

*Inst. d. Universit. Graz.* (16) Id., "Challenger" Report on the Calcareous, 1883. (17) Id., Ditto on the Ceratosa, 1884. (18) Ridley, *On the Zool. Collection of the "Alert,"* 1884. (19) Schmidt, *Sponges of the Adriatic Sea*, 1862, with Supplement I in 1864, and Supplement 2 in 1866; *Sponges of the Coast of Algeria*, 1868; *Sponge-Fauna of the Atlantic*, 1870; *Sponges of the Gulf of Mexico*, 1879. (20) F. E. Schulze, investigations into the structure and development of sponges, in *Zachr. f. wis. Zool.*,—"On *Halysarca*," vol. xviii., 1877;—"On *Chondrosida*," xxix., 1877;—"On *Aplysina*," xxx., 1878;—"On Metamorphosis of *Sycon*," xxxi., 1878;—"On *Spongilia*," xxxii., 1878;—"On *Spongidae*," ib.;—"On *Hircinia* and *Oligoceras*," xxxiii., 1879;—"On *Plakintida*," xxxiv., 1880;—"On *Corticium candelabrum*," xxxv., 1881. (21) Id.,—"On Soft Parts of *Epicrella aspergillum*," in *Trans. Roy. Soc. Edin.*, xxix., 1880. (22) Id., *Preliminary Report on the "Challenger" Hexactinellida*, (23) Id.,—"On the Relationship of the Sponges to the Choanoflagellata," in *Sitz.-Ber. d. k. preuss. Akad. f. wis. Z.*, Berlin, 1885, translated in *Ann. and Mag. Nat. Hist.*, 1885. (24) Sollas,—"On *Stauronema*," in *Ann. and Mag. Nat. Hist.*, xix., 1877;—"On *Pharospongia*," in *Quart. Journ. Geol. Soc.*, xxxiii., 1877;—"On *Siphonia*," ib.;—"On *Protospongia*," ib., xxxvi., 1880. (25) Id.,—"The Sponge-Fauna of Norway," in *Ann. and Mag. Nat. Hist.*, 1880-82. (26) Id.,—"The Flint-Nodules of the Trimmingham Chalk," ib., vi., 1879. (27) Id.,—"Development of *Halysarca lobularis*," in *Quart. Journ. Geol. Soc.*, xiv., 1884. (28) Id.,—"On *Vetulina* and the *Anomocladina*," in *Proc. R. Irish Acad.*, iv., 1885. (29) Id.,—"Physical Characters of Sponge-Spicules," in *Proc. R. Dub. Soc.*, 1885. (30) Vejdovsky,—"The Freshwater Sponges of Bohemia," in *Abh. d. k. Bohm. Akad. d. Wiss.*, ser. vi., vol. xii., 1883. (31) Vosmaer, *On Leucandra aspera* (doctor's diss., Leyden, 1880). (32) Id.,—"On the *Desmacellinidae*," in *Notes from the Leyden Museum*, vol. ii. (33) *Sponges of the Willem Barrens Expedition*, 1884. (34) "Portiere," in *Bronn's Klassen und Ordnungen*, vol. ii., 1882, and still in progress. (35) Zittel, studies of fossil sponges, in *Abh. d. k. Bayer. Akad.*,—"Hexactinellida, 1877; Lithistida, 1878; Monactinellida and Calcareous, 1878.

#### Commerce.

When the living matter is removed from a Ceratose sponge a network of elastic horny fibres, the skeleton of the animal, remains behind. This is the sponge of commerce. Of such sponges the softest, finest in texture, and most valued is the Turkey or Levant sponge, *Euspongia officinalis*, Lin. The other two varieties are the *Hippospongia equina*, O. Schmidt, and the Zimocca sponge, *Euspongia zimocca*, O.S., which is not so soft as the others (see p. 423 above). All three species are found at from 2 to 100 fathoms along the whole Mediterranean coast, including its bays, gulfs, and islands, except the western half of its northern shores as far as Venice and the Balearic Isles, Corsica, Sardinia, and Sicily. Bath sponges occur around the shores of the Bahamas, and less abundantly on the north coast of Cuba. They are of several kinds, one not distinguishable from the fine Levant sponge; others, the "yellow" and "hardhead" varieties, resemble the Zimocca sponge; and of horse sponges there appear to be several varieties, such as the "lamb's-wool" and the "velvet" sponge (*Hippospongia gossypina* and *H. meandriiformis*). The fine bath sponge occurs on the shores of Australia (Torres Straits, the west coast, and Port Phillip on the south coast). A sponge eminently adapted for bathing purposes (*Coscinoderma lanuginosum*, Ctr.; *Euspongia mathewsi*, Lfd.), but not yet brought into the market, occurs about the South Caroline Islands, where it is actually in use, and at Port Phillip in Australia. The fine bath sponge occurs in the North Pacific, South Atlantic, and Indian Oceans, so that its distribution is world-wide.

The methods employed to get sponges from the bottom of the sea, where they grow attached to rocks, stones, and other objects, depend on the depths from which they are to be brought. In comparatively shallow water they may be loosened and hooked up by a harpoon; at greater depths, down to 30 or 40 fathoms, they are dived for; and at depths of from 50 to 100 fathoms they are dredged with a net. The method of harpooning was the earliest practised, and is still carried on in probably its most primitive form by the Dalmatian fishermen. Small boats are used, manned by a single harpooner with a boy to steer; when, however, the expedition is to extend over night the crew is doubled. The harpoon is a five-pronged fork with a long wooden handle, and if this is not long enough another harpoon is lashed on to it. The Greek fishers use a large boat furnished with two or three smaller ones, from which the actual harpooning is carried on; the crew numbers seven or eight. One of the chief difficulties is to see the bottom distinctly through a troubled surface. The Dalmatian fishers throw a smooth stone dipped in oil

a yard or so in front of the boat; the stone scatters drops of oil as it flies and so makes a smooth track for the "look-out." The Greeks use a zinc-plate cylinder about 1½ feet long and 1 foot wide, closed at the lower end by a plate of glass, which is immersed below the surface of the sea; on looking through this the bottom may be clearly seen even in 30 fathoms. This plan is also adopted in the Bahamas, where harpooning carried on after the Greek system gives employment to over 5000 men and boys.

The primitive method of diving with no other apparatus than a slab of stone to serve as a sinker and a cord to communicate with the surface is still practised in the Mediterranean. The diver carries a net round his neck to hold the sponges. On reaching the bottom he hastily snatches up whatever sponge he sees. After staying down as long as he is able—an interval which varies from two to at the most three minutes—he tugs violently at the cord and is rapidly drawn up. On entering the boat from depths of 25 fathoms he quickly recovers from the effects of his plunge after a few powerful respirations; but after working at depths of 30 to 40 fathoms or more he reaches the surface in a swooning state. At the beginning of the season blood usually flows from the mouth and nose after a descent; this is regarded as a symptom of good condition; should it be wanting the diver will scarcely venture a second plunge for the rest of the season. The work is severe, and frequently the diver returns empty-handed to the boat. Diving is usually carried on in the summer months; in winter it is too cold, at all events without a diving-dress. The ordinary diver's dress with pumping apparatus is largely used by the Greeks. The diving is carried on from a ship manned by eight or nine men, including one, or rarely two, divers. At a depth of from 10 to 15 fathoms the diver can remain under for an hour, at greater depths up to 20 fathoms only a few minutes; the consequences of a longer stay are palsy of the lower extremities, stricture, and other complaints. Dredging is chiefly carried on along the west coast of Asia Minor, principally in winter after the autumn storms have torn up the seaweeds covering the bottom. The mouth of the dredge is 6 yards wide and 1 yard high; the net is made of camel-hair cords of the thickness of a finger, with meshes 4 inches square. It is drawn along the bottom by a tow-line attached to the bowsprit of a sailing vessel or hauled in from the shore.

Prompted by a suggestion made by Oscar Schmidt, that sponges might be artificially propagated from cuttings, the Italian Government supplied funds for experiments to determine the feasibility of cultivating sponges as an industrial pursuit. A station was established on the island of Lesina, off the Dalmatian coast, and experiments were carried on there for six years (1867-72) under the superintendence of Von Buccich. The results were on the whole successful, but all expectations of creating a new source of income for the sponge-fishers of Dalmatia were defeated by the hostility of the fishers themselves.

The details of the method of sponge-farming as practised by Von Buccich are briefly as follows. The selected specimens, which should be obtained in as uninjured a state as possible, are placed on a board moistened with sea water and cut with a knife or fine saw into pieces about 1 inch square, care being taken to preserve the outer skin as intact as possible. The operation is best performed in winter, as exposure to the air is then far less fatal than in summer. The sponge cuttings are then trepanned and skewered on bamboo-rods; the rods, each bearing three cuttings, are secured in an upright position between two parallel boards, which are then sunk to the bottom of the sea and weighted with stones. In choosing a spot for the sponge-farm the mouths of rivers and proximity to submarine springs must be avoided; mud in this case, as in that of reef-building

(corals, is fatal. A favourable situation is a sheltered bay with a rocky bottom overgrown with green seaweed and freshened by gentle waves and currents. So favoured, the cuttings grow to a sponge two or three times their original size in one year, and at the end of five to seven years are large enough for the market. Similar experiments with similar results have more recently been carried on in Florida. The chief drawback to successful sponge-farming would appear to be the long interval which the cultivator has to wait for his first crop.

After the sponge has been taken from the sea, it is exposed to the air till signs of decomposition set in, and then without delay either beaten with a thick stick or trodden by the feet in a stream of flowing water till the skin and other soft tissues are completely removed. If this process is postponed for only a few hours after the sponge has been exposed a whole day to the air it is almost impossible to completely purify it. After cleaning it is hung up in the air to dry, and then with others finally pressed into bales. If not completely dried before packing the sponges "heat," orange yellow spots appearing on the parts attacked. The only remedy for this is to un-pack

the bale and remove the affected sponges. The orange-coloured spots produced by this "pest," or "cholera" as the Levant fishermen term it, must not be confounded with the brownish red colour which many sponges naturally possess, especially near their base. The sponges on reaching the wholesale houses are cut to a symmetrical shape and further cleaned. The light-coloured sponges often seen in chemists' shops have been bleached by chemical means which impair their durability. Sponges are sold by weight; sand is used as an "adulteration."

It is difficult to obtain recent statistics as to the extent of the sponge trade; the following table gives a summary of the sponges sold in Trieste, the great European sponge market, in the year 1871:—

Description of Sponge.	For Export.		For Home Consumption.	
	Value in £	Mean price per pound.	Value in £	Mean price per pound.
Horse sponge.....	£60,000	6s.	£4400	6s.
Zimocca sponge.....	20,000	6s.	550	6s.
Fine Levant sponge....	20,000	14s.	950	14s.
Fine Dalmatian sponge	2,000	8s.	..	..

(W. J. S.)

**SPONSOR.** The presence of some suitable sponsor or sponsors to give the answers required and undertake the vows involved would seem to be almost essential to the right administration of the sacrament of baptism, in the case of infants at least. In this aspect, however, as in many others, the early history of the development of the rite of baptism remains obscure. The Greek word for the person undertaking this function is *διδάχος*, to which the Latin *susceptor* is equivalent. The word "sponsor" in this ecclesiastical sense occurs for the first time, but incidentally only, and as if it were already long familiar, in Tertullian's treatise *De Baptismo* (c. 18), where, arguing that in certain circumstances baptism may conveniently be postponed, especially in the case of little children, he asks, "For why is it necessary that the sponsors likewise should be thrust into danger, who both themselves by reason of mortality may fail to fulfil their promises, and may also be disappointed by the development of an evil disposition [in those for whom they become sponsors]?" There is nothing to make it unlikely that the sponsors here alluded to may have been in many cases the actual parents, and even in the 5th century it was not felt to be inappropriate that they should be so; Augustine, indeed, in one passage appears to speak of it as a matter of course that parents should bring their children and answer for them "tanquam fidejussores" (*Epist. . . . ad Bonif.*, 98). The comparatively early appearance, however, of such names as *compadres, commatres, propatres, promatres, patrini, matrinæ* is of itself sufficient evidence, not only that the sponsorial relationship had come to be regarded as a very close one, but also that it was not usually assumed by the natural parents. How very close it was held to be is shown by the Justinianian prohibition of marriage between godparents and godchildren. On the other hand, the anciently allowable practice of parents becoming sponsors for their own children seems to have lingered until the 9th century, when it was at last formally prohibited by the council of Mainz (813). For a long time there was no fixed rule as to the necessary or allowable number of sponsors, and sometimes the number actually assumed was large. By the council of Trent, however, it was decreed that one only, or at most two, these not being of the same sex, should be permitted. The rubric of the Church of England according to which "there shall be for every male child to be baptized two godfathers and one godmother, and for every female one godfather and two godmothers," is not older than 1561; in the

*Catechism* the child is taught to say that he received his name from his "godfathers and godmothers." At the Reformation the Lutheran churches retained godfathers and godmothers, but the Reformed churches reverted to what they believed to be the more primitive rule, that in ordinary circumstances this function should be undertaken by a child's proper parents. All churches, it may be added, of course demand of sponsors that they be in full communion. In the Church of Rome priests, monks, and nuns are disqualified from being sponsors, either "because it might involve their entanglement in worldly affairs," or more probably because every relationship of fatherhood or motherhood is felt to be in their case inappropriate.

SPONTINI, GASPARO LUIGI PACIFICO (1774-1851), dramatic composer, was born at Majolati (Ancona) in Italy, 14th November 1774, and educated at the Conservatorio de' Turchini at Naples under Sala, Tritto, and Salieri. After producing some successful operas at Rome, Florence, Naples, and Palermo, he settled in 1803 at Paris. His reception in the French capital was anything but flattering. His first comic opera, *Julie*, proved a failure; his second, *La Petite Maison*, was hissed. Undaunted by these misfortunes, he abandoned the light and somewhat frivolous style of his earlier works, and in *Milton*, a one-act opera produced in 1804, achieved a real success. Spontini henceforth aimed at a very high ideal, and during the remainder of his life strove so earnestly to reach it that he frequently remodelled his passages five or six times before permitting them to be performed in public, and wearied his singers by introducing new improvements at every rehearsal. His first masterpiece was *La Vestale*, completed in 1805, but kept from the stage through the opposition of a jealous clique until 15th December 1807, when it was produced at the Académie, and at once took rank with the finest works of its class. The composer's second opera, *Ferdinand Cortez*, was received with equal enthusiasm in 1809; but his third, *Olympia*, was much less warmly welcomed in 1819.

Spontini had been appointed in 1810 director of the Italian opera; but his quarrelsome and grasping disposition led to his summary dismissal in 1812, and, though reinstated in 1814, he voluntarily resigned his post soon afterwards. He was in fact very ill fitted to act as director; yet on 28th May 1820, five months after the failure of *Olympia*, he settled in Berlin by invitation of Frederick William III., commissioned to superintend all



music performed at the Prussian court and compose two new grand operas, or three smaller ones, every three years. But he began by at once embroiling himself with the intendant, Count Brühl. Spontini's life at Berlin may be best described as a ceaseless struggle for precedence, under circumstances which rendered its attainment impossible in the sense in which he desired it. Yet he did good work, and did it well. *Die Vestalin*, *Ferdinand Cortez*, and *Olympia*—the last two entirely remodelled—were produced with great success in 1821. A new opera, *Nourmahal*, founded on Moore's *Lalla Rookh*, was performed in 1822, and another, entitled *Alcidor*, in 1825; and in 1826 Spontini began the composition of *Agnes von Hohenstaufen*, a work planned on a grander scale than any of his former efforts. The first act was performed in 1827, and the complete work in three acts graced the marriage of Prince William in 1829. Though the German critics abused it bitterly, *Agnes von Hohenstaufen* is undoubtedly Spontini's greatest work. In breadth of conception and grandeur of style it exceeds both *Die Vestalin* and *Ferdinand Cortez*, and its details are worked out with untiring conscientiousness; yet Spontini was utterly dissatisfied with it, and at once set to work upon an entire revision, which on its representation in 1837 was in many parts scarcely recognizable by those who had heard the opera in its original form.

This was his last great work. He several times began to rewrite his early opera, *Milton*, and contemplated the treatment of many new subjects, such as *Sappho*, *La Colère d'Achille*, and other classical myths, but with no definite result. He had never been popular in Berlin; and he has been accused of endeavouring to prevent the performance of *Euryanthe*, *Oberon*, *Die Hochzeit des Camacho*, *Jessonda*, *Robert the Devil*, and other works of genius, through sheer envy of the laurels won by their composers. But the critics and reviewers of the period were so closely leagued together against him that it is difficult to know what to believe. After the death of Frederick William III. in 1840, Spontini's conduct became so violent and imperious that in 1842 Frederick William IV. dismissed him, with power to retain his titles and live wherever he pleased in the enjoyment of his full salary. He elected to settle once more in Paris, after a short visit to Italy; but beyond conducting occasional performances of some of his own works he made but few attempts to keep his name before the public. In 1847 he revisited Berlin and was invited by the king to conduct some performances during the winter. In 1848 he became deaf. In 1850 he retired to his birthplace, Majolati, and died there on 14th January 1851, bequeathing all he possessed to the poor of his native town.

**SPOONBILL.** The bird now so called was formerly known in England as the Shovelard or Shovelar, while that which used to bear the name of Spoonbill, often amplified into Spoon-billed Duck, is the SHOVELER (see vol. xxi. p. 842) of modern days—the exchange of names having been effected, as already stated (*loc. cit.*) about 200 years ago, when the subject of the present notice—the *Platalea leucorodia* of Linnæus as well as of recent writers—was doubtless far better known than now, since it evidently was, from ancient documents, the constant concomitant of Herons, and with them the law attempted to protect it.<sup>1</sup> Mr Harting (*Zoologist*, 1886, pp. 81 *et seq.*) has cited a case from the "Year-Book" of 14 Hen. VIII. (1523),

<sup>1</sup> Nothing shows better the futility of the old statutes for the protection of birds than the fact that in 1534 the taking of the eggs of Herons, Spoonbills (Shovelars), Cranes, Bitterns, and Bustards was visited by a heavy penalty, while there was none for destroying the parent birds in the breeding-season. All of the species just named, except the Heron, have passed away, while there is strong reason to think that some at least might have survived had the principle of the Levitical law (Deut. xxii. 6) been followed.

wherein the then bishop of London (Cuthbert Tunstall) maintained an action of trespass against the tenant of a close at Fulham for taking Herons and "Shovelars" that made their nests on the trees therein growing, and has also printed (*Zoologist*, 1877, pp. 425 *et seq.*) an old document showing that "Shovelars" bred in certain woods in west Sussex in 1570. Nearly one hundred years later (*circa* 1662) Sir Thomas Browne, in his *Account of Birds found in Norfolk Works*, ed. Wilkin, iv. pp. 315, 316), stated of the "Platea or Shovelard" that it formerly "built in the Hernerie at Claxton and Reedham, now at Trimley in Suffolk." This last is the latest known proof of the breeding of the species in England; but more recent evidence to that effect may be hoped for from other sources. That the Spoonbill was in the fullest sense of the word a "native" of England is thus incontestably shown; but for many years past it has only been a more or less regular visitant, though not seldom in considerable numbers, which would doubtless, if allowed, once more make their home there; but its conspicuous appearance renders it an easy mark for the greedy gunner and the contemptible collector. What may have been the case formerly is not known, except that, according to Belon, it nested in his time (1555) in the borders of Brittany and Poitou; but as regards north-western Europe it seems of late years to have bred only in Holland, and there it has been deprived by drainage of its favourite resorts, one after the other, so that it must shortly become merely a stranger, except in Spain or the basin of the Danube and other parts of south-eastern Europe.

The Spoonbill ranges over the greater part of middle and southern Asia,<sup>2</sup> and breeds abundantly in India, as well as on some of the islands in the Red Sea, and seems to be resident throughout Northern Africa. In Southern Africa its place is taken by an allied species with red legs, *P. cristata* or *tenuirostris*, which also goes to Madagascar. Australia has two other species, *P. regia* or *melanorhynchus*, with black bill and feet, and *P. flavipes*, in which those parts are yellow. The very beautiful and wholly different *P. ajaja* is the Roseate Spoonbill of America, and is the only one found on that continent, the tropical or juxta-tropical parts of which it inhabits. The rich pink, deepening in some parts into crimson, of nearly all its plumage, together with the yellowish green of its bare head and its lake-coloured legs, sufficiently mark this bird; but all the other species are almost wholly clothed in pure white, though the English has, when adult, a fine buff pectoral band, and the spoon-shaped expanse of its bill is yellow, contrasting with the black of the compressed and basal portion. Its legs are also black. In the breeding season, a pendant tuft of white plumes further ornaments the head of both sexes, but is longest in the male. The young of the year have the primary quills dark-coloured.

The Spoonbills form a natural group, *Plataleidae*, allied, as before stated (*Ibis*, vol. xii. p. 606), to the *Ibididae*, and somewhat more distantly to the Storks (see STORK),—all belonging to the *Pelargomorphæ* of Prof. Huxley. They breed in societies, not only of their own kind, but in company with Herons, either on trees or in reed-beds, making large nests in which are commonly laid four eggs,—white, speckled, streaked, or blotched, but never very closely, with light red. Such breeding-stations have been several times described, and among the more recent accounts of one of them are those of Messrs Sclafer and W. A. Forbes (*Ibis*, 1877, p. 412), and Mr Seeborn (*Zoologist*, 1880, p. 457), while a view of another has been attempted by Schlegel (*Vog. Nederland*, taf. xvii.). The latest systematic revision of the group is by Dr Reichenow (*Journ. für Ornithologie*, 1877, pp. 156-159), but his views have not been wholly accepted in the present article. (A. N.)

<sup>2</sup> Ornithologists have been in doubt as to the recognition of two species from Japan described by Temminck and Schlegel under the names of *P. major* and *P. minor*. Lately it has been suggested that the former is only the young of *P. leucorodia*, and the latter the young of the Australian *P. regia*.

**SPORADES**, the islands "scattered" (as the name, from *σπείρειν*, "to sow," imports) about the Greek Archipelago, are distinguished on the one hand from the Cyclades, which are grouped around Delos, and on the other from the islands attached, as it were, to the mainland of Europe and Asia. The distinction is not in either case a very definite one, and hence both ancient and modern writers differ as to the list of the Sporades. Details of classification are given by Bursian (*Griechenland*, ii. 348 *sq.*). The Doric Sporades—Melus (ΜΕΛΟΣ),<sup>1</sup> Pholegandrus, Sicinus, THERA, Anaphe, Astypalæa, and Cos—were by some considered a southern cluster of the Cyclades. In modern times the name Sporades is more especially applied to two groups—the Northern Sporades, which lie north-east of Negropont (Eubœa), along with which they constitute a nomarchy of the kingdom of Greece; and the Southern Sporades, lying off the south-west of Asia Minor, and included in the Turkish vilayet of the "Islands of the White Sea." The Northern, which have altogether an area of 180 square miles and a population of 13,394 (1879), comprise Skiatho, Khiliodromi or Ikos, Skopelo, Pelagonisi, Giura, Pipari, and Skiro (ΣΚΥΡΟΣ), with their adjacent ones. The Southern are as follows:—Icaria, PATMOS, Leros, Calymno, Astypalæa (Stampalia), Cos (Stanko), Nisyros, Tilos or Episcopi, Sime, Khalki, RHODES, CRETE, and a multitude of lesser isles.

**SPORTS, THE BOOK OF**, or more properly the DECLARATION OF SPORTS, was issued by James I. in 1617 on the recommendation of Thomas Morton, bishop of Chester, for use in Lancashire, where the king on his return from Scotland found a conflict on the subject of Sunday amusements between the Puritans and the gentry, many of whom were Roman Catholics. Permission was given for dancing, archery, leaping, vaulting, and other harmless recreations, and of "having of May games, Whitsun ales, and morris dances, and the setting up of May-poles and other sports therewith used, so as the same may be had in due and convenient time without impediment or neglect of divine service, and that women shall have leave to carry rushes to church for the decorating of it." On the other hand, "bear and bull baiting, interludes, and (at all times in the meane sort of people by law prohibited) bowling" were not to be permitted on Sunday (Wilkins, *Concilia*, iv. 483). In 1618 James transmitted orders to the clergy of the whole of England to read the declaration from the pulpit; but so strong was the opposition that he prudently withdrew his command (Wilson, in Kennet, ii. 709; Fuller, *Church History*, v. 452). In 1633 Charles I. not only directed the republication of his father's declaration (Rushworth, ii. 193) but insisted upon the reading of it by the clergy. Many of the clergy were punished for refusing to obey the injunction. With the fall of Laud all attempt to enforce it necessarily came to an end.

**SPOTSWOOD, or SPOTSWOOD, JOHN** (1565-1639), archbishop of St Andrews, was the son of John Spotswood, minister of Calder and "superintendent" of Lothian, and was born in 1565. He was educated at Glasgow, and succeeded his father in the parish of Calder when but eighteen years of age. In 1601 he attended Ludowick, duke of Lennox, as his chaplain, in an embassy to the court of France, and returned in the duke's retinue through England. In 1603 he was nominated by the king to the see of Glasgow, but his consecration (in London) did not take place until October 1610. In 1615 he was translated as successor of Gladstones to St Andrews, and thus became primate and metropolitan of Scotland. In this capacity he presided in several assemblies of the Church of Scotland.

<sup>1</sup> The names of those Sporades which are treated under separate readings are printed in small capitals.

At that of Perth, in 1618, over which he presided, he used his influence to obtain a reluctant assent to the Five Articles. He continued in high esteem with James VI. and Charles I., who was crowned by him in 1633 at Holyrood. In 1635 Spotswood was advanced to the chancellorship, but the increasing strength of the Covenanters compelled his resignation in 1638. He was deposed and excommunicated by the Glasgow assembly in that year; charges affecting his moral character were brought against him, but no attempt was made to substantiate these. He died in London on 26th December 1639 and was buried in Westminster Abbey.

In 1620 he published *Refutatio Libelli de Regimine Ecclesie Scotice*—an answer to a tract of Calderwood, who replied in the *Vindicie* subjoined to his *Allare Damascenum*. The only other writing of Spotswood published during his lifetime was the sermon he preached at the Perth assembly. His most considerable work appeared posthumously—*The History of the Church and State of Scotland, beginning the year of our Lord 203 and continued to the end of the reign of James VI. of ever blessed memory*, London, 1655, fol. It displays considerable research and sagacity, and even when dealing with contemporary events gives a favourable impression, upon the whole, of the author's candour and truth. An appendix was afterwards added by Thomas Middleton.

Spotswood left two sons,—Sir John Spotswoode of Dairsie in Fife, where the archbishop erected a church and bridge, which are still extant, and Sir Robert, a lawyer of great learning, who became president of the Court of Session, and was executed in 1646 for taking part in the expedition of Montrose.

**SPOTTISWOODE, WILLIAM** (1825-1883), mathematician and physicist, was born in London, 11th January 1825. His father, Andrew Spottiswoode, who was descended from an ancient Scottish family, represented Colchester in parliament for some years, and in 1831 became junior partner in the firm of Eyre & Spottiswoode, printers. William was educated at Laleham, Eton, Harrow, and Balliol College, Oxford. His bent for science showed itself while he was still a schoolboy, and indeed his removal from Eton to Harrow is said to have been occasioned by an accidental explosion which occurred whilst he was performing an experiment for his own amusement. At Harrow he obtained in 1842 a Lyon scholarship, and at Oxford in 1845 a first-class in mathematics, in 1846 the junior and in 1847 the senior university mathematical scholarship. In 1846 Spottiswoode left Oxford to take his father's place in the business, in which he was engaged until his death. In 1847 he issued five pamphlets entitled *Meditationes Analyticae*. This was his first publication of original mathematical work; and from this time scarcely a year passed in which he did not give to the world further mathematical researches. In 1856 Spottiswoode travelled in eastern Russia, and in 1860 in Croatia and Hungary; of the former expedition he has left an interesting record entitled *A Tarantasse Journey through Eastern Russia in the Autumn of 1856* (London, 1857). In 1870 he was elected president of the London Mathematical Society. In 1871 he began to turn his attention to experimental physics, his earlier researches bearing upon the polarization of light and his later work upon the electrical discharge in rarefied gases. He wrote a popular treatise upon the former subject for the "Nature" series (1874). In 1878 he was elected president of the British Association, and in the same year president of the Royal Society, of which he had been a fellow since 1853. He died of fever on 27th June 1883, and was buried in Westminster Abbey.

As a mathematician he occupied himself with many branches of his favourite science, more especially with higher algebra, including the theory of determinants, with the general calculus of symbols, and with the application of analysis to geometry and mechanics. The following brief review of his mathematical work is quoted from the obituary notice which appeared in the *Proceedings of the Royal Society* (vol. xxxviii. p. 34):—"The interesting series of communications on the contact of curves and surfaces which are contained in the *Philosophical Transactions* of 1862 and



subsequent years would alone account for the high rank he obtained as a mathematician. . . . The mastery which he had obtained over the mathematical symbols was so complete that he never shrank from the use of expressions, however complicated—nay, the more complicated they were the more he seemed to revel in them—provided they did not sin against the ruling spirit of all his work,—symmetry. To a mind imbued with the love of mathematical symmetry the study of determinants had naturally every attraction. In 1851 Mr Spottiswoode published in the form of a pamphlet an account of some elementary theorems on the subject. This having fallen out of print, permission was sought by the editor of *Crelle* to reproduce it in the pages of that journal. Mr Spottiswoode granted the request and undertook to revise his work. The subject had, however, been so extensively developed in the interim that it proved necessary not merely to revise it but entirely to re-write the work, which became a memoir of 116 pages. To this, the first elementary treatise on determinants, much of the rapid development of the subject is due. The effect of the study on Mr Spottiswoode's own methods was most pronounced; there is scarcely a page of his mathematical writings that does not bristle with determinants." The Royal Society's *Catalogue of Scientific Papers* (vols. i.-viii.) shows a list of 49 papers by Spottiswoode, to which must be added about 66 more, the titles of which have not yet been printed in that catalogue. These were published principally in the *Philosophical Transactions*, *Proceedings of the Royal Society*, *Quarterly Journal of Mathematics*, *Proceedings of the London Mathematical Society*, and *Crelle*, and one or two in the *Comptes Rendus* of the Paris Academy. Another list of his papers, arranged according to the several journals in which they originally appeared, with short notes upon the less familiar memoirs, is given in *Nature*, vol. xxvii. p. 599.

SPRAIN. See SURGERY, p. 682, *infra*.

SPRAT, a marine fish (*Clupea sprattus*), named "garvie" in Scotland, one of the smallest species of the genus *Clupea* or herrings, rarely exceeds 5 inches in length, and occurs in large shoals on the Atlantic coasts of Europe. It is found also in the southern hemisphere, on the coasts of Tasmania and New Zealand, where, however, it seems to be less abundant, since its presence at the antipodes has been discovered only recently, and it does not seem to be the object of a regular fishery. Sprats are very often confounded with young herrings, which they much resemble, but can always be distinguished by the following characters: they do not possess any teeth on the palate (*vomer*), like herrings; their gill-covers are smooth, without the radiating striæ which are found in the shad and the pilchard; the anal fin consists of from seventeen to twenty rays, and the lateral line of forty-seven or forty-eight scales. The ventral fins are even with the origin of the dorsal fin; and the spine consists of from forty-seven to forty-nine vertebrae. The sprat is one of the more important food-fishes on account of the immense numbers which are caught when the shoals approach the coasts. They are somewhat capricious, however, as regards the place and time of their appearance, the latter falling chiefly in the first half of winter. They are caught with the sein or with the bag-net in the tideway. Large quantities are consumed fresh, but many are pickled or smoked, and others prepared like anchovies. Frequently the captures are so large that the fish can be used as manure only.

SPREMBERG, a small town of Prussia, in the province of Brandenburg, is situated about 75 miles to the south-east of Berlin, partly on an island in the river Spree and partly on the west bank. It carries on considerable manufactures of woollen cloth, and has greatly advanced in importance and population since the beginning of the 19th century. In 1885 its population numbered 11,011. The only building of note is the château, built by a son of Elector John George about the end of the 16th century.

SPRENGEL, KURT (1766-1833), German botanist and physician, was born on 3d August 1766 at Boldekow in Pomerania. His father, a clergyman, provided him with a thorough education of wide scope; and the boy at an early age distinguished himself as a linguist, not only in Latin and Greek, but also in Arabic. He appeared as an author at the age of fourteen, publishing a small work

called *Anleitung zur Botanik für Frauenzimmer* in 1780. In 1784 he commenced in the university of Halle to study theology and medicine, but soon relinquished the former. He graduated in medicine in 1787. In 1789 he was appointed an extraordinary professor of medicine in his *alma mater*, and in 1795 was promoted to an ordinary professorship. He devoted much of his time to medical work and to investigations into the history of medicine; and he published several very valuable works in this department of knowledge, and made himself well known as one of the ablest medical men in Germany. He held a foremost rank in medicine and in botany as an original investigator, and in both published works of great value, besides numerous articles in scientific journals and in the proceedings of learned societies. His accomplishments as a linguist probably, in part at least, determined him in the choice of the department to which he most fully devoted himself, and in which he stood *facile princeps*. Among the more important of his many services to the science of botany was the part he took in awakening and stimulating microscopic investigation into the anatomy of the tissues of the higher plants, though defective microscopic appliances rendered the conclusions arrived at by himself unreliable. He also made many improvements in the details of both the Linnæan and the "natural" systems of classification. His life passed quietly at Halle in the pursuit of the studies dear to him, and in the enjoyment of the honours bestowed upon him by over seventy learned societies, and also by monarchs. In 1828 the death of a son, professor of surgery at Greifswald, was felt by him very severely. He experienced several apoplectic seizures, and died in one on 15th March 1833.

Subjoined is a list of the more important of his works:—*Beiträge zur Geschichte d. Pulses*, 1787; *Galens Fieberlehre*, 1788; *Apologie des Hippocrates*, 1789; *Versuch einer pragmatischen Geschichte der Arzneykunde*, 1792-99; *Handbuch der Pathologie*, 1795-97; *Institutiones Medicæ*, 1809-16 (in 6 vols.); *Geschichte der Medicin*, completed in 1820; *Antiquitatum botanicarum specimen*, 1798; *Historia rei herbariæ*, 1807-8; *Anleitung zur Kenntniss der Gewächse*, 1802-4, and again 1817-18; *Geschichte der Botanik*, 1817-18; *Von dem Bau und der Natur der Gewächse*, 1812; *Flora Halensis*, 1806-15, and in 1832; *Species umbelliferarum minus cognita*, 1818; *Neue Entdeckung im ganzen Umfang der Pflanzenkunde*, 1820-22. He edited an edition of Linnæus's *Systema vegetabilium* in 1824 and of the *Genera plantarum* in 1830. His short papers are too numerous to be quoted; a list of those in botany, from 1798 onwards, will be found in the Royal Society's *Catalogue of Scientific Papers*.

SPRINGBOK. See ANTELOPE, vol. ii. p. 101.

SPRINGFIELD, a city of the United States, capital of Illinois and the county seat of Sangamon county, 185 miles south-west of Chicago and 95 north-east of St Louis, at the intersection of the main lines of the Chicago and Alton and the Wabash, St Louis, and Pacific Railways. It is situated in 39° 48' N. lat. and 89° 33' W. long., on a plateau 4 miles south of the Sangamon river. The State capitol (1868-1886) is constructed of Joliet marble in the form of a Greek cross, with porticos of granite; it is 385 feet long and 296 wide, and has a central dome surmounted by a lantern with a ball on the pinnacle (360 feet). It contains a general library, a law library, geological and agricultural museums, and a memorial hall of the Civil War, as well as the usual Government offices. Other buildings of note are the United States executive mansion, custom-house and post-office (1866-68), and the house formerly occupied by Lincoln. In Oak Ridge cemetery, adjacent to the city, is the Lincoln monument (1874), beneath which that president was buried. The monument, designed by Larkin G. Mead, consists of a granite obelisk, reaching a height of 98½ feet from the centre of a spacious basement (119½ feet long and 72½ wide), which contains a catacomb and a memorial hall,—the latter a museum of Lincolniana. A bronze statue of Lincoln and four groups

of figures in bronze, symbolizing the army and navy of the United States, are arranged round the foot of the obelisk. The town has a public library, two hospitals, two orphanages, and various other charitable institutions. Extensive deposits of bituminous coal occur in and near Springfield, which is the seat of extensive iron-rolling mills, watch factories, railway machine shops, plough works, and woolen, paper, and flour mills. It is also the headquarters of six of the principal live-stock associations of the country. The population was 4533 in 1850, 9820 in 1860, 17,364 in 1870, 19,743 (1328 coloured) in 1880, and in 1887 it was estimated at 25,000.

Laid out in 1822, Springfield was selected as State capital in 1837, and was made a city in 1840.

SPRINGFIELD, a city of the United States, the county seat of Hampden county, Massachusetts, on the east bank of Connecticut river, opposite West Springfield, with which it is connected by road and railway bridges. By rail it is 98 miles west by south of Boston on the route to Albany, and it forms a very important railway junction. The western part of Springfield is built on low and level ground, the eastern on the ascent from the river valley. The streets are wide and well shaded with elm and maple. A United States arsenal (founded 1777) and armoury (1794), employing some 460 hands, is the largest in the republic. The Springfield breech-loading rifle of 45 calibre has been the regulation pattern in the United States army since 1873. A pistol factory, car-works, manufactories of cotton and silk goods, buttons, needles, envelopes, paper, watches, skates, and brass-work may be mentioned among the industrial establishments. The city hall (1855), a Romanesque building with an audience-room capable of holding 2700 persons; the city free library (1871), a Gothic building of brick, which contains 56,000 volumes and a museum; the granite court-house; the Roman Catholic cathedral of St Michael; Christ Church, Episcopal; the Church of the Unity, a fine Gothic structure in brown stone; the South Congregational church; the office of the Boston and Albany Railroad, a massive granite block; and the high school are among the chief architectural features of the city. Races are held in Hampden Park by the river side. The population was 15,199 in 1860, 26,703 in 1870, 33,340 in 1880 (775 coloured), and 37,577 in 1885.

Springfield was settled in 1636 by William Pynchon and emigrants from Roxbury,—the determination of the founder being to limit the "town" to forty or at most fifty families. The name was at first Agawam; but the present designation was adopted in 1641 in memory of Springfield (Essex), Pynchon's residence in his native country, England, to which he was obliged to return in 1652 to escape the clerical persecution called forth by his book on the *Meritorious Price of Christ's Redemption*. The town was burned by the Indians in 1675; and in 1787 the arsenal was attacked by Shays's rebels. The opening of the Boston and Albany Railroad in 1839 was the beginning of rapid development, and the town was made a city in 1852. The manufacture of firearms carried on here during the Civil War, 1861-65, gave the city a great impulse.

SPRINGFIELD, a city of the United States, county seat of Greene county, Missouri, occupies a pleasant and healthy site on the Ozark Hills, 238 miles by rail south-west of St Louis by the St Louis and San Francisco Railroad, which here joins with the Kansas City, Fort Scott, and Gulf Railroad. Springfield is the chief commercial centre of south-west Missouri, one of the great lead and zinc mining districts of the States. It contains a number of factories (cotton, wool, waggons, furniture, tobacco, &c.), and is the seat of a court-house and of Drury College (1873), which provides scientific and classical training and has a musical conservatory attached. The population was 5555 in 1870, 6522 in 1880, and in 1886 was estimated at 18,000.

Originally an Indian trading post and frontier village, Springfield was incorporated in 1830 and began to be a prosperous place at the close of the Civil War, during which it had several times changed hands and been the scene of hostilities.

SPRINGFIELD, a city of the United States, county seat of Clarke county, Ohio, lies at the confluence of Mad river and Lagonda Creek (sub-tributaries of the Ohio through the Miami), 84 miles north-east of Cincinnati. It has a large trade in the agricultural produce of the fertile and populous district in which it is pleasantly situated, and is the seat of a very large manufactory of agricultural machinery, which turns out 75,000 reapers and mowers per annum, besides grain-drills, steam-engines, cider-mills, and a great variety of articles. In 1870 the population of the city was 12,652, in 1880 20,730 (township, 24,455), and 33,484 in 1886. Among the public institutions are Wittenberg College (Lutheran), founded in 1845, and a small public library.

SPRINGS. See GEOLOGY, vol. x. pp. 223, 269 *sq.*, and MINERAL WATERS.

SPRUCE. See FIR, vol. ix. p. 222.

SPURZHEIM, KASPAR, phrenologist, was born at Longwich near Treves on 31st December 1776, and died at Boston, United States, on 10th November 1832. See PHRENOLOGY.

SQUARING (or QUADRATURE) OF THE CIRCLE is the problem of finding a square equal in area to a given circle. Like all problems, it may be increased in difficulty by the imposition of restrictions; consequently under the designation there may be embraced quite a variety of geometrical problems. It has to be noted, however, that, when the "squaring" of the circle is especially spoken of, it is almost always tacitly assumed that the restrictions are those of the Euclidean geometry.

Since the area of a circle equals that of the rectilinear triangle whose base has the same length as the circumference and whose altitude equals the radius (Archimedes, *Κύκλου μέτρησις*, prop. 1), it follows that, if a straight line could be drawn equal in length to the circumference, the required square could be found by an ordinary Euclidean construction; also, it is evident that, conversely, if a square equal in area to the circle could be obtained, it would be possible to draw a straight line equal to the circumference. Rectification and quadrature of the circle have thus been, since the time of Archimedes at least, practically identical problems. Again, since the circumferences of circles are proportional to their diameters—a proposition assumed to be true from the dawn almost of practical geometry—the rectification of the circle is seen to be transformable into finding the ratio of the circumference to the diameter. This correlative numerical problem and the two purely geometrical problems are inseparably connected historically.

Probably the earliest value for the ratio was 3. It was so among the Jews (1 Kings vii. 23, 26), the Babylonians (Oppert, *Journ. Asiatique*, August 1872, October 1874), the Chinese (Biot, *Journ. Asiatique*, June 1841), and probably also the Greeks. Among the ancient Egyptians, as would appear from a calculation in the Rhind papyrus, the number  $(\frac{256}{81})^2$ , i.e., 3.16... was at one time in use.<sup>1</sup> The first attempts to solve the purely geometrical problem appear to have been made by the Greeks (Anaxagoras, &c.),<sup>2</sup> one of whom, Hippocrates,<sup>3</sup> doubtless raised hopes of a solution by his quadrature of the so-called *meniscoid*. As for Euclid, it is sufficient to recall the facts that the original author of prop. 8 of book iv. had strict proof of the ratio being < 4, and the author of prop. 15 of the ratio being > 3, and to direct attention to the importance

<sup>1</sup> Eisenlohr, *Ein math. Handbuch d. alten Aegypter*, übers. u. erklärt, Leipsic, 1877; Rodet, *Bull. de la Soc. Math. de France*, vi. pp. 139-149.

<sup>2</sup> Hankel, *Zur Gesch. d. Math. im Alterthum*, &c., chap. v., Leipsic, 1874; Cantor, *Vorlesungen über Gesch. d. Math.*, i., Leipsic, 1880; Tannery, *Mém. de la Soc., &c., à Bordeaux*; Allman, in *Hermathena*.

<sup>3</sup> Tannery, *Bull. des Sc. Math.*, [2], x. pp. 213-226.