Not long afterwards his strong Protestant sympathies and his acquaintance with Scottish affairs recommended him as a fit person to be employed by Elizabeth in her intrigues with the Scottish lords of the congregation against Queen Mary. In 1584 he was appointed keeper of Mary queen of Scots in the castle of Tutbury; but on account of "age and infirmity" he was permitted to resign his charge some time before the death of the queen. His last service was to repair to Scotland to pacify the king's indignation on account of Mary's death. He died after his return home at Standon in Hertfordshire, 30th March 1587.

The *Letters and Negotiations* of Sir Ralph Sadler were published at Edinburgh in 1720, and a more complete collection under the title *State Papers and Letters of Sir Ralph Sadler*, with a life by Sir Walter Scott, in 1809. *The Memoir of the Life and Times of Sir Ralph Sadleir, by his Descendant Major F. Sadleir Stoney*, appeared in 1877.

SADOLETO, Jacopo (1477-1547), Italian humanist and churchman, was born at Modena in 1477, and, being the son of a noted jurist, was designed for the same profession. He gave himself, therefore, to humanistic studies and acquired reputation as a Latin poet, his best-known piece being one on the group of Laocoon. Passing to Rome, he obtained the patronage of Cardinal Carafa and adopted the ecclesiastical career. Leo X. chose him as his secretary along with Peter Bembo, and in 1517 made him bishop of Carpentras. Sadoleto had a remarkable talent for affairs and approved himself a faithful servant of the papacy in many difficult negotiations under successive popes, especially as a peacemaker; but he was no bigoted advocate of papal authority, and the great aim of his life was to win back the Protestants by peaceful persuasion—he would never countenance persecution—and by putting Catholic doctrine in a conciliatory form. Indeed his chief work, a *Commentary on Romans*, though meant as a prophylactic against the new doctrines, gave great offence at Rome and Paris. Sadoleto was a diligent and devoted bishop and always left his diocese with reluctance even after he was made cardinal (1536). His piety and tolerant spirit, combined with his reputation for scholarship and eloquence and his diplomatic abilities, give him a somewhat unique place among the churchmen of his time. He died in 1547. His collected works appeared at Mainz in 1607, and include, besides his theologico-irenical pieces, a collection of *Epistles*, a treatise on education (first published in 1533), and the *Phædrus*, a defence of philosophy, written in 1538.

SÆMUND. See Edda, vol. vii. p. 650, and Iceland, vol. xii. p. 624.

SAFES. A safe is any repository in which valuable property is guarded against risk of loss by fire or from the attacks of thieves. The protection of valuable documents and possessions was only imperfectly effected in the charter-rooms of old mansions and in the iron-bound oaken chests and iron coffers of the Middle Ages; but these in their day represented the strong rooms and safes of modern times. The vast increase in realized wealth and the complication of financial and banking operations necessitate in our days the greatest attention to the safeguarding of securities and property. The ingenuity of inventors has, within practicable limits, effected much in safe-making, but the cunning of thieves has increased in proportion to the obstacles to be overcome and to the value of the booty at which they aim. No safe can be held to be invulnerable; for, whatever human ingenuity can put together and close, the same ingenuity can tear down and open. An impregnable safe would indeed be a source of greater danger than of security to its owner, for, were the key or other means of access lost or rendered unworkable, the contents of the safe would of necessity be irrecoverable. The efficiency of a safe, therefore, does not depend on absolute impregnability, but on the nature of the obstacles it presents to successful attack, and to the generally unfavourable conditions under which such attacks are made. It is common to make safes both thief- and fire-resisting, and the conditions necessary for the one object to a certain extent conduce to the attainment of both; but for many purposes security from the one danger alone is requisite.

The devices for baffling thieves are numerous. The safe must in the first place be made heavy and unwieldy, or otherwise it must be so fixed that it can only be carried away with the utmost difficulty. Next, the greatest obstacles to obtaining illegitimate access must be presented. To prevent fracturing a tough metal must be used in the construction, and to resist penetration by drilling metal of great hardness must be interposed. These conditions are commonly met by making the outer casing of the safe of boiler plate, backed by a lining of hard steel, over which is an inner lining of thin boiler plate, the three layers being securely bolted together by screws from within. By some makers a layer of hard metal is poured, in a fluid state, between the outer and inner casing; others case-harden one surface; and there are numerous additional devices for securing the combination of hardness and toughness. To prevent wrenching of joints, the two sides with top and bottom of the outer shell are sometimes made out of a single plate welded at the joint, and the back and front are then attached to that shell by angle irons screwed from within. The frame upon which the door hangs and into which the bolts shoot is made of great strength, with special precautions to prevent the wrenching off of the door by means of crowbars or wedges. In an ordinary safe the massive bolts, three or more in number, shoot only at the front, and fixed dogs or sham bolts fit into slots at the back or hinged side. This arrangement is sufficient to keep the door closed independent of hinges, which are merely the pivot on which the door turns. In all Chubb's safes bolts shoot both to front and back; and in the higher quality of that and of every other good maker bolts shoot on every side,—front, back, top, and bottom. Ordinarily the bolts shoot straight into the slot as in an ordinary lock; but, to defy wrenching, additional grip is secured by Chatwood, who makes a bolt with a clutch or projection, which falls into a recess in the slot and thus holds against any direct wrench. In Chubb's finer safes the bolts shoot diagonally all round, so that in each face of the door they go in two different directions. Safe bolts are shot not by the key, as in an ordinary lock, but by the door handle, and the key simply secures them in their position. By this arrangement, patented by Mr Charles Chubb in 1835, a series of the most ponderous bolts can be secured in locked position by a small key which can be carried in the vest pocket. The lock of a safe must be a careful piece of mechanism, not subject to derangement, unpickable, and gunpowder-proof. The portion of the door on which it is fastened is generally provided with extra precautions against drilling. A safe being well made and securely locked remains vulnerable through the medium of the key, which may be surreptitiously obtained either for direct use or to form a mould by which false keys can be cut. On this account, keyless locks and time locks are coming into great favour in America. In keyless permutation locks, such as those of Hall, Sargent, Yale, and Dalton, the bolts can be withdrawn only after an indicator has been successively set against a combination of numbers arranged before the closing of the door; and in the time lock of these inventors the safe can only be opened at any hour to which the time controller is set before closing. Electrical arrangements have also been attached to safes by which signals are conveyed to any spot when a safe so guarded is unlawfully interfered with.

It is much easier to render a safe fire-proof than to guard it against burglary. It requires nothing more than a calculation of the intensity and duration of any fire to which it is likely to be exposed, and the provision of a sufficient lining of fire-resisting material. What is principally used is a mixture of some absorbent medium—such as sawdust, powdered gypsum or cement, or infusorial earth—with ground alum. Asbestos, silicate cotton, mica, and other non-conductors are also used; and by some makers sealed tubes of alkaline salts are distributed through the absorbent material. These burst when exposed to high heat and their contents saturate the surrounding substance. A carefully packed shell of not less than 3½ inches of the fire-resisting medium should line the interior of every fire-proof safe; but in many cheap safes a quantity of brick dust is the only fire-resisting medium.

Where an ordinary safe provides insufficient accommodation the strong room takes its place. Such an apartment, being generally in the basement of a building, presents no special difficulties to make it proof against fire and thieves. Thickness of walls, built by preference of hard brick laid in cement, and liberal use of cement within the walls, as well as at the floor and over the arched roof, give strength against both fire and burglars. The interior of a strong room is generally lined with boiler-plate, and, in addition to the massive steel and iron door, it has an inner wrought-iron grill-door, which secures the vault during business hours and permits the ventilation of the apartment. Within such a strong room extra strong chambers or separate safes may be placed, and in this way precautions may be indefinitely multiplied.

The most complete examples of safe and strong-room arrangements are afforded by the public safes or safe-deposits erected in most of the great cities of America and in London. The premises of the National Safe Deposit Company in London consist of a large isolated building in Queen Victoria Street. The building, which is fire-proof, covers and surrounds the great safe vault or citadel, which is sunk in the ground to a depth of 45 feet. The vault itself, founded on a bed of concrete 20 feet in thickness, has walls, 3 feet thick, of hard blue brick laid in cement, with an external lining of fire-brick, and is lined internally with cast-iron plates 4½ inches thick chilled on one side, the plates having embedded in them a network of strong interlaced wrought-iron bars. The vault is divided into four tiers or stories with eight separate compartments in each, which, after business hours, are closed with doors raised and lowered by hydraulic power. These doors, which each weigh four tons, are built up, 12 inches thick, of combinations of hard and tough metal to resist fracture and drilling, and when they are raised for business purposes the entrance to each compartment is protected by a massive wrought-iron grill. Within the thirty-two compartments there is space for about 20,000 safes of various sizes, which are let to owners of valuables, each renter having the sole control of the safe hired by him. Additional security is obtained by the patrol of armed watchmen, and generally it may be said that in the institution precautions have been carried almost to the pitch of perfection, if indeed they have not been pushed to needless excess. (J. PA.)

SAFETY LAMP. See Coal, vol. vi. p. 72 *sq.*

SAFFARIDS, a Persian dynasty of the 9th century. See Mohammedanism, vol. xvi. p. 586.

SAFFI (Asafi), a seaport of Morocco, with 6000 inhabitants, some commerce, and a famous shrine, the House of the Seven Sleepers, frequented by Moslem and Jewish pilgrims. See vol. xvi. p. 831.

SAFFLOWER, or Bastard Saffron (*Carthamus tinctorius*), belongs to the natural order *Compositæ*; its flowers form the basis of the safflower dye of commerce. The plant is a native of the East Indies, but is cultivated in Egypt and to some extent in southern Europe. To obtain the dyeing principle—carthamine—the flowers are first washed to free them from a soluble yellow colouring matter they contain; they are then dried and powdered, and digested in an alkaline solution in which pieces of clean white cotton are immersed. The alkaline solution having been neutralized with weak acetic acid, the cotton is removed and washed in another alkaline solution. When this second solution is neutralized with acid, carthamine in a pure condition is precipitated. Dried carthamine has a rich metallic green colour; it forms a brilliant but fugitive scarlet dye for silk, but is principally used for preparing toilet rouge. In 1884 there were imported into the United Kingdom 179 t tons of safflower, valued at £7109, almost the whole of which came from the East Indies.

SAFFRON (Arab. *za'farān*) is manufactured from the dried stigmas and part of the style of the saffron crocus, a cultivated form of *Crocus sativus*, L., the precise origin of which is unknown; for, though some of the wild forms (var. *Thomasii*, *Cartwrightianus*) are also employed for the manufacture of saffron, they differ in character from the cultivated type and are somewhat restricted in geographical range, while the cultivated form extends with little or no change through nearly ninety degrees of longitude (Spain to Kashmir) and twenty-five degrees of latitude (England to Persia). It is invariably sterile, unless artificially fertilized with the pollen of some of the wild varieties. The purple flower, which blooms late in autumn, is very similar to that of the common spring crocus, and the stigmas, which are protruded from the perianth, are of a characteristic orange-red colour. The Egyptians, though acquainted with the bastard safflower (see preceding article), do not seem to have possessed saffron; but it is named in Canticles iv. 14 among other sweet-smelling herbs. It is also repeatedly mentioned (κρόκος) by Homer, Hippocrates, and other Greek writers; and the word "crocodile" was long supposed to have been derived from κρόκος and δειλός, whence we have such stories as that "the crocodile's tears are never true save when he is forced where saffron groweth" (Fuller's *Worthies*). It has long been cultivated in Persia and Kashmir, and is supposed to have been introduced into China by the Mongol invasion. It is mentioned in the Chinese materia medica (*Pun tsaou*, 1552-78). The chief seat of cultivation in early times, however, was the town of Corycus (modern Korghoz) in Cilicia, and from this central point of distribution it may not improbably have spread east and west. According to Hehn, the town derived its name from the crocus; Reymond, on the other hand, with more probability, holds that the name of the drug arose from that of the town. It was cultivated by the Arabs in Spain about 961, and is mentioned in an English leech-book of the 10th century, but seems to have disappeared from western Europe till reintroduced by the crusaders. According to Hakluyt, it was brought into England from Tripoli by a pilgrim, who hid a stolen corm in the hollow of his staff. It was especially cultivated near Hinton in Cambridgeshire and in Essex at Saffron Walden (*i.e.*, Saffron Woods, not Saffron Walled-in, as the canting crest of the town would imply), its cultivators being called "crokers." This industry, though very important in the 15th century, when English saffron commanded the highest prices on the Continent, appears to have died out about 1768.

Saffron was used as an ingredient in many of the complicated medicines of early times. According to Gerard "the moderate use of it is good for the head and maketh the sences more quicke and lively. It shaketh off heavie and drowsy sleep and maketh a man mery." It appears to be really a stimulant and antispasmodic, though its powers are slight. It is scarcely ever employed by modern pharmacists unless for the mere coloration of other tinctures, or at most as a cordial adjunct to other medicines. That it was very largely used in cookery is evidenced by many writers; thus Laurenbergius (*Apparatus Plantarum*, 1632) makes the large assertion "In re familiare vix ullus est telluris habitatus angulus ubi non sit croci quotidiana usurpatio aspersi vel incocti cibis." The Chinese used also to employ it largely, and the Persians and Spaniards

still mix it with their rice. As a perfume it was strewn in Greek halls, courts, and theatres, and in the Roman baths. The streets of Rome were sprinkled with saffron when Nero made his entry into the city.

It was, however, mainly used as a dye. It was a royal colour in early Greek times, though afterwards perhaps from its abundant use in the baths, and as a scented salve, it was especially appropriated by the hetairæ. In ancient Ireland a king's mantle was dyed with saffron, and even down to the 17th century the "lein-croich," or saffron-dyed shirt, was worn by persons of rank in the Hebrides. In mediæval illumination it furnished, as a glaze upon burnished tinfoil, a cheap and effective substitute for gold. The sacred spot on the forehead of a Hindu pundit is also partly composed of it. Its main use in England was to colour pastry and confectionery,—hence "I must have saffron to colour the Warden pies" (*Winter's Tale*, act iv. sc. i.),—and it is still often added to butter and cheese. One grain of saffron rubbed to powder with sugar and a little water imparts a distinctly yellow tint to ten gallons of water. This colouring power is due to the presence of polychlorite, a substance whose chemical formula appears to be $C_{48}H_{60}O_{18}$, and which may be obtained by treating saffron with ether, and afterwards exhausting with water. Under acids it yields the following reaction—

$$\underset{\text{Polychlorite.}}{C_{48}H_{60}O_{18}} + H_2O = 2(\underset{\text{Crocin.}}{C_{24}H_{38}O_{13}}) + \underset{\text{Essential oil.}}{C_{20}H_{12}O} + \underset{\text{Sugar.}}{C_6H_{12}O_6}.$$

Crocin, according to Watts, *Dict. of Chem.*, has a composition of $C_{20}H_{42}O_{15}$ or $C_{58}H_{42}O_{30}$. This crocin is a red colouring matter, and it is surmised that the red colour of the stigmas is due to this reaction taking place in nature.

At present saffron is chiefly cultivated in Spain, France, Sicily, on the lower spurs of the Apennines, and in Persia and Kashmir. The ground has to be thoroughly cleared of stones, manured, and trenched, and the corms are planted in ridges. The flowers are gathered at the end of October, in the early morning, just when they are beginning to open after the night. The stigmas and a part of the style are carefully picked out, and the wet saffron is then scattered on sheets of paper to a depth of 2 or 3 inches; over this a cloth is laid, and next a board with a heavy weight. A strong heat is applied for about two hours so as to make the saffron "sweat," and a gentler temperature for a further period of twenty-four hours, the cake being turned every hour so that every part is thoroughly dried.

It is calculated that the stigmas of about 4300 flowers are required to give an ounce of saffron; but the experiments of Chappellier indicate a possibility of greatly increasing the yield by the cultivation of monstrous forms.

The drug has naturally always been liable to great adulteration in spite of penalties, the severity of which suggests the surviving tradition of its sacred character. Thus in Nuremberg a regular saffron inspection was held, and in the 15th century we read of men being burned in the market-place along with their adulterated saffron, while on another occasion three persons convicted of the same crime were buried alive. Grease and butter are still very frequently mixed with the cake and shreds of beef dipped in saffron water are also used. Good saffron is distinguished by its deep orange-red colour; if it is light yellow or blackish, it is bad or too old. It should also have a peculiar and rather powerful odour, and a bitter pungent taste. If oily it is probably adulterated with butter or grease.

See Flückiger and Hanbury, *Pharmacographia*, and Maw, *Monograph of the Genus Crocus*, upon which the preceding account is essentially based; also Pereira, *Materia Medica*, and the pharmacopoeiae.

SAFFRON WALDEN, a market-town and municipal borough of Essex, England, is finely situated near the Cam in a valley surrounded by hills, on a branch of the Great Eastern Railway, 44 miles north-north-east of London and 4 south of Cambridge. It has a somewhat ancient appearance and possesses good streets and a spacious market-place. Of the old castle, dating probably from before the Conquest, the keep and a few other portions still remain. The church of St Mary the Virgin, a beautiful specimen of the Perpendicular style, dating from the reign of Henry VII., but frequently repaired and restored, contains the tomb of Lord Audley, chancellor to Henry VIII. There is an Edward VI. grammar-school, for which new buildings have recently been erected. Amongst the modern public buildings are the corn exchange (1848) and the new town-hall (1879). The town possesses a museum, a literary institute, and a horticultural society. The benevolent institutions include the hospital and the Edward VI. almshouses. In the neighbourhood is the fine mansion of Audley End, built by Thomas, first earl of Suffolk, in 1603 on the ruins of the abbey, converted in 1190 from a Benedictine priory founded by Geoffrey de Mandeville in 1136. The town is an important centre of agricultural industry and has large corn, cattle, and sheep markets. Brewing and malting are carried on. The population of the municipal borough (area, 7416 acres) in 1871 was 5718, and in 1881 it was 6060.

The original name of the town was Wealdenberg, and when it received a grant of a market in the time of Geoffrey de Mandeville it was called Cheping Walden. The substitution of the prefix Saffron is accounted for by the former culture of SAFFRON (*q.v.*) in the neighbourhood. The town has existed for more than 500 years as a guild, and the government is now vested in a mayor, four aldermen, and twelve councillors.

SAGAN, a manufacturing town in Prussian Silesia, situated on the Bober, a tributary of the Oder, lies 60 miles south-south-east of Frankfort-on-the-Oder and 102 miles south-east of Berlin. It contains the handsome palace of the dukes of Sagan, several interesting churches, a Roman Catholic gymnasium, and a large Gothic hospital, named after its founder, the duchess Dorothea (1793-1862). The leading industry of the town is cloth-weaving, with wool and flax spinning; it has also some trade in wool and grain. The population in 1880 was 11,373.

The mediate principality of Sagan, formed in 1397 out of a portion of the duchy of Glogau, has several times changed hands by purchase as well as by inheritance. One of its most famous possessors was Wallenstein, who held it for seven years before his death in 1634. Bought by Prince Lobkowitz in 1646, the principality remained in his family until 1786, when it was sold to Peter, duke of Courland, whose descendant, the duke of Talleyrand-Périgord and Valençay in France, now owns it. The area of the principality is about 467 square miles, and its population is about 65,000.

SAGAR, or SAUGOR, a British district of India, situated in the extreme north-west of the Central Provinces, and comprised between 23° 4′ and 24° 27′ N. lat., and between 78° 6′ and 79° 12′ E. long., with a total area of 4005 square miles. It is bounded on the N. by the Lálitpur district of the North-Western Provinces and the native states of Bijáwar, Panná, and Charkhári; on the E. by Panná and Damoh district; on the S. by Narsinhpur district and the native state of Bhopal; and on the W. also by Bhopal. Ságar district is an extensive, elevated, and in parts tolerably level plain, broken in places by low hills of the Vindhyan sandstone. It is traversed by numerous streams, chief of which are the Sunar, Bebs, Dhupan, and Bina, all flowing in a northerly direction towards the valley of the Ganges. In the southern and central parts the soil is black, formed by decaying trap; to the north and east it is a reddish-brown alluvium. Iron ore of excellent quality is found and worked at Hirapur, a small village in the extreme north-east. The district contains several densely wooded tracts, the largest of which is the Ramna teak forest preserve in the north. Roads are the only means of communication; of these the total length is 134 miles, 50 being returned as first class. The climate is moderate; the average temperature is 75°, and the average rainfall is about 46 inches.

By the census of 1881 the population numbered 564,950 (294,795 males and 270,155 females). Hindus numbered 498,071, Mohammedans 25,396, Buddhists and Jains 16,432, Christians 1034, and aboriginals 19,144. The only town except the capital (see below) with a population exceeding 10,000 is Garhakota, which contains 11,414 inhabitants. Of the total area only 1396 square miles are cultivated, and of the portion lying waste 1220 are returned as cultivable. Wheat forms the principal crop, which is produced in large quantities all over the district; other products are food grains, rice, oil-seeds, cotton, and sugar-cane. Cattle and buffaloes are bred to a large extent both for draught and carriage, and also for dairy purposes, especially for the manufacture of ghee. The revenue of Ságar district in 1883-84 amounted to £68,376, of which the land-tax contributed £44,429.

By a treaty concluded with Baji Rao in 1818, the greater part of the present district was made over to the British. During the mutiny of 1857 the whole district was in the possession of the rebels, excepting the town and fort, in which the Europeans were shut up for eight months, till relieved early in the following year by Sir Hugh Rose. The rebels were totally defeated and order was again restored by March 1858. Ságar was formed into a separate district of the Central Provinces in 1861.

SAGAR, principal town and headquarters of the above district, situated in 23° 50′ N. lat. and 78° 49′ E. long., is well built with wide streets and stands on the borders of a small but beautiful lake, and has military cantonments. Ságar is the entrepôt of the salt trade with Rájputána, and carries on a large trade with Mírzápur district in the North-Western Provinces, importing sugar and other grocery, besides English cloth. The population of the town in 1881 was 44,416 (males 22,556, females 21,860).

SAGE, LE. See LE SAGE.

SAGHALIN, or SAKHALIN, is the name improperly given to a large elongated island in the North Pacific, lying between 45° 57′ and 54° 24′ N. lat. and 141° 30′ and 144° 50′ E. long., off the coast of Russian Manchuria. Its proper name is *Karaftu*, or *Karafuto*. It is separated from the mainland by the narrow and shallow Strait of Tartary, which often freezes in winter in its narrower part, and from Yezo (Japan) by the Strait of La Pérouse. This island (670 miles long, 20 to 150 broad, with an area of 24,560 square miles), about equal in size to Belgium and Holland together, must be considered as a continuation of the mountains bordering the Manchurian littoral. Its orography is still imperfectly known. The present maps represent it as formed of two parallel ridges, running north and south and reaching from 2000 to 4000 or 5000 feet (Mounts Berniget and Ktõus-pal) high, with two or more wide depressions, not exceeding 600 feet above the sea. The general configuration of the littoral and the island, however, renders it more probable that there are three chains running south-west to north-east, forming continuations of those of the mainland. The geological structure of the island is also imperfectly known. A few crystalline rocks are found at several capes; Cretaceous limestones containing a rich and specific fauna of gigantic ammonites occur at Dui; and Tertiary conglomerates, sandstones, marls, and clays, folded by subsequent upheavals, are widely spread. The clays, which contain layers of good coal and a rich fossil vegetation, show that during the Miocene period Saghalin was part of a continent which comprised both north Asia, Alaska, and Japan, and enjoyed a much warmer climate than now. The Pliocene deposits contain a mollusc fauna more arctic than the present, and probably indicating that the connexion between the Pacific and Arctic Oceans was broader than now. Only two rivers, the Tym and the Poronai, are worthy of mention. The former, 250 miles long, and navigable by rafts and light boats for 50 miles from its mouth, flows north and north-east with numerous (about 100) rapids and shallows, in a wild valley suitable only for fishing or hunting settlements, and enters the Sea of Okhotsk at the Bay of Nyi. The Poronai flows north and then south to the Gulf of Patience, a wide bay on the south-east coast. Three other small streams enter the wide semicircular Gulf of Aniva at the southern extremity of the island.

Owing to the cooling influence of the Sea of Okhotsk, the climate is very cold. At Dui the average yearly temperature is only 33°·0 Fahr. (January, 3°·4; July, 61°·0), 35°·0 at Kusunai, and 37°·6 at Aniva (January, 9°·5; July, 60°·2). A dense covering of clouds for the most part shuts out the rays of the sun; while the cold current issuing from the Sea of Okhotsk, aided by north-east winds, in summer brings immense ice-floes to the east coast. The whole of the island is covered with dense forests (mostly coniferous). The Ayan fir (*Abies ayanensis*), the Saghalin pichta, and the Daurian larch are the chief trees; and the upper parts of the mountains have the Siberian rampant cedar (*Cembra pumila*) and the Curilian bamboo (*Arundinaria kurilense*), 4 feet high and half an inch thick. Birch, both European and Kamchatkan (*B. alba* and *B. Ermani*), elder, poplar, elm, wild cherry (*Prunus padus*), *Taxus baccata*, and several willows are mixed with the Conifers; while farther south the maple, the ash, and the oak, as also the Japanese *Panax ricinifolium* and the Amur cork (*Philodendron amurense*), make their appearance. The number of phanerogamous species known reaches 590 and may reach 700, of which only 20 are peculiar to Saghalin, the remainder belonging to the Amur and partly to the Japanese flora. The fauna of Saghalin closely resembles that of the Amur region, and in fact the Siberian. Bears, foxes, and sables are still numerous, as also the reindeer in the north and the antelope; and tigers are occasionally met with in the south. The avifauna is the common Siberian; and the rivers are exceedingly rich in fish, especially species of salmon (*Oncorhynchus*), which make their way up the rivers in vast numbers to spawn. The lower marine fauna, explored by Schrenck, is also rich, while numerous whales, not in high esteem with whalers, are met with on the sea-coast. Otarias, seals, and dolphins are a source of profit.

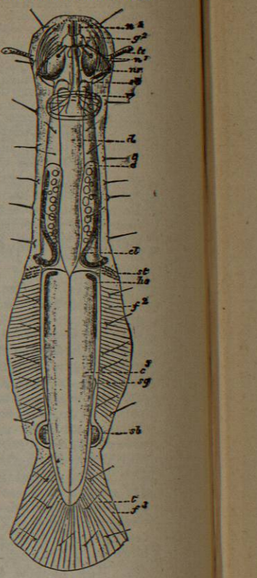
Saghalin has been inhabited since at least the Neolithic Stone Age. Flint implements, exactly like those of Siberia and Russia, have been found at Dui and Kusunai in great numbers, as well as polished hatchets (of trap, diorite, and argillaceous schists)—also like the European ones—primitive pottery with decorations like those of Olonetz, and stone weights for nets. Afterwards came a population to whom bronze was known; they have left their traces in earthen walls and kitchen-middens (in the Bay of Aniva). The present inhabitants consist of some 2000 Gilyaks, 2500 Ainos, 500 Oroks, as many Japanese, and about 6000 Russians. The Gilyaks, who do not differ from those of the Amur, inhabit the northern part of the island. They support themselves by fishing and partly by hunting, but suffer from competition with the Japanese, who take possession of the best fishing-grounds. The Oroks, of Tungus origin, resemble the Orotchons of the Amur; they live by hunting. The Ainos, who are still the subject of so much discussion among ethnologists, are the aborigines of the island; they are closely akin to the Curilians, and, like these, differ from all other Mongolian races by their luxuriance of hair and beard. They now inhabit only the south part of the island, and have been brought into a condition of slavery by the Japanese, by whom they have been driven out of Yezo and Nippon, in both of which they were the aborigines. The Japanese have several colonies on Saghalin and force the Ainos to fish and to collect seaweed for exportation. They send their ships to the south part of the island and have colonies there, and also on the east coast, at the mouth of the Tym. The Russians began to settle permanently on Saghalin in 1867; and, though next year posts were established in the southern part of the island, it still continued to belong to Japan, which definitely ceded it to Russia in 1875. A scheme having been lately formed for colonizing the island with convicts, several thousands have been transported thither, especially to Dui (Alexandrovsk), where they are employed in coal-mining (annual output from 3000 to 30,000 cwts.), or make some attempt at agriculture; they are either kept in the Alexandrovsk prison, or permitted to build houses and to settle with their families. These efforts towards colonization, however, encounter great difficulties from the quality of the soil, the cultivable patches occurring here and there in the marshy valley of the Duika river, on the upper course of the Tym, and in the bays of Patience and Aniva. The only crops that thrive are various kinds of kitchen produce. The Russian settlements are at Dui on the west coast, Malo-Tymovsk and Rykovsk on the upper Tym, Korsakoff and Muravieff on the Bay of Aniva.

History.—Saghalin, which was under Chinese dominion until the present century, became known to Europeans from the travels of Martin Gerrits in the 17th century, and still better from those of La Pérouse (1787) and Krusenstern (1805), who described large parts of its coasts. Both, however, regarded it as a mere appendage of the continent, and were unaware of the existence of the Strait of

Tartary, which was discovered a few years later by a Japanese, Mamia Rinso, whose discovery is embodied in Siebold's *Nippon*. The Russian navigator Nevelskoi, in 1849, definitively established the existence and navigability of this strait; since that time the Russian expeditions of Boshnyak (1851) and Rimskiy-Korsakoff (1853) continued the explorations, and in the latter year a Russian post was temporarily established at Aniva Bay. L. Schrenck in 1855-56, and MM. Schmidt, Glehn, Brylkin, and Shebunin in 1860, explored the geology, fauna, flora, and ethnology of the island; M. Lopatin in 1867 explored, on foot, the east coast; MM. Dobrotvorsky published (1869 and onwards) interesting data as to the inhabitants, and M. Polyakoff was entrusted in 1881-82 with a detailed exploration, and returned with rich ethnological and zoological collections, with regard to which only preliminary reports have as yet been published. (P. A. K.)

SAGINAW, a city of the United States, capital of Saginaw county, Michigan, lies on an elevated plateau about 30 feet above the water on the left bank of the Saginaw river, which falls into Saginaw Bay on Lake Huron, about 18 miles lower down. It is a railway junction of some importance, 100 miles north-west of Detroit, is connected with East Saginaw by a street railway, and can be reached by the largest vessels that ply on the lake. The upper branches of the river are also available for boat traffic throughout a considerable district. Saw-mills, planing-mills, and salt-works are the principal industrial establishments. The population was 7460 in 1870 and 29,541 in 1880. The city charter dates from 1859, the first settlement from 1822.

SAGITTA. The name "Sagitta" was given by Martin Slabber in 1775 to a small marine worm which is now known as the type of a distinct group, the *Chætognatha* (Leuckart). The group comprises two genera (*Sagitta* and *Spadella*) and a considerable number of species; they are small transparent pelagic animals, varying in length from a few lines up to two inches, and are universally distributed. The body (see fig.) is elongated and furnished with a tail and lateral fins, which are prolongations of the chitinous cuticle; the head is provided with a great number of variously shaped chitinous setæ. The body is divided by transverse septa into three distinct segments: the first septum is placed just behind the head (*st*), the second (*st*) about the middle of the body, separating the ovaries and testes. The body-cavity is likewise separated into right and left halves by a continuous vertical mesentery, which suspends the gut. The alimentary canal is a simple straight tube of uniform structure passing from the mouth to the anus, which is placed ventrally and at the second transverse septum; the alimentary tube is ciliated and is unprovided with glands of any kind. The body-wall is composed of (1) an outer layer of epidermis, which secretes the chitinous cuticle already referred to,—the thickness of the epidermis varying from five or six cells in the region of the head to a single layer of cells in the "fins"; (2) a delicate structureless supporting lamella; (3) a layer of longitudinal muscles. These last have a peculiar arrangement and structure: they are disposed in four bands, two dorsal and two ventral, the action of which is evidently favourable to producing the onward movements of the creature. The muscular fibres, which are transversely striated, are arranged in a series of lamellæ whose direction is perpendicular to the longitudinal axis of the body. Projections inward of the supporting lamella bear on either side a single row of muscular fibres; a similar muscular structure occurs in the *Nematoidea* and in many *Oligochæta*. In the anterior region of the body the muscular layer is differentiated into special muscles for the movement of the setæ. (4) The body-cavity is lined by a delicate peritoneal epithelium closely applied to the muscular layer of the body-wall and to the gut. The nervous system consists of a cerebral ganglion and a large ventral ganglion—the two united by commissures which pass round the gut; both ganglia are embedded in the epidermis. This primitive condition of the nervous system is retained in other lowly organized worms (*e.g.*, *Polygordius*). The ventral ganglion is connected with an intra-epidermic nervous plexus which surrounds the whole body. Eyes are present, besides a number of tactile cells upon the outer surface of the body; anteriorly is a ring-shaped structure (*r*) which is supposed to be olfactory in function. The generative organs consist of ovaries and testes, which are united in the same individual; the ovaries (*e*), placed anterior to the testes, are furnished with oviducts, which appear to terminate in a cæcal extremity. The testes (*ho*) are placed behind the second septum; they are each furnished with a vas deferens opening on to the exterior and into the body-cavity by a ciliated funnel. For embryology, see Balfour, *Comparative Embryology*, vol. i. p. 303.



Spadella cephaloptera (Busch).

St, septa dividing body-cavity transversely; *g*, cerebral ganglia; *n*, commissure uniting this with ventral ganglion (not shown in fig.); *n*², nerve uniting cerebral ganglia with small ganglia on head; *nr*, olfactory nerve; *d*, alimentary canal; *r*, olfactory organ; *te*, tentacle; *t*, tactile hairs springing from surface of body; *e*, ovary; *el*, oviduct; *ho*, testes; *sg*, vas deferens; *f*², *f*³, lateral and caudal fins; *sb*, seminal pouch. The eyes are indicated as black dots behind the cerebral ganglia.

In spite of the detailed knowledge which we now possess of the structure and development of the *Chætognatha*, the systematic position of the group remains a matter of the greatest uncertainty. That they are an archaic group is shown by their hermaphroditism, by the primitive condition of the nervous system, and by the persistence of the vertical mesentery among other characters; in all these points and in others they agree with such primitive *Annelida* as *Protodrilus* and *Polygordius*. On the other hand, their similarity to the *Nematoidea* has been dwelt upon; the disposition of the muscles is the same in both groups, and the *Gordiacea* have the gut suspended by a dorsal and ventral mesentery in the same fashion as has been described above in *Sagitta*; the *Chætognatha* differ, however, from the *Nematoidea* in the important fact of their segmentation. On the whole, it appears that the *Chætognatha* are best regarded as a special phylum equivalent to such groups as *Annelida*, *Platyhelminthes*, *Nematoidea*, but having no special relation to any one of them.

SAGO is a food-starch prepared from a deposit in the trunk of several palms, the principal source being the sago palm, *Metroxylon Rumphii* (Mart.), and *M. læve* (Mart.). These palms are natives of the East Indian Archipelago, the sago forests being especially extensive in the island of Ceram. The trees flourish only in low marshy situations, seldom attaining a height of thirty feet, with a thick-set trunk. They attain maturity as starch-yielding plants at the age of about fifteen years, when the stem is gorged with an enormous mass of spongy medullary matter, around which is an outer rind consisting of a hard dense woody wall about two inches thick. When the fruit is allowed to form and ripen, the whole of this starchy core disappears, leaving the stem a mere hollow shell; and the tree immediately after ripening its fruit dies. When ripe the palms are cut down, the stems divided into sections and split up, and the starchy pith extracted and grated to a powder. The powder is then kneaded with water over a strainer, through which the starch passes, leaving the woody fibre behind. The starch settles in the bottom of a trough, in which it is floated, and after one or two washings is fit for use by the natives for their cakes and soups. That intended for exportation is mixed into a paste with water and rubbed through sieves into small grains, from the size of a coriander seed and larger, whence it is known according to size as pearl sago, bullet sago, &c. A large proportion of the sago imported into Europe comes from Borneo, and the increasing demand has led to a large extension of sago-palm planting along the marshy river banks of Sarawak.

Various palms, in addition to the two above named, yield sago, but of an inferior quality. Among them may be mentioned the Gomuti palm (*Arenga saccharifera*), the Kittul palm (*Caryota urens*), the cabbage palm (*Corypha umbraculifera*), besides *Corypha Gebanga*, *Raphia flabelliformis*, *Phœnix farinifera*, and *Metroxylon filare*—all East Indian palms—and *Mauritia flexuosa* and *Guilielma speciosa*, two South-American species. The imports of sago into the United Kingdom for 1884 amounted to 346,188 cwt., valued at £195,680, the whole of which, excepting less than 300 tons, is entered as coming from the Straits Settlements.

SAGUNTUM, an ancient city of Hispania Tarraconensis, was situated near the mouth of the river Pallantias (Palancia). It was the centre of a fertile district and was a rich trading place in early times, but owes its celebrity to the desperate resistance it made to Hannibal (see vol. xi. p. 441). The Romans restored the city and made it a colony; later writers speak of its figs, which were esteemed at Rome, and of its earthenware, which enjoyed a certain reputation. The most important remains are those of the theatre.

The modern Sagunto or Murviedro (*muri veteres*), 18 miles by rail from Valencia on the line to Tarragona, is now about 3 miles from the sea; the population within the municipal boundaries was 6287 in 1877.

See vol. i., Plate II.

SAHARA is the great desert region which stretches across the continent of Africa eastwards from the Atlantic for a considerable distance on both sides of the Tropic of Cancer, and is generally distinguished by aridity of soil, absence of running water, dryness of atmosphere, and comparative scarcity of vegetable and animal life. The physical limits of this region are in some directions marked with great precision, as in part of Morocco and Algeria, where the southern edge of the Atlas range looks out on what has almost the appearance of a boundless sea, and forms, as it were, a bold coast-line, whose sheltered bays and commanding promontories are occupied by a series of towns and villages—Tizgi, Figig, Laghouat, &c. In other directions the boundaries are vague, conventional, and disputed. This is especially the case towards the south, where the desert sometimes comes to a close as suddenly as if it had been cut off with a knife, but at other times merges gradually and irregularly into the well-watered and fertile lands of the Sudan (Soudan). While towards the east the valley of the Nile at first sight seems to afford a natural frontier, the characteristics of what is usually called the Nubian or Arabian desert are so identical in most respects with those of the Sahara proper that some authorities extend this designation over the whole country to the shores of the Red Sea. The desert, indeed, does not end with Africa, but is prolonged eastwards through Arabia towards the desert of Sind. As the Nubian region has been described under the heading NUBIA (vol. xvii. p. 610), attention will in the present article be confined to the desert country west of the Nile valley. Even as thus defined the Sahara is estimated to have an area of 3,565,565 square miles, or nearly as much as all Europe minus the Scandinavian peninsula and Iceland; but, while Europe supports a population of 327,000,000, the Sahara probably does not contain more than 2,500,000,—a figure, however, which is sufficiently startling to those who think of it as an uninhabitable expanse of sand. The sea-like aspect of certain portions of the Sahara has given rise to much popular misconception, and has even affected the ideas and phraseology of scientific writers. Instead of being a boundless plain broken only by wave-like mounds of sand hardly more stable and little less dangerous than the waves of ocean, the Sahara is a region of the most varied surface and irregular relief, ranging in altitude from 100 feet below to some 5000 or 6000 or even it may be 8000 feet above the sea-level, and, besides sand-dunes and oases, containing rocky plateaus, vast tracts of loose stones and pebbles, ranges of hills of the most dissimilar types, and valleys through which abundant watercourses must once have flowed.

The culminating points of the Sahara are probably the summits of the Ahaggar (Hoggar), a great mountain plateau, not inferior to the Alps in the area which it covers, crossing the Tropic of Cancer about 5° and 6° E. long., almost midway between the Atlantic and the valley of the Nile. In its central mass rise with red steep cliffs two peaks, Watellen and Hikena, which Duveyrier believes to be volcanic like those of Auvergne. The height of this country has not been ascertained by direct European observation, but may be gathered from the fact that according to the Tuareg the snow lies for three months of the year, from December to March. To the north-west, and separated from the Atakor-'n-Ahaggar by a wide plain, rises the Muydir plateau, lying nearly east and west for a distance of about 200 miles. Its north-eastern extremity is extended towards Timassinin by the Irawen Mountains, which in their turn are separated by a narrow valley from the Tasili plateau (strictly Tasili of the Asjer or Asgar). This great plateau stretches south-east for 300 miles parallel with the Atakor-'n-Ahaggar (from which it is separated by the Amadghor and Adamar plains), and then the line of elevation is continued by low ridges to the Tummo or War Mountains, and so onwards to the highland country of Tibesti or Tu, whose highest point, Tusidde, is 7880 feet above the sea-level, while its south-eastern eminences gradually die away in the direction of Wadai and Darfor (Darfur). About midway between Tibesti and the Niger rises the isolated mountain mass of Air or Asben, in which Dr Erwin von Bary[1] discovered the distinct volcanic crater of Teginjir with a vast lava-bed down its eastern side. By some this country is assigned to the Sudan, as it lies within the limit of the tropical rains; but the districts farther south have all the characteristics of the desert. The low but extensive plateau of Adghagh lies between Air and the Niger. Away to the north-east, in the country of FEZZAN (*q.v.*), are the dark mountains of Jebel es-Sóda, which are continued south-east towards Kufra by the similar range of the Haruj; and in the extreme south-west at no great distance from the Atlantic is the hilly country of Adrar (Aderer).

Nearly all the rest of the Sahara consists in the main of undulating surfaces of rock (distinguished as *hammada*), vast tracts of water-worn pebbles (*serir*), and regions of sandy dunes (variously called *maghter*, *erg* or *areg*, *igidi* and in the east *rhart*), which, according to M. Pomel, occupy about one-ninth or one-tenth of the total area. The following is the general distribution of the dunes. From the Atlantic coast to the south of Cape Blanco a broad belt extends north-east for a distance of about 1300 miles, with a breadth varying from 50 to 300 miles. This is usually called the Igidi or Gidi, from the Berber word for dunes. Eastward it is continued to the south of Algeria and Tunis by the Western Erg and the Eastern Erg, separated by a narrow belt at Golea. To the south of the Eastern Erg (which extends as far north as the neighbourhood of the Lesser Syrtis) the continuity of the sandy tract is completely broken by the Hammada al-Homra (or Red Rock Plateau), but to the south of this region lie the dunes of Edeyen, which, with slight inter-

[1] *Zeitschrift für Erdkunde*, 1880.

ruptions, extend to Murzuk (Morzúk). To the south of the hammada of Murzuk the dunes of Murzuk stretch away south-east. Looked at in its entirety, this series of tracts may be called the northern zone; it forms a kind of bow, with its extremities respectively at the Atlantic and the Libyan Desert and its apex in the south of Tunis. In the south are the Juf,[1] covering a vast area to the south-east of the middle portion of the Igidi, another area between the Adghagh plateau and the Tasili wan Ahaggar, and a third between Air and Tibesti. Away to the east in the Libyan Desert is a vast region of dunes of unascertained limits. It must be borne in mind that the sands do not entirely cover the areas assigned to them in the ordinary maps, which are of too small a scale to show the interchange of different kinds of surface. In the Eastern Erg especially the dunes lie in long lines in a north-north-west and south-south-east direction, presenting a gradual slope to windward and an abrupt descent to leeward. There they are generally about 60 or 70 feet high, but in other parts of the Sahara they are said to attain a height of upwards of 300 feet. The true dune sand is remarkable for the uniformity of its composition and the geometrical regularity of its grains, whi h measure less than ·03937 inch.[2] While individually these appear crystalline or reddish yellow (from the presence of iron), they have in the mass a rich golden hue. According to M. Tissandier's examination, animal organisms, such as the microscopic shells of *Rhizopoda*, so abundant in sea-sand, are strikingly absent. Under the influence of the wind the surface of the dunes is subject to continual change, but in the mass they have attained such a state of comparative equilibrium that their topographic distribution may be considered as permanent, and some of them, such as Gern (Peak) al-Shúf and Gern Abd-al-Kader, to the south of Golea, have names of their own. The popular stories about caravans and armies being engulfed in the moving sands are quite apocryphal, but there is abundant evidence against the theory of M. Vátonne as to the dunes having been formed *in situ*. To understand their origin it is necessary to glance at the general geology of the Sahara, which, however, in this aspect, is only known in detail to the south of Algeria and along the routes of the Rohlfs expedition (1873-74, Dr Zittel) and that of Dr Lenz (1880).

Granite, which, along with gneiss and mica schists, seems to be the prevailing rock in the highlands of Air (Von Bary), comes to the surface more or less sporadically in the neighbourhood of Al-Eglab and in the Adrar districts in the south-west. Gneiss and mica schists are probably the main materials of the Ahaggar plateau. Volcanic rocks (basalt, &c.) form the mountain masses of Jebel es-Sóda and the Haruj; in Air they break through the granite and other rocks in a very erratic fashion. Slates and quartzite (possibly Silurian, according to Lenz), which play so great a part in Senegambia, appear to the north of the Senegal, along the edge of the desert, and crop out again in Adrar, on the eastern borders of the Juf, and to the east of Wady Sus. An immense tract from Adrar north-east to the borders of Algeria seems to be occupied by Devonian and Carboniferous formations, the characteristic fossils of which frequently show on the surface; farther east these rocks are covered by Cretaceous and Quaternary deposits, though they again appear in the Muydir and Tasili plateaus (M. Roche's report[3]). The development of the Cretaceous system is altogether one of the most striking features of Saharan geology, its extreme limits being the coasts of the Atlantic and the Red Sea, and the area occupied by it in the Algerian Sahara alone being equal to the whole of France. In the Algerian Sahara the Cretaceous rocks are covered by no later sediments, with the exception of certain Quaternary deposits, but in the Libyan Desert Tertiary deposits are abundant, though, according to Zittel, there is no sharp distinction between Cretaceous and Tertiary, the one seeming (certain palæological characteristics apart) to pass gradually into the other. Eocene limestones, rich in nummulites and operculines, stretch south and east from the oasis of Siwa and are well seen in the cliffs enclosing the depressed oasal areas which sink down to the Cretaceous rocks. To the south of Farafreh extends a vast tract of Nubian sandstone.

In all parts of the Sahara there is evidence of denudation carried out on a scale of unusual magnitude. The present surface of the desert has been exposed to the protracted wear and tear of the elements. But to determine the exact method by which the elements have done their work has hitherto proved beyond the power of science. The superficial observer is at once tempted to accept the theory of *submarine* denudation: the Sahara is still the "dried bed of a sea" in even such text-books as Professor Huxley's *Physiography* and Stanford's *Compendium of Geography*. The sand-dunes, the salt efflorescence and deposits, and the local occurrence of certain modern marine molluscs all go to help the hypothesis of a diluvial sea. But a more extensive acquaintance with Saharan characteristics shows that such a sea for the Sahara as a whole is impossible. The denudation must probably be explained as due to the combined action of fresh water and atmospheric agencies. Even at present the Sahara is not so destitute as has been supposed of fresh water. Though rain is one of the rarest phenomena of the lowlands, the mountains on its northern borders and the central highlands are both regions of precipitation, and discharge their surplus waters into the hollows. A glance at a good physical map of the Sahara shows in fact the skeleton of a regular river-system. From the north side of the Atakor-'n-Ahaggar, for instance, begins Wady Igharghar, which, running northwards between the Tasili plateau and the Irawen Mountains, appears to lose itself in the sands of the Eastern Erg, but can be distinctly traced northwards for hundreds of miles. Its bed contains rolled fragments of lava and freshwater shells (*Cyrena* and *Planorbis*). In a line almost parallel to Wady Igharghar Wady Mya descends from the plateau of Tademaït, and shows the importance of its ancient current by deep erosion of the Cretaceous rocks, in which a large number of left-hand tributaries have also left their mark. Away in the far east of the Libyan Desert Dr Zittel discovered stalactite caves in the limestone. The question arises, What has become of the abundant water-supply which filled the wadies and hollowed out the caves? Recent discoveries in the Algerian Sahara suggest that part of the water circulation has become subterranean. The streams from the Atlas which seem to be absorbed in the sands of the desert evidently find a series of underground reservoirs or basins capable of being tapped by artesian wells over very extensive areas. As Olympiodorus (quoted by Photius) mentions that the inhabitants of the Sahara used to make excavations from 100 to 120 feet deep, out of which jets of pure water rose in columns, it is clear that this state of matters is (historically) of ancient date. Since 1856 the French engineers have carried on a series of borings which have resulted in the fertilizing of extensive tracts; between 1856 and 1879 155 wells were bored in the province of Constantine alone. In Wady Rir', which runs for 80 miles towards the south-west of the Shott Melrir (comp. *infra*), the water-bearing stratum is among permeable sands, which are covered to a depth of 200 feet by impermeable marls, by which the water is kept under pressure. The wells, varying much in their discharge and "head," give a total of 3·5 cubic metres per second at an average temperature of 25°·1 Fahr. A similar artesian zone exists between Negussa and Wargla. Connexions probably exist with subterranean water-supplies in the mountains to the north. That in some way the water in the artesian reservoirs is kept aerated is shown by the existence below ground of fishes, crabs, and freshwater molluscs, all of which were ejected by the well called Mezer in Wady Rir'. Hitherto those subterranean basins have been verified only in a comparatively limited area (the whole expanse of the Sahara being considered); but the same phenomena are probably repeated to some extent in other regions.[4] The oases are of course proofs of the presence of a steady supply of underground moisture, for vegetation under the Saharan climate is exceptionally thirsty.

Everything considered, it may therefore be assumed that the desert formerly possessed a surface circulation of water capable of aiding in the processes of disintegration, removal, and deposition. Since the water disappeared other agencies have been at work. The surface of the rocks, heated by the sun and suddenly chilled by rapid radiation over night, gets fractured and crumbled; elsewhere the cliffs have been scored and the sand thus formed is at once turned by the wind into an active instrument of abrasion. In many places it has planed the flat rocks of the hammada as smooth as ice. Elsewhere it has scored the vertical faces of the cliffs with curious imitations of glacial striation, and helped to undercut the pillar- or table-like eminences which, under the name of *gurs* or "witnesses," are among the most familiar products of Saharan erosion. The softer quartz rocks of the Quaternary and Cretaceous series (and according to Zittel especially the Nubian sandstone) have been made to yield the sand which, drifted and sifted by the winds, has taken on the form of dunes. The slightest breeze is enough to make the surface "smoke" with dust; and at times the weird singing of the sands, waxing louder and louder, tells the scientific traveller that the motion is not confined to the superficial particles.[1] How important a part the winds may play in the redistribution of the lighter particles is probably shown by the clouds of red dust which were noticed by Edrisi as frequently obscuring the Atlantic sky between Cape Verd and the American coast, and which have recently been referred by Dr Gustav Hellemann to the African Sahara, whence Professor Tacchini also derives the similar clouds of dust observed in many parts of Italy (comp. Tchihatchef).

But even such a river-system as that supposed combined with all conceivable atmospheric agencies would only account for the minor phenomena of erosion. Dr Zittel in dealing with the Libyan Desert finds it necessary to assume violent freshwater floods proceeding from the south, though, as he confesses, this only shifts the difficulty a stage further back, as it involves an enormous change of climate. To render such a change of climate a probable hypothesis various recent speculations combine; and Dr Theobald Fischer and Dr Oscar Fraas agree in believing that the desiccation has markedly increased in historic times. Evidence derived from ancient monuments combined with the statements of Herodotus and Pliny are held to prove that the elephant, the rhinoceros, and the crocodile existed in North African regions where the environment is now utterly alien, and on the other hand that the camel is a late introduction. Humboldt sought to attribute the desiccation of the desert region of Asia and Africa to the effects of the north-east trade-wind; but Dr Lenz, who points out that in North Africa the wind seldom blows from the north-east but generally from the north or north-west[2] (the latter of course from the Atlantic, in the western parts, but farther east from the European regions of precipitation), argues that one of the principal causes has been the destruction of the forests on the highlands. The dry winds from the Sahara are known in Europe as the Scirocco and the Föhn or Fön.

Botanically the Sahara is the meeting-ground of representatives of the "Mediterranean" and the "Tropical" floras which have managed to accommodate themselves to the peculiar climatic conditions. The line of demarcation between the two floral areas, almost coinciding in the west with the Tropic of Cancer and in the east dipping south towards the meridian of Lake Tchad, assigns by far the greater portion of the area to "Mediterranean" influences.[3] Uniformity, in spite of differences of altitude and soil, is a general characteristic of the vegetation, which outside of the oases consists mainly of plants with a tufty dry stiff habit of growth. The oases are the special home of the date-palm, of which there are about 4,000,000 in the Algerian oases alone. In company with this tree, without which life in the Sahara would be practically impossible, are grown apples, peaches, oranges, citrons, figs, grapes, pomegranates, &c. During the months from December to March wheat, barley, and other northern grain crops are successfully cultivated and in the hotter season rice, dukhn, durra, and other tropical products. Altogether the oasal flora has considerable variety; thirty-nine species are known from the Kufra group, forty-eight from the Aujila group.

Zoologically the Sahara is also a debatable territory, partly Mediterranean, partly Tropical. Apart from the domestic animals (camels, asses, &c., and very noticeably a black breed of cattle in Adrar), the list of fifteen mammals comprises the jerboa, the fennek or fox, the jackal, the sand rat (*Psammomys obesus*), the hare, the wild ass, and three species of antelope. In Borku, Air, &c., baboons, hyænas, and mountain sheep are not uncommon. Without counting migratory visitants, about eighty species of birds have been registered—the ostrich, the *Certhilauda deserti* or desert-lark (which often surprises the traveller with its song), *Emberiza Saharæ*, three species of *Dromolœa*, &c. Tortoises, lizards, chameleons, geckos, skinks, &c., of fifteen different species were collected by the single Rohlfs expedition of 1873-74; the serpents comprise the horned viper, *Psammophis sibilans*, *Coelopeltis lacertina*, the python, and several other species. The edible frog also occurs. *Cyprinodon dispar*, a fish not unlike *Cyprinodon calaritanus*, is found in all the brackish waters of north Sahara and swarms in the lake of the Siwa oasis. The brine-shrimp has been described in the article FEZZAN.

The present population of the Sahara consists almost exclusively of Arabs, Berbers, and Negro tribes. The Berbers (Tuareg or Tuarik, &c.) occupy the west central region almost exclusively, appear sporadically in the western, and stretch northwards into Morocco and Algeria; the Negro tribes form a compact block in the east central region northwards and north-eastwards from Lake Tchad; and the Arabs are in possession of all the rest of the country. Politically the Sahara belongs partly to Morocco (Tafilet, &c.), partly to Algeria and Tunis (and thus to France), and partly to the Turkish empire (Tripolis, Egypt, &c.). France especially has been steadily pushing south with the purpose of forming a junction ultimately with her colony on the Senegal. The spirit of independence among the Mohammedan populations has been crystallized and stimulated by the remarkable confraternity of Sidi Mohammed ben 'Alí es-Senusi, founded about 1837, and now possessing about 120 convents or zawiga (mostly in the Saharan region), with its headquarters at Jerabub.[4] With this organization the French have already come into conflict in their southward progress. To establish their influence they propose the construction of a trans-Saharan railway and the opening up of the region to the south of Algeria and Tunis by the construction of an inland sea. According to M. Roudaire, the author and protagonist of this scheme, which is familiarly but deceptively styled the "flooding of the Sahara,"[5] it is possible by proper engineering works to create an inland sea to the south of Algeria and Tunis with an average depth of 78 feet and an area of 3100 square miles, or about fourteen times the size of the Lake of Geneva. A Government commission decided that the excavation of the necessary canal would not be difficult, and that, in spite of silting-up processes, the work would at least last 1000 to 1500 years. M. de Lesseps, M. Roudaire's principal supporter, visited the district in 1883 and reported that the canal would cost five years' labour and 150,000,000 francs. The scheme, which has met with persistent hostility on the part of M. Cosson and others, is based on the following facts. The Gulf of Gabes is separated by a ridge 13 miles across and 150 feet high from Shott al-Fejej, a depression which extends south-west into the Shott Jerid, which in its turn is separated from the Shott Rharsa only by a still narrower ridge. Shott Rharsa is succeeded westwards by a series of smaller depressions and beyond them lies the Shott Melrir, whose north-west end is not far from the town of Biskra. What we know about such inland seas as the Caspian and the Aral seems to cast serious doubt on the probability of any increase of the rainfall in the Sahara by the formation of Roudaire's sea.

The commerce of the Sahara is not inconsiderable. Among the more important trade routes are—(1) from Morocco to Cairo by Insalah and Ghadames, which is followed by the pilgrims of Western Africa bound for Mecca; (2) from Kuka to Murzuk and Tripolis; (3) from the Sudan to Tripolis by Air and Ghat; (4) from Timbuktu to Insalah, Ghadames, and Tripolis; (5) from Timbuktu to Insalah and thence to Algeria and Tunis; (6) from Timbuktu to Morocco. The two great products are dates and salt. Full details of the date trade will be found in Fischer's *Die Dattelpalme*, 1881. The principal sources of salt are the rock-salt deposits of the Juf (especially Taudeni), the lakes of Kufra, and the rock-salt and brine of Kawar (Bilma).

See, besides the works already quoted, Vatonne, *Mission de Ghadames*, 1863; Duveyrier, *Les Touaregs du Nord*, 1864; Ville, *Explor. géologique du Meab, &c.*, 1867; Pomel, *Le Sahara*, 1872; Rohlfs, *Quer durch Afrika* (1874), *Drei Monate in libyschen Wüste* (1875), and *Kufra* (1881); Largeau, *Le pays de Rirha-Ouargla*, 1879; Nachtigal, *Sáhárá und Súdán*, 2 vols., 1879; Rolland, "Le Crétacé du Sahara Septentrional" (with geological map of the Central Sahara), in *Bull. de la Soc. Géol. de France*, 1881; Roudaire, *Rapport sur la dernière exped. des Chotts*, 1881 (and other reports by the same author); Tchihatchef, "The Deserts of Africa and Asia," in *British Association Reports* (Southampton, 1882); Derrécagaix, "Explor. du Sahara: Les deux missions du Lieut.-Colonel Flatters," in *Bull. de la Soc. de Géogr.*, 1882; Lenz, *Timbuktu: Reise durch Marokko, &c.*, 1884; and Reclus, *Nouv. Géographie Univ.*, xi., 1886, which contains an admirable résumé.

(H. A. W.)

SAHÁRANPUR, or SEHARUNPOOR, a British district of India, in the Meerut division of the lieutenant-governorship of the North-Western Provinces. It lies between 29° 35′ and 30° 21′ N. lat., and between 77° 9′ and 78° 15′ E. long., and is bounded on the N. by the Siwálik Hills, separating it from the district of Dehra Dún, on the S. by the district of Muzaffarnagar, on the E. by the Ganges, and on the W. by the Jumna. Saháranpur forms the most northerly portion of the Doáb, or alluvial tableland, which stretches between the valleys of the Ganges and the Jumna. The Siwálik Hills rise precipitously on its northern frontier; at their base stretches a wild submontane tract, with much forest and jungle. Cultivation generally in this part is backward, the surface of the country being broken by wild and magnificent ravines. South of this tract, flanked on the east and west by broad alluvial plains, lies the Doáb, with fertile soil and good natural water-supply. This portion of the country is divided into parallel tracts

[1] This name, meaning the "depression," has long been in use, but appears to be a misnomer; the lowest point in Lenz's route, which, however, only crossed the east end of the Juf, was 400 feet above the sea.

[2] See Rolland, in *Bull. de la Soc. géol. de France*, 1881, and *Revue Scientifique*, 1881.

[3] *Comptes Rendus, Acad. des Sciences.*

[4] See Rolland, "Le régime des eaux artésiennes de l'Oued Rir et du Bas Sahara," in *Comp. Rend., Acad. des Sc.*, Sept. 1885.

[1] See Lenz's chapter on this phenomenon.

[2] Comp. Derrécagaix, "Le sud de la province d'Oran," in *Bull. de la Soc. de Géogr.*, Paris, 1873.

[3] Comp. Drude, *Florenreiche der Erde*, 1884; and Cosson, *Compendium Floræ Atlanticæ*, 1881, &c.

[4] See list in Duveyrier's paper, *Bull. de la Soc. de Géogr.*, 1884.

[5] In this connexion it is enough to mention Mr Mackenzie's scheme for flooding the Western Sahara; see *Flooding Sahara*, 1877, and Ravenstein, "The Western Sahara," in *Geog. Mag.*, 1876.