are as familiar among uncivilized races as they were in ancient Rome; their symbolism is apparent in such rules as that a hawk means victory, an owl's hoot is unlucky, and that a beast or bird on the right hand portends good, but on the left hand evil (Tylor, *P. C.*, vol. i. p. 119). Another class of arts depend on the unconscious or half-conscious action of some person, often the diviner himself. Among these is the use of the well-known divining-rod, which when held in the hands, dips to indicate a hidden spring of water, a vein of ore, or a buried treasure (Brand, vol. iii. p. 332; see Chevreul, *De la Baguette Divinatoire*, &c.) The use of this instrument remains in some districts of England; it is locally known as "dowsing," whence no doubt the name of Dousterswivel in *The Antiquary*. Similar in principle is the ancient *coscinomancy*, or divining by a sieve held suspended, and giving its indications by turning. In later times this gave place to the ordeal by the Bible and key, where the book is suspended by a key tied in with its wards between the leaves and the key supported on two persons' forefingers, and the whole turns round to prove guilty some servant maid accused of theft (Brand, vol. iii. p. 351). In such cases, where the culprits' fears are apt to betray them, the process of divination really serves as a practical test. Dreams are not only considered visits from ghosts, but often also as supernatural signs to be interpreted symbolically, as when a Kamtschatkan dreaming of dogs or lice would take it as foretelling a visit from Russians (Steller, *Kamtschatka*, p. 279). Of such interpretations the ancient art of *oneiromancy* consists, as may be seen in such rules as that if a woman dreams of kindling a fire, she will bear a male child; if one dreams of white clouds it means joy, but if black clouds trouble (Brand, vol. iii. p. 132; Tylor, *l.c.*). It remains to mention in few words *astrology*, the branch of divination whose importance

[1] By these writers the name *Colymbus* is generally used for what others term *Podiceps*.

[2] The remains of *Colymboides minutus*, from the Miocene of Langy, described by this naturalist in the work just cited, seem to show it to have been a generalized form. Unfortunately its *tibia* is unknown.

[3] Garrod, in his tentative and chiefly myological arrangement of Birds (*Proc. Zool. Society*, 1874, p. 117), placed the *Colymbidæ* and *Podicipedidæ* in one Order (*Anseriformes*) and the *Alcidæ* in another (*Charadriiformes*); but the artificial nature of this assignment may be realized by the fact of his considering the other Families of the former Order to be *Anatidæ* and *Spheniscidæ*.

[4] The osteology and myology of this species are described by Dr Coues (*Mem. Boston Soc. Nat. History*, i. pp. 131–172, pl. 5).

[5] Mr Lawrence's *C. pacificus* seems hardly to deserve specific recognition.

[6] In this connexion should be mentioned the remarkable occurrence in Europe of two birds of this species which had been previously wounded by a weapon presumably of transatlantic origin. One had "an arrow headed with copper sticking through its neck," and was shot on the Irish coast, as recorded by Thompson (*Nat. Hist. Ireland*, iii. p. 201); the other, says Herr H. C. Müller (*Vid. Medd. nat. Forening*, 1862, p. 35), was found dead in Kalbaksfjord in the Færoes, with an iron-tipped bone dart fast under its wing.

in the world has exceeded that of all the rest together. Researches into the ancient writings of Chaldæa have now shown how fully historians were justified in treating that country as the principal among the sources whence the star-gazers received their precepts (see Sayce, "Astronomy and Astrology of the Babylonians," in *Trans. Soc. Bibl. Arch.*, vol. iii.; Maury, *La Magie et l'Astrologie*.) The rules in such comparatively modern works as Sibly's *Occult Sciences* and Lilly's *Astrology* fairly enough represent the ancient traditions, and show their still intelligible symbolism,—how the stars rising at a child's birth are made in the horoscope to typify its destiny, and the planets and signs of the zodiac exercise "influences" often plainly drawn from their natures or names. Thus Mars has to do with soldiers, Venus with lovers, and Mercury with prattlers; the solar man is grand and generous, the lunar man unsteadfast and inclined to change his dwelling, the sign Leo presides over places where wild beasts abound, but Aries over pastures. At the courts of Asiatic rulers, the state astrologer still nominally holds a position like that of his predecessor in the ancient empires of the world, but it is evident that the last twenty years have shaken, even in the barbaric East, the power of the occult sciences over the human mind. (E. B. T.)

DIVING. The art of diving to considerable depths under water to bring up pearls, corals, and sponges has been practised in the Indian seas from very early times, and if we may believe the accounts that have come down to us, the feats of early divers are truly remarkable—some of them, it is said, having been able to prolong their submarine descents for periods varying from two to three minutes. It is obvious, however, that not having the aid of any artificial appliances for supplying air, the powers of these bold adventurers, both as regards the depth to which they could descend and the length of time they could remain submerged, were comparatively limited.

At an early period, therefore, the attention of philosophers and mechanics was turned to the discovery of a contrivance for aiding the diver in prosecuting his daring but useful calling, which was rendered all the more important from its being no longer confined to the acquisition of Eastern luxuries, but to the raising of treasure from sunken vessels. It is not considered expedient to occupy space by further reference to the feats of the early divers, but rather to pass at once to the history and construction of the diving apparatus of modern times, as illustrated by the Diving Bell and the Diving Dress at present in use. And here it may be stated that in addition to the sponge and coral trade of foreign lands, which has been greatly advanced by the use of modern appliances, there are the works of the naval engineer, and more particularly of the civil engineer, in which diving apparatus is so extensively employed and so essentially necessary as to place the art of diving on a wider basis, and to give it an importance only fully developed within the present century.

Diving Bell.—The most useful of ancient contrivances is the diving bell, which, introduced at an early period and gradually improved, is now the well-known apparatus used by engineers in the present day; and it may be interesting to trace the successive improvements that have brought it to its present state of perfection and usefulness in conducting submarine works.

The conception of the diving bell is very simple. The air contained in an inverted jar sunk in a vessel of water excludes the water from the interior, and if the vessel be made of sufficient size to contain persons within it, it may be sunk without their being wetted, and they may continue to be submerged so long as the air within the bell continues pure enough to support animation. Such were the "diving-chests" of the first makers, which, though they differed in form and details, were constructed on the same principle as the modern bell, and were generally formed of wood, girded with iron hoops, like a barrel.

It will be obvious that if such a vessel were submerged in shallow water, having a depth of say one foot of water, a large supply of air would be inclosed in the bell, and the bottom on which it rested would, from the small depth of water upon it, be easily reached for any operation to be performed on it. But if we conceive the same bell to be lowered further below the surface, the air being compressible will be reduced in volume, and the water will rise in the bell to fill its place. The result would be that at the depth of about 33 feet the air would be compressed into about one-half its original bulk, and the bell itself would be half filled with water; and the bottom of the sea on which it rested would no longer be so conveniently reached as when the water was only a few inches above the lips of the bell. Moreover, the air by repeated inspiration becomes unfit to support life, and the ancient bells had to be raised to the surface at very short intervals of time that fresh air might be supplied to the men employed. Although, therefore, the *original* diving bell was a step towards the perfect appliances afterwards introduced, it will readily be seen that its use in diving operations was very limited indeed.

Dr Halley, the secretary of the Royal Society, who seems to have taken an interest in diving and divers, and compassionated their want of fresh air, communicated a paper to the Royal Society in which, to use his own words, he proposes a plan "for carrying the *pabulum vitæ* down to the divers, who must without being supplied therewith return very soon to the surface or perish." The following is the description of his arrangements for this purpose. After describing the bell itself, which was of wood of the form of a truncated cone, with a capacity of 60 cubic feet, and was suspended by a sprit from the mast of a ship, he says—

"To supply air to this cell when under water, I caused a couple of barrels, of about 36 gallons each, to be cased with lead, so as to sink empty, each of them having a bung-hole in its lowest parts to let in the water, as the air in them condensed on their descent, and to let it out again when they were drawn up full from below. And to a hole in the uppermost part of these barrels I fixed a leathern hose, long enough to fall below the bung-hole, being kept down by a weight appended, so that the air in the upper part of the barrels could not escape, unless the lower ends of these hose were first lifted up.

"The air-barrels being thus prepared, I fitted them with tackle proper to make them rise and fall alternately, after the manner of two buckets in a well; and in their descent they were directed by lines fastened to the under edge of the bell, which passed through rings on both sides of the leathern hose in each barrel, so that, sliding down by these lines, they came readily to the hand of a man, who stood on purpose to receive them, and to take up the ends of the hose into the bell. Through these hose, as soon as their ends came above the surface of the water in the barrels, all the air that was included in the upper parts of them was blown with great force into the bell, whilst the water entered at the bung-holes below and filled them, and as soon as the air of one barrel had been thus received, upon a signal given that was drawn up, and at the same time the other descended, and, by an alternate succession, furnished air so quick, and in so great plenty, that I myself have been one of five who have been together at the bottom, in nine to ten fathoms water, for above an hour and a half at a time, without any sort of ill consequence, and I might have continued there so long as I pleased, for anything that appeared to the contrary. I only observed that it was necessary to be let down gradually at first, at about 12 feet at a time; and then to stop and drive out the air that entered, by receiving 3 or 4 barrels of fresh air before I descended further. But being arrived at the depth designed, I then let out as much of the hot air that had been breathed as each barrel would replenish with cool, by means of the cock at the top of the bell, through whose aperture, though very small, the air would rush with so much violence as to make the surface of the sea boil, and to cover it with a white foam, notwithstanding the weight of the water over us.

"Thus I found that I could do anything that required to be done just under us, and that I could, for a space as wide as the circuit of the bell, lay the bottom of the sea so far dry, as not to be over shoes thereon. And, by the glass window, so much light was transmitted, that when the sea was clear, and especially when the sun shone, I could see perfectly well to write or read, much more to fasten or lay hold on anything under us that was to be taken up; and, by the return of the air barrels, I often sent up orders, written with an iron pen on small plates of lead, directing how to move up from place to place as occasion required. At other times when the air was troubled and thick, it would be as dark as night below; but in such cases I have been able to keep a candle burning in the bell as long as I pleased, notwithstanding the great expense of air necessary to maintain flame. This I take to be an invention applicable to various uses, such as fishing for pearls, diving for coral or sponges and the like, in far greater depths than has hitherto been thought possible; also for the fitting and placing of the foundations of moles, bridges, &c., in rocky bottoms, and for cleaning and scrubbing of ships' bottoms when foul, in calm weather at sea. I shall only intimate that, by an additional contrivance, I have found it not impracticable for a diver to go out of an engine, to a good distance from it, the air being conveyed to him with a continued stream by small flexible pipes; which pipes may serve as a clue to direct him back again when he would return to the bell."

Such is an account of Dr Halley's apparatus, which undoubtedly effected an important improvement; but it involved the sending down of constant relays of air vessels, and the great loss of time and interruption which attended such a means of supply. It remained for Smeaton to overcome these objections. In repairing the shoeing of the foundations of Hexham Bridge, in 1778, there being but a small depth of water, to work in, he contrived a bell to the top of which he attached a force pump in lieu of Dr Halley's air-barrels, and as the bell, in consequence of the small depth of water, did not require to be wholly submerged, the supply of air for the divers was forced directly into the bell, being the first application of the force pump for that purpose.[1] Subsequently to this, in 1748, having occasion to remove stones in clearing the foundations for a pier at Ramsgate, he applied an air-pump placed in a ship or barge, and pumped air into the bell at any depth under water by means of a hose screwed into an air-hole in the top of the bell. The following is Smeaton's description of his last improvement:—

"Instead of the usual form of a bell, or of a conical tub of wood sunk by weights (externally applied), this for convenience was a square chest of cast iron, which being 50 cwts. was heavy enough to sink itself, and being 4½ feet in height, 4½ feet in length, and 3 feet wide, afforded room sufficient for two men at a time to work under it. But it was *peculiar* to this machine that the men therein were supplied with a constant influx of fresh air without any attention of theirs, that necessary article being amply supplied by a *forcing air-pump* in a boat upon the water's surface."[2]

Modern diving bell

It will thus be seen that Smeaton's Ramsgate bell contained all the elements of the present appliances, which, as improved in details, and constructed by Messrs Rennie, has been so extensively employed in harbour works.

The bell as now used is shown in plan and section in figs. 1 and 2. It is a cast-iron chest weighing about 5 tons, and is suspended by block and tackle. On the top of the bell there are 8 apertures *a*, fitted with very thick glass for admitting light; and in the centre is the passage *b*, into which the hose is screwed for admitting the air supply. The interior is fitted with two seats *e*, which can be removed to make room when the men are at work; and in the centre is a lifting chain *c*, to which stones are attached to facilitate their being lifted and properly adjusted to the beds on which they are to be laid. The bell is used according to two different systems, depending on the nature of the work to be performed. In building masonry under water it is suspended from a staging of timber, but in excavating rock or removing boulders, scattered over

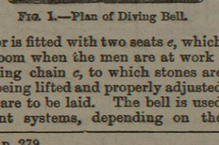

Fig. 1.—Plan of Diving Bell.

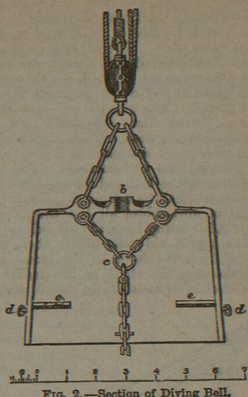

Fig. 2.—Section of Diving Bell.

a considerable area, where a staging would be inapplicable, it is suspended from a barge or lighter.

Fig. 3 shows the arrangement as employed in laying stones or blocks of concrete. It represents a cross section of the staging, bell framing, and bell carriage, in which *a*

Bell staging

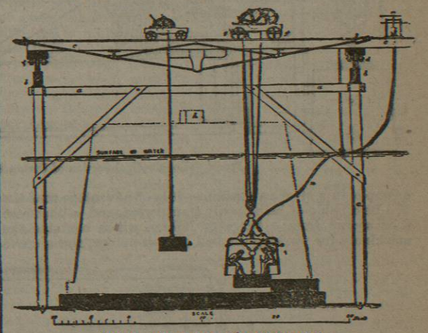

Fig. 3.—Block-laying by Diving Bell.

is the staging, *b* longitudinal beams on which the bell-framing *cc* traverses on the wheels and toothed racks *d*. The diving bell *e* is suspended from the bell carriage *f*, which traverses on the bell framing by the wheels and toothed rack *g* across the whole breadth of the pier. The stones *h* are brought along the surface of the finished part of the pier, and lowered down by the travelling crab-winch *l*. The force-pumps by which the bell is supplied with air are shown at *m*, and the air-hose at *n*. It will be understood from this description that the bell framing *c*, moves freely *along* the staging, while the bell carriage has a

[1] Smeaton's *Reports*, vol. iii. p. 279.

[2] *Historical Report on Ramsgate Harbour*, by John Smeaton, London 1791, p. 70.