grain-export season. The principal church, completed in 1867, is a large and costly building with an imposing dome. Sistova was one of the first of the Bulgarian towns to introduce the national language into its schools (1833), some of which are now well-endowed and flourishing. More than half the inhabitants, who numbered 11,560 in 1881, are Bulgarians, the rest being Turks, Walachians, and Gipsies.

Sistova is identified with the old Roman colony *Nove* mentioned by Ptolemy and others. The exact site appears to have been Staklen, a cluster of vineyards with remains of ancient buildings to the west of the present town, which has gradually moved eastward since the 16th century, when it was reduced by the Turkish wars to a miserable village. It was at Sistova that the peace of 1790 was signed, by which the Austrian-Turkish boundary was determined. The town was burned in 1810 by the Russian general Saint Priest; but subsequent to 1820 it began to revive, and the introduction of steam traffic on the lower Danube (1835) restored its prosperity in spite of the effects of the Russian war of 1828–29, when the Walachian town of Alexandria was founded by fugitives from Sistova. In 1877 the Russians entered Bulgaria by passing the river just below Sistova.

SISTRUM, a kind of rattle used by the ancient Egyptians in religious ceremonies, especially in the worship of Isis. It consisted of a frame through which passed four rods; attached to the frame was a handle. When shaken the rods rattled and produced the sound. After the introduction of Egyptian worships into Italy the Romans became familiar with the sistrum. It is described by Apuleius (*Metam.*, xi. 4). An ancient sistrum formerly existed in the library of Ste Geneviève at Paris. In paintings found at Portici a priest of Isis and a woman are represented rattling the sistrum. The instrument is said to be still in use in Nubia and Abyssinia.

SISYPHUS, a famous character of Greek mythology, was a son of Æolus and Enarete and brother of Cretheus, Athamas, and Salmoneus. He built Ephyra (Corinth), and married Merope, daughter of Atlas, by whom he had a son Glaucus. According to Pausanias (ii. 3, 11) Sisyphus succeeded Medea in the sovereignty of Corinth. Having found the body of the drowned Melicertes lying on the shore of the isthmus, Sisyphus buried him and instituted in his honour the Isthmian games. From Homer onwards Sisyphus was famed as the craftiest of men. His name (formed by reduplication from the same root as σοφός) means the Wise, Wise One. When Death came to fetch him, Sisyphus put him into fetters, so that no one died till Ares came and freed Death, and delivered Sisyphus into his custody. But Sisyphus was not yet at the end of his resources. For before he died he told his wife that when he was gone she was not to offer the usual sacrifice to the dead. So in the under world he complained that his wife was neglecting her duty, and he persuaded Hades to allow him to go back to the upper world and expostulate with her. But when he got back to Corinth he positively refused to return to Deadland; so he lived to a good old age, and even then Hermes had a tough job to carry him off. In the under world Sisyphus was compelled to roll a big stone up a steep hill; but before it reached the top of the hill the stone always rolled down, and Sisyphus had to begin all over again. The subject was a commonplace of ancient writers, and was depicted by the painter Polygnotus on the Lesche at Delphi.

The way in which Sisyphus cheated Death is a common incident in folk-tales. Thus in a Venetian story the ingenious Beppo ties up Death in a bag and keeps him there for eighteen months; there is general rejoicing; nobody dies, and the doctors are in high feather. In a Sicilian story an innkeeper corks up Death in a bottle; so nobody dies for years, and the long white beards are a sight to see. In another Sicilian story a monk keeps Death in his pouch for forty years. (See Crane, *Popular Italian Tales*, Nos. 63, 64, 65, 66, with the translator's notes.) The German parallel is Gambling Hansel, who kept Death up a tree for seven years, during which no one died (Grimm, *Household Tales*, No. 82; in his notes Grimm cites a number of German parallels). The Norse parallel is the tale of the Master Smith (Asbjörnsen og Moe, *Norske Folke-Eventyr*, 21; Dasent, *Popular Tales from the Norse*, p. 106). For a Lithuanian parallel, see Schleicher, *Litauische Märchen, Sprichwörte, Rätsel, und Lieder*, p. 108 *sq.*); for Slavonic parallels, Krauss, *Sagen und Mährchen der Südslaven*, ii., Nos. 125, 126.

SITÁPUR, a British district in Sitápur division or commissionership of Oudh, under the jurisdiction of the lieutenant-governorship of the North-Western Provinces of India. It lies between 27°7′ and 27° 53′ N. lat. and between 80° 21′ and 81° 26′ E. long., and it is bounded on the N. by Kheri district, on the E. by that of Bahraich, from which it is separated by the Gogra river, and on the S. and W. by Bara Banki, Lucknow, and Hardoi districts, the Gumti river forming the boundary. Sitápur district is elliptical in shape; its greatest length from south-east to north-west is 70 miles, and its extreme breadth from north-east to south-west 55 miles; its area is 2251 square miles. Being without hills or valleys, and devoid of forests, Sitápur presents the appearance of a vast plain sloping imperceptibly from an elevation of 505 feet above sea-level in the north-west to 400 feet in the south-east. The country is, however, well wooded with numerous groves, and well cultivated, except in those parts where the soil is barren and cut up by ravines. It is intersected by numerous streams, and contains many shallow ponds and natural reservoirs, which overflow during the rains, but become dry in the hot season. Except in the eastern portion, which lies in the doabs or alluvial plains between the Kewáni and Chauka and the Gogra and Chauka rivers, the soil is as a rule dry, but even this moist tract is interspersed with patches of land covered with saline efflorescence called "reh." The principal rivers are the Gogra, which is navigable by boats of large tonnage throughout the year, and the Chauka. Nylghau, many varieties of deer, wild hog, wolf, jackal, and fox are common, but none of the larger wild animals are found within the district. The climate is considered healthy, and the cantonments of Sitápur are famous for the low mortality of the British troops stationed there. The average annual rainfall is about 33 inches. The district contains no railway, but it is well provided with good unmetalled roads.

In 1881 the population was returned at 958,251 (505,986 males and 452,265 females); Hindus numbered 818,738, Mohammedans 138,733, and Christians 443. Sitápur contains but two towns with more than 10,000 inhabitants,—namely, Khairabad, 14,217, and Laharpur, 10,437. The administrative headquarters of the district are at Sitápur town, which is prettily situated on the banks of the Saráyan river, with good groves in all directions, and with a population in 1881 of 6780. Of the total district area 1455 square miles are cultivated and 510 are cultivable. The principal staples are wheat, barley, joar, gram, bajra, and rice; besides these a considerable quantity of sugar-cane is raised, as also oil seeds, cotton, and tobacco. The only manufactures of any note are tobacco and tazias at Biswán, with a little cotton printing and weaving in most of the towns. The history of Sitápur is closely associated with that of the rest of Oudh. The district figured prominently in the mutiny of 1857, when the native troops quartered in the cantonments rose in mutiny and fired on their officers, many of whom were killed, as were also several military and civil officers, with their families, in attempting to escape. Order being restored in 1858, the Government offices were re-opened, and nothing has since occurred to disturb the peace of the district.

SITTINGBOURNE, an ancient town of Kent, is situated on a navigable creek of the Swale, and on the London, Chatham, and Dover Railway, at the junction for Sheerness, 7 miles south from the latter town and 45 east-south-east of London. It consists principally of one long street and the northern suburb of Milton, formerly celebrated for its oysters, the fishery of which used to employ a large number of the inhabitants. Brickmaking is a very important industry, and there are large paper-

mills. St Michael's church, in the Early English and later styles, underwent extensive restoration in 1873 at a cost of nearly £3000. The principal other public buildings are the old town-hall, the corn exchange (erected 1859), and the museum. Public gardens 10 acres in extent have recently been laid out. The local government board was instituted in 1878. The population of the urban sanitary district (area 1004 acres) in 1871 was 6148 and in 1881 it was 7856.

Sittingbourne, or Sedyngburne, received a grant of a market and two annual fairs by a charter of Queen Elizabeth. The style "guardian and free tenants," applied to the corporation in this charter, was subsequently changed to that of "mayor and jurats."

See W. A. Scott Robertson, *Sittingbourne and the Names of Lands and Houses in or near it*, Sittingbourne, 1879.

SIÚT, or ASYÚT (ASIOOT), more correctly OSYÚT, a town of Upper Egypt, and southern terminus of the railway on the left bank of the Nile, by which it is 229 miles from Búlák Dakrúr. The population is about 25,000. See EGYPT, vol. vii. p. 775.

SIVA. See BRAHMANISM.

SÍVÁS, or Síwás, a pashalic and capital of a pashalic of great importance in Asia Minor. The town is situated on the right bank of the Kizil Irmak (Halys), in a plain of some 16 to 20 miles in length and 4 to 6 in breadth. From the south the approach is by a good road among the mountains, and the aspect from the heights is pleasing. Dotted here and there with trees, some in large extended clusters, the houses and citadel cover a considerable space and appear much scattered. On the north a military road has been constructed to facilitate communication with the coast. Sívás is 4670 feet above the level of the Black Sea, and should be a healthy residence for Europeans. The population, estimated on the spot in 1864 at 10,000 houses, more than a fifth being Armenians, is stated in Murray's *Handbook* of 1878 to consist of 5000 Turkish and 1200 Armenian families. There are some respectable residences but not many buildings or monuments of note; and the streets are narrow and ill-maintained. The bazaars are fairly stocked with goods, British as well as of other European nations.

Sívás is the ancient *Sebasteia* (not to be confounded with Sebaste or Cabira on the Lycus, the modern Niksar), the capital of Armenia II., and the seat of an archbishop. In 1021 it was ceded by the emperor Basil to the Armenian king, Senekharim. It again became Greek in 1080, but soon after fell to the Seljúks. In the 13th century Marco Polo speaks of Sevaste as the place "where the glorious Messer Saint Blaise suffered martyrdom." It was, when he wrote, in the possession of the Turkmáns of Karamania, living under the government of the Seljúk princes. In the 14th century we have the testimony of Ibn Batuta, who says (ii. 289):—"It is one of the possessions of the king of Irak, and the largest town owned by him in the country. His chiefs and his collectors reside there. It is well-built, and has wide streets and crowded markets." Colonel Goldsmid visited Sívás in July 1864, and was shown some fine monuments described as the mausolea of the Seljúks, the inscriptions on which he found to date no earlier than 670 of the Hijra, though the actual tombs might be traceable to a former period.

SIXTUS I. (XYSTUS) figures in the lists accepted by the Roman Church as having been bishop of Rome from about 119 to about 126. He is conjectured to have been a presbyter and a martyr.

SIXTUS II. followed Stephanus I. as bishop of Rome in 257, and suffered martyrdom under Valerian in the following year. He restored the relations with the African and Eastern Churches which had been broken off by his predecessor on the question of heretical baptism. Dionysius succeeded him.

SIXTUS III., bishop of Rome from July 31, 432, to August 18, 440, had Cœlestinus I. as his predecessor, and was succeeded by Leo I.

SIXTUS IV. (Francesco della Rovere), pope from 1471 to 1484, was born 21st July 1414, near Savona. The statements respecting his parents' situation in life are very conflicting. In consequence of a vow made by his mother he entered the Franciscan order at an early age, and speedily acquired a great reputation for eloquence and learning. After filling several minor offices he became general of his order, and in 1467 was to his own surprise made cardinal by Paul II., at the recommendation, it is asserted, of Cardinal Bessarion. When, upon Paul's death in 1471, the rigour of Bessarion's principles prevented his profiting by the favourable sentiments of influential cardinals, who, nevertheless, expected to be recompensed for their suffrages, Rovere seems to have been found more accommodating. The liberality of his donations after his election, at all events, raised suspicion; but the friendship of Bessarion has also been enumerated among the causes of the sudden elevation of the most recent member of the Sacred College. He was elected on 9th August 1471, and immediately proceeded to lavish Paul's treasures—partly in laudable preparations against the Turks; partly in embassies, receptions of foreign princes, public improvements, and other expenses possibly imprudent, but at least not indecorous; partly, without any excuse, upon his unworthy nephews, Count and Cardinal Riario. The prodigalities of the latter surpassed all measure, and he compromised his uncle much more seriously by his complicity in the conspiracy of the Pazzi, aiming at the assassination of the Medici family. Sixtus was cognizant of the plot, but had positively forbidden the shedding of blood, which he must nevertheless have known to be inevitable. He deserves still more censure for entering into a fruitless and inglorious war with Florence, which terminated in 1480, after having kept Italy for two years in confusion. Scarcely was it over when he allowed himself to be involved in yet more troublesome and discreditable contests,—first inciting the Venetians to attack Ferrara, and then, after having been delivered by their general Roberto Malatesta from a Neapolitan invasion, turning round upon them and eventually assailing them on their refusal to desist from the hostilities which he had himself instigated. He relied on the co-operation of Lodovico Sforza, who speedily forsook him; and the scandal was witnessed of the secular princes and cities of Italy agreeing to a peace which the Father of Christendom did his best to thwart, and vexation at which was believed to have hastened his death. He died, at all events, a few days afterwards, 13th August 1484, leaving an unfortunate reputation as the first pope who brought nepotism into politics, and, not content with enriching his relatives by gifts and lucrative offices, made their aggrandizement the principal object of his policy as a secular prince. His private character was nevertheless estimable: he was pious, of blameless morals, hospitable and munificent to a fault, and so exempt from avarice, says his secretary Conti, that he could not endure the sight of money. His faults were those of a monk who had no natural outlet for strong affections except unworthy relatives, and who had been called from a cloister to fill the most conspicuous position in the world. His secular policy was capricious and spasmodic; he neither maintained the peace of Italy like his predecessor and successor nor carried out a consistent and well-considered scheme of conquest like Alexander VI. He was, notwithstanding, always firm in his resistance to the Turks, and showed magnanimity by aiding his enemy the king of Naples against the common foe of Christendom. The brilliant side of his administration was his munificence as a founder or restorer of useful institutions and a patron of letters and art. He established and richly endowed the first foundling hospital, built and repaired numerous churches, constructed the Sixtine Chapel and the Sixtine Bridge commissioned paintings on the largest scale, pensioned ar-

rewarded men of learning, and, above all, immortalized himself as the second founder of the Vatican library. It has been said that the stones alone inscribed with his name would serve to erect a considerable edifice. These great works, however, were not accomplished without grievous taxation and questionable methods of raising money; and Sixtus's successor expressed the general condemnation of his government when he declared that he for his part would imitate the example of Paul II. Sixtus was succeeded by Innocent VIII. (R. G.)

SIXTUS V. (Felice Peretti), pope from 1585 to 1590, was born 13th December 1521 at Grottamarina, in the district of Fermo, of a family said to be of Dalmatian extraction. His parents were undoubtedly in humble circumstances, but the story of his having been a swineherd in his youth seems to be a mere legend. He entered the Franciscan order at an early age, and obtained great celebrity as a preacher. After having been successively professor at Rimini and at Siena, he became inquisitor-general in Venice (where his firmness in controversy with the Venetian Government exposed him to personal danger), theologian at the council of Trent, and ultimately vicar-general of his order. In 1565 he accompanied the papal legate to Spain, and in 1570 was created cardinal by Pius V., and entrusted with the publication of a correct edition of the works of St Ambrose, which appeared in 1579–1585. Finding himself out of favour with Pius's successor, Gregory XIII., he withdrew to a villa which he had purchased, and lived in strict retirement, affecting, it is said, to be in a precarious state of health. According to the usual story, which is probably at least exaggerated, this dissimulation greatly contributed to his unexpected elevation to the papacy on the next vacancy, 24th April 1585. If the electors had indeed anticipated a weak or ephemeral pontificate, they were grievously disappointed. Sixtus speedily proved himself one of the most vigorous popes, both in body and mind, that had ever occupied the chair of St Peter. Within two years he issued seventy-two bulls for the reform of religious orders alone. Ardent, despotic, indefatigable, he did everything by himself, rarely invited advice and still more rarely followed it, and manifested in all his actions a capacious and highly original genius, in most respects eminently practical, but swayed in some things towards the visionary and fantastic by the inevitable effects of a monastic training. His first great aim was to purge the papal dominions of the robbers who had overrun them under the weak administration of his predecessor. This salutary undertaking was effectually accomplished, not without many instances of tyranny and cruelty which have left a stain upon his name; but security of life and property returned. Sixtus's financial management seemed on a superficial view equally brilliant; he had found the exchequer empty, and speedily accumulated an immense treasure. But this end was obtained partly by excessive taxation, partly by the sale of offices which had never before been venal; and the withdrawal of such an amount of specie from circulation impoverished the community. His intention was to amass a fund for use in special emergencies, such as a crusade or a hostile invasion, which never arose. Much, nevertheless, was expended by Sixtus in the encouragement of agriculture and commerce, and in public works, either of signal utility, like his supply of Rome with water, or such at least as impressed the popular imagination with his munificence, as the completion of the cupola of St Peter's, the construction of six new streets, and the elevation of four Egyptian obelisks in various parts of Rome. Though a scholar, Sixtus was no humanist, and did much mischief to the monuments of antiquity, ruthlessly destroying some, and disfiguring those which he repaired by the addition of Christian attributes. In his ecclesiastical and foreign policy good sense contended with eccentricity but usually obtained the upper hand. He thought of attacking Turkey with the alliance of Poland and Russia, of subjugating Egypt by his own forces, of making a descent into Syria and carrying off the Holy Sepulchre. But he never attempted to realize these projects, and his conduct of the affairs which imperatively required his attention evinced more moderation than could have been expected. After having strongly sided with Spain and the League, he allowed himself to be convinced by the Venetian ambassador of the evil consequences of Spanish preponderance in Italy, and showed a manifest disposition to acknowledge Henry IV. as king of France, on condition of his abjuration. This led to violent altercations with the Spanish ambassador, and the death of the pope on 27th August 1590 was attributed by many to poison, though without sufficient ground. He was succeeded by Urban VII. Sixtus V. left the reputation of a zealous and austere pope,—with the pernicious qualities inseparable from such a character in his age,—of a stern and terrible but just and magnanimous temporal magistrate, of a great sovereign in an age of great sovereigns, of a man always aiming at the highest things and whose great faults were but the exaggeration of great virtues.

The best view of his character and government is that given by Ranke. Leti's well-known biography is full of fables; Tempesti is too panegyrical; and Lorentz is little more than a compiler from the two. The most valuable part of Baron von Huebner's *Sixte Quint* (Paris, 1870) is the rich appendix of documents. Sixtus's note-books and drafts of letters in the Chigian library, frequently referred to by Tempesti and Ranke, were published by Cugnoni in 1882. (R. G.)

SKATE. See RAY.

SKATING, as at present practised, may be defined as a mode of progression (usually rapid) upon smooth ice, by the aid of steel blades attached to the soles of the feet. It probably originated in the far north of Europe, in Scandinavia and Germany, where it is still in common use. In Russia it has never been a national pastime, as no smooth ice is formed in the rapidly running rivers. Even in St Petersburg it is mainly engaged in by English and Germans. The earliest skates appear to have been certain bones of large animals, but wood was also used from an early period.

In modern skating there are two totally distinct styles, which require different skates differently attached to the feet, and different extents and qualities of ice. The first, the "running" or "fen" style, simply consists in going straight ahead at the highest possible speed. Its home is on the fiords of Scandinavia, the fens of Lincolnshire, and the large rivers and lakes of North America. In Holland, Denmark, and North America it is the medium for carrying a large winter market traffic. It first became common in England in 1662 after the return of the Stuarts. The wooden part or stock of a running skate is from 8 to 12 inches long, according to the length of the foot. The blade is made of the best steel, with an average width of $\frac{5}{32}$ inch. The heel is at right angles to the surface of the ice. The prow begins to rise off the ice at the fore end of the stock, at a gradually increasing angle, and projects 4 inches. The entire skate is attached to the foot by an iron screw in the heel of the stock which enters the skater's boot heel and two long straps which pass through slots in the stock and fasten round the ankle and toes of the skater. The length of the heel strap varies from 22 to 32 inches, and that of the toe strap from 15 to 23 inches. Formerly the bottoms of the blades were fluted. A concavity is now effected by grinding; and, when in motion, the blade is rarely flat on the ice. The curve should be slight, and the depth

no greater than will ensure a curve being made without touching the ice. The feet are placed at right angles to each other with the toes turned out and the body bent slightly forward. Each foot is then raised alternately and set down slightly on the inside edge. It immediately acquires a forward motion, which is increased by pushing with the other foot, that being at right angles and having no sliding motion. The feet must be kept perfectly level when raised and set down, and the skate carried in the same manner an inch above the ice when going forward. The forward stroke is made on the outer edge, and the pressure applied to the inner edge of the other foot. The arms are swung across the chest from side to side, and opposite to the direction of the striking leg in order to balance the weight. The quickest method of stopping is to place the feet parallel, dig the heels into the ice, and arch the back. A longer but more graceful method is to turn the toes inwards, thus spreading the outside edges athwart the line of going. The feet should never be looked at, as the balance of the body is thereby disturbed. The eye should always be on a line with the horizon.

The fastest skating times recorded, from a standing start, and with no rear wind, have all been made in the United States, at New York, as follows:—100 yards, $10\frac{3}{5}$ s.; 200, $21\frac{3}{5}$ s.; 300, $31\frac{2}{5}$ s.; $\frac{1}{4}$ mile, $44\frac{1}{5}$ s.; $\frac{1}{2}$, 1 m. $41\frac{1}{5}$ s.; $\frac{3}{4}$, 2 m. $34\frac{4}{5}$ s.; 1, 3 m. $26\frac{2}{5}$ s.; 2, 6 m. $56\frac{3}{5}$ s.; 3, 10 m. $33\frac{3}{5}$ s.; 4, 14 m. $10\frac{1}{5}$ s.; 5, 17 m. 45 s.; 6, 21 m. 38 s.; 7, 25 m. $17\frac{3}{5}$ s.; 8, 29 m. $9\frac{2}{5}$ s.; 9, 32 m. $54\frac{1}{5}$ s.; 10, 36 m. $37\frac{1}{5}$ s.; 20, 1 h. 14 m. $7\frac{1}{5}$ s.; 30, 2 h. 31 m. 12 s.; 40, 3 h. 21 m. 22 s.; 50, 4 h. 13 m. 36 s. The best running high jump on skates recorded is 3 ft. $1\frac{2}{3}$ in., and running long jump 15 ft. 2 in.

The second style, termed "figure skating," is quite modern and purely English in its origin. This may be practised on any small pond, provided the ice is clear of snow and perfectly smooth. The more numerous opportunities thus afforded make it the more popular style in Great Britain, where the large streams seldom freeze. Figure skating consists in cutting arcs, circles, figures, letters, serpentines, and spirals,—either forwards or backwards, slowly or rapidly, on one or both feet, singly or in combination. The style can ultimately be analysed into four kinds of strokes, all made on the edges of the blade—the inside forward, the outside forward, the inside backward, and the outside backward. The variety of evolutions which can be developed from these four movements is endless. The figure skate is made entirely of metal, is strapless and fixed to the boots by clamps or like devices. Unlike the running skate, it can be instantly put on or taken off. Many kinds have been invented, but the "Acme," first produced in Canada, is generally acknowledged the best. The blade projects the merest trifle beyond the length of the foot and is rounded off in an upward direction from the ice at both toe and heel. The bottom is $\frac{1}{4}$ inch wide, and the best curve for grinding it is to that of a seven-foot radius, equal throughout and not increased at either end. In stopping, the end of one skate is placed at right angles to the other.

Summer skating has been occasionally provided in "glaciariums" by means of artificially produced ice.

The London Skating Club, founded in 1830, is the leading skating society of Great Britain. Comprising but 170 members, including 20 ladies, and practising on exclusively private water in Regent's Park, it countenances figure skating only and gives no encouragement whatever to the spread or teaching of a national pastime. The National Skating Association was formed in the year 1879, and, on December 8, held the first race for the running championship at Thorney, Cambridgeshire. The objects of the association are as follows:—

To promote, ascertain, and reward speed in skating,—by the establishment and management of amateur and open skating championships of England; by stimulating and supplementing local action in holding of skating matches; by establishing an order of merit for speed skaters and awarding badges for the same; by assisting in providing facilities for skating by the shallow flooding of land in each locality where local branches exist; and by collecting through corresponding members information of the existence of ice on which skating is practicable, and the supplying of such information to its members; and to promote and encourage figure skating, by the establishment of standards at which figure skaters may aim, by bestowing badges of merit on those who attain these standards, and by promoting and assisting in the formation of skating clubs. To provide rules and regulations for the game of hockey on the ice. Also to promote the establishment of international skating contests in various countries under the direction of an international council

In the United States and Canada large and shallow artificial ponds under cover, termed "rinks," are in winter frozen by filling them with water. Each night the surface is covered with a layer of water, which gives a fresh sheet of ice by morning. The covers protect the rinks from snow, another great advantage.

As regards a substitute for ice and ice skating on wooden or asphalt floors, the only invention that has ever been found even partially successful is that of James L. Plimpton of New York in 1869. The implements may be described as skates with two parallel wheels at the toe and heel, so hung that the wheel axles are moved out of parallel by the transverse rocking of the skater's foot, the wheels setting squarely on the surface whether the skater be upright or canted. The fatigue caused by these "roller skates" is quadruple that of ordinary ice skating.

See *The Field*, December 23, 1882, January 6 and February 3, 1883; N. and G. A. Goodman, *Handbook of Fen Skating*, 1882; G. Anderson, *Art of Skating*, 4th ed., 1880; H. C. Vendervell and T. M. Witham, *Figure Skating*, 3d ed., 1880; and M. F. M. and S. F. M. Williams's *Combined Figure Skating*, 1883.

SKELETON

THE word "skeleton," meaning in Greek a mummy, is popularly taken to denote that assemblage of bones and cartilages which forms the internal support of the body of man and of the animals more or less nearly resembling him. A slight acquaintance with the structure of these animals, however, seems to make it evident that a wider signification must be given to the term, since parts which in man and many of his animal allies are bony or cartilaginous may be only membranous in other such animals; and, conversely, parts sometimes quite external, which are merely membranous in man and many animals, may in others assume the structure of horn or bone or may contain bones or cartilages. The word skeleton may indeed be taken to denote both a more or less firm and complete *external* protection to a living body, and also a more or less firm and complete *internal* support to such body.

In this very wide sense even many vegetal structures may be said to possess a skeleton. For all plants which can sustain themselves in an upgrowth from the ground obviously both require and possess solid structures—various groups and varieties of woody fibres—to support such an upgrowth. Organs also, such as leaves, which need to be maintained in the form of a thin flat expanse, require and possess bundles of fibres (vulgarly called veins) which are even popularly said to constitute the skeleton of the leaf. Many plants form such skeletal structures largely of silex, as do the grasses and the horsetails (*Equisetum*), and others invest themselves to a greater or less degree with carbonate of lime, as do some *Algæ*, such as *Corallina* and *Melobesia*, while the *Desmidiæ* clothe themselves with a horny coat. Ordinarily, however, the word skeleton is only used to denote certain animal structures, and mainly such structures as form the skeleton of man and of creatures so nearly allied to him as to constitute, together with him, that primary division of animals known as backboned animals or *Vertebrata*.

It is to a concise description of the skeleton as it exists in Vertebrates generally that this article is devoted. For the details of the human skeleton the reader is referred to the article ANATOMY. In order, however, that its condition in Vertebrate animals may be better understood, it will be well briefly to point out some of the more important varieties of condition presented by the protecting or supporting parts of the body of the lower, or Invertebrate, animals.

THE SKELETON OF INVERTEBRATA.

A great and fundamental distinction exists, however, between those lowly organisms known as *Protozoa* or *Hypozoa*—which are generally reckoned as animals—on the one hand and all the higher forms, both Vertebrate and Invertebrate, on the other. It is a distinction which renders it difficult to regard any skeletal structures of the *Hypozoa* as answering to, in the sense of being the homologues[1] of, any of the skeletal structures of higher animals. This great fundamental distinction consists in the fact that the bodies of all the higher animals are made up of distinct "tissues," which are derived from three different layers of cells, of which the embryos of all[2] of them are for a time composed, whereas the bodies of the *Hypozoa* either consist of but a single cell or else of a smaller or larger number of cells more or less loosely aggregated and not forming any distinct tissue. It follows of course that their reproduction does not take place by means of embryos formed of cellular layers.

Nevertheless the *Hypozoa* or *Protozoa* may exhibit very distinct protective structures. Thus the outermost layer of the substance of an *Amœba*, called its ectosare, is of a firmer consistency than its interior, and it may in allied forms take on a chitinous character or become quite hard through the deposition within it of calcareous salts (as in the sometimes singularly complex shells of the *Foraminifera*) or form symmetrical cases of silica.

In the *Radiolaria*, the skeleton of the *Protozoa* attains its maximum of beauty and complexity. It consists of spicules which are generally siliceous, but may consist of a peculiar firm organic substance termed "acanthin." The spicules arrange themselves in an extraordinarily symmetrical manner, generally radiating from the central portion of the organism and being connected with one or more series of encircling spicules which may constitute a series of concentric spheres.

Among the *Infusoria* we also find examples of a hardening of the external cuticle, as in *Tintinnus lagenula* and in some other forms.

When we pass to that vast group of animals—the *Metazoa*—which includes all but the *Protozoa* (and all those therefore the bodies of which are formed of tissues derived from the three primitive layers), a distinction again requires to be drawn between the Sponges (*Porifera*), which constitute its lowest group, and all higher forms. The three primitive or germinal layers of the *Metazoa* are termed respectively—(1) the epiblast, (2) the mesoblast, and (3) the hypoblast. Of these three layers the epiblast and the hypoblast are to be regarded as primary.[3] The epiblast is essentially the primitive integument, and its cells give rise to the epidermis and cuticle and to the organs of sense. The hypoblast is essentially the digestive layer, and gives rise to the epithelium lining the alimentary canal. The mesoblast seems to originate from one or both of the two preceding layers, and gives rise to the general substance of the body—including that part of the skin which is beneath the epidermis, the muscles, and the blood-vessels. It may divide into two layers, whereof the more external is distinguished as "somatic," while the more internal is called "splanchnic." Such is the general condition of the three germinal layers in the *Metazoa*. In the Sponges, however, it seems probable[4] that the germinal layers have a different nature—the epiblast and mesoblast being respectively the digestive and sensory layers.

The skeletal structures of the Sponges have the form of spicules, which may vary greatly in different genera as to their form, while they may be siliceous, calcareous, or horny. Sometimes they constitute structures of singular beauty. They appear to be formed in or on the cells of the mesoblast, and it does not seem that any skeletal structures arise in the epiblast or hypoblast of the *Porifera*. Should such, however, be hereafter found, then it must be borne in mind that their homologies with analogous skeletal structures of other organisms must depend on the final decision of the question of the exact relations which may exist between such germinal layers in Sponges and the epiblast and hypoblast of higher *Metazoa*.

In the great group of the *Cœlentera*, the skeleton may be either epiblastic or mesoblastic in nature. Thus in the *Hydrozoa*—where it mostly has the form of a horny investment, but may be (as in the Millepores) calcareous—it is epiblastic. In the *Actinozoa*—which includes the true coral animals—it is generally mesoblastic, although it is formed from the epiblast in the *Gorgoniæ*, *Isidinæ*, and *Pennatulidæ*.

In *Isis* the skeleton curiously consists of a series of segments which are alternately horny and calcareous.

In the *Echinodermata* we generally have, notably in the Sea-Urchin (*Echinus*), a wonderfully complex skeleton, which is so near the outer surface that at the first glance it seems necessarily a most external form of skeleton. Nevertheless the plates which compose it are mesoblastic in nature and are independent of the epidermis.

The two valves forming the shell of the Lamp-shells (*Branchiopoda*), and the very different two valves which constitute the shells of creatures of the Oyster class (*Lamellibranchiata*), as well as the single shells of the Snail and Whelk class (*Gasteropoda*), are all epiblastic in nature, and are calcifications of the outer part of the epidermis. The same is the origin of the apparently internal shell of the Slug, which is at first external in the embryo and subsequently becomes enclosed.

Similar is the nature of both the internal and external shells of the Squids, Cuttle-fishes, and Nautili, *i.e.*, of the class *Cephalopoda*. In the last-named class, as in some Gasteropods, there is a cartilaginous structure inside the head, which structure supports and partly protects the brain. It is unlike any skeletal part yet mentioned save in its mode of origin, which, like the skeleton of some of the *Actinozoa*, is mesoblastic.

Lastly may be mentioned the hard protecting external coat of insects and animals of the Crab and Lobster class—in short, the external skeleton of that primary division of animals which is called *Arthropoda*. This is again epiblastic, and a hardening of a cuticle on the outer surface of the epidermis—a hardening effected generally by chitinization (the deposition in it of a substance termed "chitin"), or, as in many *Crustacea* and some *Myriapoda*, by calcification.

GENERAL SKELETAL CONDITIONS.

Having thus briefly glanced at the leading skeletal structures of a number of groups of lower organisms, we may make the following generalization, which will be of use to us in helping us to understand how the skeletal parts of backboned animals stand related to the skeletal parts of animals lower in the scale :—

(1) Skeletal structures may conceivably arise in parts which are epiblastic, or mesoblastic, or hypoblastic.
(2) Skeletal structures belonging to any one of those three categories may be further divisible into two subordinate categories according as they belong to a superficial or a deep part of the layer to which they appertain.
(3) Skeletal structures may be siliceous, chitinous, calcareous, cartilaginous, or horny.
(4) In certain animals the mesoblast subdivides into two layers, one *somatic* and the other *splanchnic*. Obviously, then, there may be skeletal parts corresponding to either of these last-named layers, and conceivably to a deeper or more superficial portion of either of them.

THE SKELETON OF VERTEBRATA.

The skeleton of the *Vertebrata*—that is, of the five classes of animals named *Pisces*, *Amphibia*, *Reptilia*, *Aves*, and *Mammalia*—may in the first place be most conveniently considered as consisting of two parts—a dermal skeleton, or *exoskeleton*, and an internal framework, or *endoskeleton*. The latter, which is generally much the more considerable, is mesoblastic, and the muscles are external to it.

External Skeleton of Vertebrata.

This division of the skeleton is itself again made up of two parts. The more external of these is the epidermis and is of epiblastic origin, and dense epidermal structures may arise towards its inner or its outer surface. The more internal constituent of the exoskeleton is the dermis and dense structures formed in it, and these are from the outer portion of the mesoblast.

Epidermal hard structures formed towards either surface of the epidermis may become intimately united with subjacent dermal hard structures, and then again, as we shall see, with parts of the true endoskeleton.

[1] "Homologous parts," or "homologues," are parts of an organism which correspond in relative position, that is, in their relation to surrounding structures, whether or not they serve the same ends. They thus differ from "analogous parts," which are parts performing similar functions whether or not they agree as to their relations of position to surrounding structures. Thus, *e.g.*, the nail of a man's middle toe and the hind hoof of a horse are "homologous parts," but the hoof, as the support of the body and agent in locomotion, is analogous to the whole foot of a man.

[2] Certain Cœlenterate animals consist but of two layers.

[3] See F. Balfour's *Comparative Embryology*, vol. i. p. 108.

[4] *Op. cit.*, vol. i. p. 122, and vol. ii. p. 283.

Any hard structures formed in the walls of the alimentary canal—the lining of which is continuous at either end with the external skin—are to be reckoned as fundamentally exoskeletal. In the process of development the epiblast becomes inflected more or less into either extremity of the alimentary tube, but the intermediate portion, together of course with any hard structures developed in it, is of hypoblastic origin.

In the great majority of Vertebrate animals the two layers of the skin, the epidermis and the dermis are, as in man, soft, though locally provided with certain denser appendages, such as epidermal and dermal scales, hairs, nails, scutes, and teeth.

The soft, general exoskeleton or skin invests the body of Man pretty closely, though slightly projecting folds of it extend between the roots of the fingers and toes. In some abnormal cases these folds extend so far and bind the digits together so much that the thus malformed person is said to be "web-fingered" or "web-toed." Such a condition is found normally in many animals, as notably in Ducks and Geese, and such parts form a large portion of the "wing" of the Bat.

Other extensions of the skin of the body are noteworthy. Thus in the "Flying" Squirrels and Opossums, and the curious Rodent named *Anomalurus*, the skin of the sides, between the arms and the legs, is much expanded, serving for a parachute. There may be a skin parachute supported by long free movable ribs, such as we shall see exist in the little Lizards called "Flying Dragons." There may be a very remarkable extensive skin round the neck, as in the Frilled Lizard, and folds of skin may hang freely, as in the "dewlap" of Cattle, or may be formed here and there as in the Rhinoceros, the skin of which animal is so thick as to necessitate the existence of such folds to allow free movements to the body and limbs. Long filamentary processes may be formed along the back, as in the Iguana and various other Lizards.

In the Seals a fold of skin connects together the hind legs and the tail, and also in our common Bats, which have in addition their very elongated webbed fingers connected with the sides of the body and legs by another great fold of skin which, with those between the fingers, forms the entire bat's "wing."

The integument may be very distensible, as in those Fishes (*e.g.*, *Diodon*) which distend themselves with air and then float belly upwards.

The epidermis of many Vertebrates, and of Man, is shed in minute fragments, constantly removed by friction and ablution, and constantly replaced; only under abnormal conditions and after certain diseases does it come away in large and continuous patches. In some other Vertebrates, as notably in Snakes, the entire epidermal investment of the body, even that of the eyes, is cast off entire as one whole.

The epidermis never has its superficial layer connected with bone, but it often becomes thickened and horny, as we see in the sole of the foot, or the labourer's hand, and in those abnormal thickenings called "corns." Certain local thickenings which are not abnormal may exist in animals; such are the callosities on the inner side of the legs of the Horse, on the breast of the Camel, and on the nates of the lower Old-World Apes.

Of the appendages of the epidermis the most simple are scales, such as we find on the legs of Birds and the bodies of Serpents and Reptiles generally.

A *scale*—a true scale, such as those of Snakes and Lizards—consists of papillæ of the dermis invested by the epidermis, the whole being covered by a cornification of the external part of the epidermis. Scales may be very diverse in shape, prominence, and relative size, and may form very large plates. The so-called scales of Fishes are of deeper origin and are a form of scutes.

A *hair* differs from a scale in that, instead of being an epidermic investment of a dermal projection outwards, it originates by an epidermal projection inwards into the subjacent dermis. A small papilla of the dermis, however, soon projects upwards, in turn, into the descending epidermal process, and then cornification sets in (at first in the immediate vicinity of the dermal papilla) in the cells around the axis of the epidermal descending projection, and this hardened portion soon projects beyond the surface of the body, while the part of the epidermis about its deepest part becomes modified into its so-called "root."

A *nail* or *claw* arises as a cornification of the epidermis (but not of its deepest layer) lying upon numerous very vascular ridges (or transversely elongated papillæ) of the dermis, forming the primitive bed of the nail, and enclosed in a deep fold of the integument. One end of the structure becomes free and projecting superficially, while the opposite region grows by epidermal additions from beneath and at its attached extremity.

A *feather* is more nearly related to a scale than it is to a hair. It consists at first of an upwardly-projecting dermal papilla invested with epidermis, and it is only at a later stage that its base sinks into a sack or "feather follicle." The outermost layer of epidermis becomes converted into a horny sheath, which is thrown off when the feather is completed. The *quill* is formed by cornification of the deepest and more superficial layer of epidermis investing the base of the dermal and vascular papilla, and is open at both ends. The vascular papilla it encloses shrinks up when the feather is fully formed. The *vane* of the feather is formed from the more apical portion of the papilla, and its central part, or *shaft*, is continuous with the quill, while ridge-like thickenings of epidermis diverging from either side of this central part constitute the barbs of the vane, from each of which yet smaller processes or barbules proceed.

A *scute* is a hardening of the outermost portion of the dermis, with an investment from the deepest layer of the epidermis. Such are the so-called scales of ordinary Fishes, which may be represented by the bony plates and processes called placoid scales—so common in the groups of Sharks and Rays. In these latter structures dermal papillæ appear and calcify, forming a dense structure without corpuscles, called dentine, beneath which may be a corpusculated structure of true bone. The calcifying papillæ receive an investment of still denser calcareous tissue, called enamel, from the deepest layer of the epidermis. These placoid structures often come to project outwards on the surface of the body as long spines or as shorter tooth-like processes, or they may protect the surface of the body as flat plates. Often the dentine more or less entirely atrophies, so that the structure comes to be formed almost entirely of true bone or of that peculiar calcified tissue of which the scales of ordinary Fishes (such, *e.g.*, as the Perch and Carp) are composed.

A *tooth* is a structure closely related to a scute. It differs from the latter just as a hair differs from a scale—namely, by owing its origin to an ingrowth of the epidermis instead of merely to a primitive outgrowth of the dermis.

The so-called teeth of the Lamprey are not true teeth, but are merely horny epidermal structures essentially similar to scales.

In the origin of a true tooth a process of the epiblastic layer of the mouth—the buccal epithelium—grows into the subjacent dermis, and, assuming a cup-like form (with the concavity of the cup turned away from the epithelial surface of the mouth), a dermal papilla rises into the cup. The apex of this papilla then superficially calcifies into dentine, and becomes invested with a layer of enamel formed from the immediately adjacent surface of the epidermic cup or "enamel organ." An investment of connective tissue called the dental capsule becomes formed round the whole. The dentine then increases, a remnant of the papilla remaining as the "pulp." The young tooth gradually approaches the buccal surface, and the base of the papilla becomes formed into the root or fang of the tooth. The enamel organ does not descend so far, but only invests the crown of the tooth. The inner layer of the capsule, however, investing the fang gives rise to a third dental tissue known as the cement. A bud may or may not be given off from the developing tooth to serve as its future successor.

Thus teeth are normally both epiblastic and mesoblastic structures, but in certain Fishes they line parts of the throat (the branchial arches), the superficial membrane of which is derived from the hypoblast, and such may of course be considered as hypoblastic skeletal elements, and, thus considered, must be reckoned as constituting a separate category of teeth.

Such being the various kinds of dense structures which enter into the composition of the Vertebrate exoskeleton, each kind may be developed to a greater or less extent in different groups of Vertebrate animals.

Exemplifications of Epidermal Skeletal Parts.

Scales entirely clothe the bodies of most Lizards and Snakes and the legs of Birds. In Tortoises and Turtles they take the form of large plates, which in one species are known as tortoise-shell. The