

referred to under **ABIogenesis**. In this regard also he was led to pay considerable attention to the infusorial animalcules. His great work, however, is the *Dissertationi de Fisica Animale e Vegetale* (2 vols., 1780). Here he first interpreted the process of digestion, which he proved to be no mere mechanical process of trituration, but one of actual solution, taking place primarily in the stomach, by the action of the gastric juice. Verifying this by the important experiment of artificial digestion outside the stomach in sealed tubes, he was attacked by John Hunter, but emerged victorious from the encounter. Of no less importance are his researches on reproduction, in which he experimentally settled the relative functions of the ovum and the spermatozoon. See **REPRODUCTION**.

SPANDAU, a strongly-fortified town in the province of Brandenburg, Prussia, is situated at the confluence of the Havel and Spree, 8 miles to the north-west of Berlin. It has recently been converted into a fortress of the first class, and is now the key of the defences of the capital. The Julius tower in the citadel, which is surrounded by water, contains the imperial war treasure (Reichskriegsschatz),—a sum of £6,000,000 in gold, kept in readiness for any warlike emergency. Besides numerous barracks, Spandau contains various military establishments appropriate to an important garrison town; and its chief industries are connected with the preparation of munitions of war. The Government factories for the manufacture of small arms, artillery, gunpowder, &c., cover upwards of 200 acres, and employ about 4000 workmen. The other industries are not very important; they comprise miscellaneous manufactures, fishing, boat-building, and some shipping on the Havel. The population in 1885, including the garrison of nearly 4000 men, was 31,463.

Spandau is one of the oldest places in the Altmark, and received town-rights in 1232. It afterwards became a favourite residence of the Hohenzollern electors of Brandenburg, and was fortified in 1577-83. In 1635 it surrendered to the Swedes, and in 1806 to the French. A short investment in 1813 restored it to Prussia. The population in 1816 was 6250.

SPANGENBERG, **AUGUST GOTTLIEB** (1704-1792), Count Zinzendorf's successor, and bishop of the Moravian Brethren, was born July 14, 1704, at Klettenberg, on the south of the Harz Mountains, where his father was court-preacher, and ecclesiastical inspector of the grafschaft of Hohenstein. Left an orphan at the early age of ten, he was sent to the excellent high school at Ilfeld, and passed thence (1722), in poorest circumstances, to Jena to study law. Prof. Buddeus received the poor youth into his family, and a "stipendium" was procured for him. Theology rather than law was his natural destination, and it needed only the impulse of the remark of Buddeus that the inevitable prospect before a true theologian is ignominy and trial to convert the student of law, who was profoundly exercised with religious conflicts, into a student of theology. Somewhat after the manner of the Wesleys at Oxford a little later, he studied the mystics, read the Bible, observed rigid devotional exercises, sought to quicken his sense of sin, avoided taking the Lord's Supper with unbelievers in the Lutheran Church, and took an active part in a religious union of students and in schools for poor children just outside Jena. He took his degree in 1726, and began to give free lectures on theology. In 1727 he made the acquaintance of the Moravian colony at Herrnhut and its head, Count Zinzendorf. A "collegium pastorale practicum" for the care of the sick and poor was in consequence founded by him at Jena, which the authorities at once broke up as a "Zinzendorfsian institution." But Spangenberg's relations with the Moravians were confirmed by several visits to the colony, and the accident of an unfavourable appeal to the lot alone prevented his appointment as chief elder of the community, March 1733. Meanwhile his free lectures in Jena met with much acceptance, and led to an invitation from Gotthelf Francke to the post of assistant professor of theology and superintendent of the educational depart-

ment of his orphanage at Halle. He accepted the invitation, and entered on his duties in September 1732. But it soon appeared that the differences between the Pietists of Halle and himself were far too serious to admit of any harmonious co-operation. He found their religious life too formal, legal, external, and worldly; and they could not sanction his comparative indifference to doctrinal correctness and his incurable tendency to separatism in church life. Spangenberg's participation in private observances of the Lord's Supper brought matters to a crisis. His intimate connexion with Count Zinzendorf was made a further charge against him. His preaching was pronounced "singular," and an "affected humility towards common people" obnoxious. He was offered by the senate of the theological faculty of Halle the alternative of doing penance before God, submitting to his superiors, and separating himself from Zinzendorf, or leaving the matter to the decision of the king, unless he preferred to "leave Halle quietly." The case came before the king, and on April 8, 1733, Spangenberg was conducted by the military outside the gates of Halle. At first he bent his steps to Jena, but Zinzendorf at once sought to secure him as a fellow-labourer, though, with that "jesuitry" of which Wesley subsequently complained, the count wished to obtain from him a declaration which would remove from the Pietists of Halle all blame with regard to the disruption. Spangenberg found amongst the Moravians his life-work. He could amongst them carry out his fundamental principle that the churches are but spheres in all of which Christians are to be found, and that the one church of Christ is only where believers live in Christian fellowship. He joined the Moravians at a moment when the stability of the society was threatened, and a wise organizer, enterprising missionary, and theological teacher was imperatively required. He became its theologian, its apologist, its statesman and corrector, through sixty long years of incessant labour. For the first thirty years (1733-62) his work was mainly devoted to the superintendence and organization of the extensive missionary enterprises of the body in Germany, England, Denmark, Holland, Surinam, Georgia, and elsewhere. His missionary work tended to still further modify and broaden his theological opinions, unsatisfactory as the Pietists of Halle had found them in 1733. It was on an island off Savannah that Spangenberg startled John Wesley with his questions and profoundly influenced his entire future career. One special endeavour of Spangenberg in Pennsylvania was to bring over the scattered Schwenkfeldians to his faith. In 1741-42 he was in England collecting for his mission and obtaining the sanction of the archbishop of Canterbury. During the second half of this missionary period of his life he superintended as bishop the churches of Pennsylvania, defended the Moravian colonies against the Indians at the time of war between France and England, became the apologist of his body against the attacks of the Lutherans and the Pietists, and did much to moderate the mystical extravagances of Zinzendorf, with which his simple, practical, and healthy nature was out of sympathy. The second thirty years of his work (1762-92) were devoted to the consolidation of the German Moravian Church. Zinzendorf's death (1760) had left room and need for his labours at home. At Herrnhut there were conflicting tendencies, doctrinal and practical extravagances, and the organization of the brethren was very defective. Spangenberg proved himself to be the man required. In 1777 he was commissioned to draw up an *idea fidei fratrum*, or compendium of the Christian faith of the United Brethren, which was published two years afterwards and became the accepted declaration of the Moravian belief. As compared with

Zinzendorf's own writings, this book exhibits the finer balance and greater moderation of Spangenberg's nature, while those offensive descriptions of the relation of the sinner to Christ in which the Moravians at first indulged are almost absent from it. In his last years Spangenberg devoted special attention to the education of the young, in which the Moravians have since been so successful. He died at Berthelsdorf, September 18, 1792. In addition to the *Idea Fidei Fratrum*, Spangenberg wrote, besides other apologetic books, a *Declaration über die zeitlich gegen uns ausgegangenen Beschuldigungen* (Leipsic, 1751), an *Apologetische Schlusschrift* (1752), *Leben des Grafen Zinzendorf* (1772-75); and his hymns are well known beyond the Moravian circle.

See Ristler, *Leben Spangenberg's*, Barby, 1794; K. F. Ledderhose, *Das Leben Spangenberg's*, Heidelberg, 1846; Frick, *Beiträge zur Lebensgeschichte A. G. Spangenberg's*, Halle, 1884; Herzog-Plitt's *Realencyklopädie*, s.v. "Spangenberg."

SPARROW (A.S. *Spearwa*; Icel. *Spörr*; Old High Germ. *Sparo*), a word perhaps (like the equivalent Latin *Passer*) originally meaning almost any small bird, but gradually restricted in signification and nowadays in common English applied to only four kinds, which are further differentiated as Hedge-Sparrow, House-Sparrow, Tree-Sparrow, and Reed-Sparrow—the last being a BUNTING (vol. iv. p. 525)—though when used without a prefix the second of these is usually intended.

1. The **HEDGE-SPARROW**, called "Duncock" in many parts of Britain, the *Accentor modularis* of ornithologists, is the little brown-backed bird with an iron-grey head and neck that is to be seen in nearly every garden throughout the country, unobtrusively and yet tamely seeking its food, which consists almost wholly of insects, as it progresses over the ground in short jumps, each movement being accompanied by a slight jerk or shuffle of the wings. Though on the Continent it regularly migrates, it is one of the few soft-billed birds that reside throughout the year with us, and is one of the earliest breeders,—its well-known greenish-blue eggs, laid in a warmly-built nest, being recognized by hundreds as among the surest signs of returning spring; but a second or even a third brood is produced later. The cock has a sweet but rather feeble song; and the species has long been accounted, though not with accuracy, to be the most common dupe of the Cuckoo. Several other species are assigned to the genus *Accentor*; but all, except the Japanese *A. rubidus*, which is the counterpart of the British Hedge-Sparrow, inhabit more or less rocky situations, and one, *A. collaris* or *alpinus*, is a denizen of the higher mountain-ranges of Europe, though it has several times strayed to England. The taxonomic position of the genus is regarded by some systematists as doubtful; but to the present writer there seems no good reason for removing it from the group which contains the Thrushes and Warblers (*Turdidae* and *Sylviidae*), to which it was long referred.

2. The **HOUSE-SPARROW**, the *Fringilla domestica* of Linnaeus and *Passer domesticus* of modern authors, is far too well known to need any description of its appearance or habits, being found, whether in country or town, more attached to human dwellings than any other wild bird; nay, more than that, one may safely assert that it is not known to thrive anywhere far away from the habitations or works of men, extending its range in such countries as Northern Scandinavia and many parts of the Russian empire as new settlements are formed and land brought under cultivation. Thus questions arise as to whether it should not be considered a parasite throughout the greater portion of the area it now occupies, and as to what may have been its native country. Moreover, of late years it has been inconsiderately introduced to several of the large towns of North America and to many of the British colonies, in nearly all of which, as had been foreseen by ornithologists, it has multiplied to excess and has become an intolerable nuisance, being unrestrained by the natural checks which partly restrict its increase in Europe and Asia. Whether indeed in the older seats of civilization the House-Sparrow is not decidedly injurious to the agriculturist and horticulturist has long been a matter of discussion, and no definite result that a fair judge can accept has yet been reached. It is freely admitted that the damage done to growing crops is often enormous, but as yet the service frequently rendered by the destruction of insect-pests cannot be calculated. Both friends and foes of the House-Sparrow write as violent partisans,¹ and the truth will not be known until a series of experiments,

¹ The most recent attacks upon it are contained in the various issues of the *Report of Observations of Injurious Insects and Common Crop Pests*, annually made by Miss Eleanor Ormerod, and in a little volume bearing the title of *The House Sparrow*, published in 1885.

conducted by scientifically-trained investigators, has been instituted, which, to the shame of numerous agricultural and horticultural societies, has not yet been done. It is quite likely that the result will be unfavourable to the House-Sparrow, from what has been said above as to its being so dependent on man for its subsistence; but, while the evil it does is so apparent,—for instance, the damage to ripening grain-crops,—the extent of the counterbalancing benefit is quite uncertain, and from the nature of the case is often overlooked. In the South of Europe the House-Sparrow is in some measure replaced by two allied species, *P. hispaniolensis* and *P. italia*, whose habits are essentially identical with its own; and it is doubtful whether the Sparrow of India, *P. indicus*, is specifically distinct; but Africa has several members of the genus which are decidedly so.

3. The **TREE-SPARROW**, the *Fringilla montana* of Linnaeus and *Passer montanus* of modern writers, in appearance much resembling the House-Sparrow, but easily distinguishable by its reddish-brown crown, the black patch on the sides of its neck, and its doubly-barred wings,² is a much more local species, in England generally frequenting the rows of pollard-willows that line so many rivers and canals, in the holes of which it breeds; but in some Eastern countries, and especially in China, it frequents houses, even in towns, and so fills the place of the House-Sparrow. Its geographical distribution is extensive, and marked by some curious characters, among which may be mentioned that, being a great wanderer, it has effected settlements even in such remote islands as the *Færoes* and some of the Outer Hebrides.

That the genus *Passer* properly belongs to the *Fringillidae* is admitted by most ornithologists, yet there have been some who would refer it to the Weaver-birds, *Ploceidae*, if they are to be accounted as forming a distinct Family,—a matter which is not at all clear. The American birds called "Sparrows" have little in common with the members of the genus *Passer*, and probably belong rather to the family *Emberizidae* than to the *Fringillidae*. (A. N.)

SPARROWHAWK. See **HAWK**.

SPARTA, after Athens, was the most powerful and important of the Greek states. Her fame rested mainly on her soldiers, her military discipline, her somewhat narrow patriotism, and her intense political conservatism; in general intellectual culture, in art and in everything connected with it, she was immeasurably inferior to Athens, and even to some of the other Greek states, though there is evidence to show that a genius and a taste for sculpture and music were by no means wanting to her citizens. Her eminent men were almost all eminent as soldiers, and few of them had any pretensions to rank as able and enlightened statesmen. No such man as Themistocles or Pericles ever appeared in Sparta; she produced no great thinkers or philosophers; the typical Spartan, in short, was a brave and well-trained soldier, with a decided simplicity of character and strong religious scruples, amounting to what we must call superstition, which from time to time were a hindrance to prompt action and discredited the state in the public opinion of Greece.

Sparta was not so much a city as a cluster of open villages in a plain in the heart of Laconia (see vol. xi. plate I.), in the middle valley of the Eurotas, on the west bank of the river, between the ranges of Taygetus and Parion, and built in part on the spurs of these mountains. Its situation was very picturesque: "hollow, lovely Lacedæmon"³ is Homer's description. Taygetus on the west rises to its greatest height of nearly 8000 feet just above the city, with primeval forests on its lower slopes, in which Spartans hunted the stag and the wild boar. Sparta seems to have been about six miles in circuit; it was not, like most Greek cities, near the coast,—Gythium, and consisting chiefly of three essays by Mr J. H. Gurney, jun., Lieut.-Col. C. Russell, and Prof. Coues, but the last has only reference to the behaviour of the bird in the United States of America, where, from the reason above assigned, its presence was expected by almost all well-informed persons to be detrimental.

² A more important difference is that the two sexes have almost the same plumage, while in the House-Sparrow they are unlike in this respect.

³ Lacedæmon was simply another name for Sparta, though sometimes it seems to stand for the surrounding district.

the chief port of Laconia, being 30 miles distant; nor was it built with anything like the compactness of an Athens or a Corinth. The houses for the most part stood in spacious gardens, an open-air life being altogether to the Spartan taste, and well suited to the pleasant genial climate of the valley. The olive still grows to great perfection in the neighbourhood, and the silk is said to be of particularly fine quality. The mountain ranges round the city gave it a very strong defensive position, and for a long period Sparta was without walls or fortifications, trusting exclusively to the prowess of her citizens till she was seriously menaced by the victorious Macedonians in the 4th century B.C. The city was never a very splendid one; the houses were plain and simple and there seem to have been no public buildings of striking magnificence. There was the so-called Brazen House of Athene on a hill within a large enclosure, with plates of bronze which gave it its name, on which, among other mythological scenes, were represented the labours of Hercules and the exploits of the great twin brethren, Castor and Pollux, who were specially honoured at Sparta. There was the theatre, still to be traced in huge quadrangular blocks of stone, and there were porticos and colonnades, and the chapels and tombs of Spartan heroes, such as Lycurgus, Leonidas, Brasidas. Sparta delighted to honour her worthy citizens, and paid them divine honours after death. The site of the city has not been thoroughly investigated, but it is a question whether much remains worth bringing to light. What has hitherto been discovered is poor and disappointing. Sparta's greatness as a city, as Thucydides (i. 10) clearly implies, fell very far short of her political importance as a state.¹

Sparta's history, passing over her share in the prehistoric Trojan War under her king Menelaus, the brother of Agamemnon, begins with the legislation of Lycurgus in the 9th century B.C. It was this, as has been explained in the article LYCURGUS, which made Sparta what she was, a state whose aim it was rather to hold her own within the Peloponnesus than to launch out into doubtful enterprises far away from home. Sparta was not naturally aggressive or ambitious; she was not easily roused to action even in great emergencies. She was safe amid her mountains from the perils to which other Greek cities were exposed. It would seem that in early days Argos had been decidedly the first power in the Peloponnesus, Sparta being second to her by a long interval. The relative position of the two states was reversed soon after the time of Lycurgus. The spirit and vigour which his discipline infused no doubt enabled Sparta, after two severe wars in the 8th and 7th centuries, to accomplish at last the complete conquest of Messene, the south-western portion of the Peloponnesus, and so to become the undisputed mistress of at least two-fifths of the whole peninsula. By the year 600 B.C. Sparta was quite in the first rank of Greek states, and it was generally felt that she had a right to take the lead in Greek politics. In the 6th century she put down the tyrants, the heads of the democratic and popular party, in several Greek cities, and drove, for a time at least, the reforming and innovating Clisthenes from Athens. Sparta was the steady foe of democracy and popular government. The Spartans were themselves a small landowning aristocracy, in the midst of a comparatively numerous population, consisting of so-called Perioeci (dwellers round about), the aboriginal inhabitants, in fact, of Laconia, and of Helots or serfs, taken to a great extent from the conquered Messenians.

¹ For topographical details we must refer the reader to the elaborate works of the German scholar Curtius on the Peloponnesus and works based on them. Mure's *Greece* and Leake's *Morea* should be consulted.

The government was highly centralized; it was wholly in the hands of the Spartans, the Perioeci having no share in it, though many of them may have themselves been landowners, or at any rate have held land under Spartan landlords, and been well-to-do and prosperous. The Helots were farm labourers bound to the soil, slaves in every sense of the word, anything like self-respect being studiously made impossible for them. Spartans could put down a popular rising or a slave insurrection with cold-blooded cruelty, and in a panic following on an earthquake of unusual violence in 464 there was a deliberately-planned massacre of a multitude of Helots for the safety of Sparta, carried out and executed by Spartans in person. A calculating selfishness was a marked trait in Spartan character. Sparta seems always to have put her own interests before those of Greece, though she claimed to be the leading and representative Greek state. She was cautious and even timid, though the courage of her individual citizens in war was unsurpassed. Every Spartan was a hero on the battlefield, and a Spartan army was long assumed to be invincible. Sparta was not much of a colonizing state, but she could point to the famous city of Tarentum in southern Italy as her offspring, and to Lyctus (*H.*, ii. 647; xvii. 611) in Crete, whence came warriors to the Trojan War. In 491, when Greece was threatened with invasion by Persia, we find Athens appealing to Sparta and urging a complaint against the Æginetans as traitors to Greece for having given earth and water, the symbols of submission, to the emissaries of the great king. In 480 a Spartan admiral commanded the Greek fleet off Artemisium against Xerxes, and in the following year a Spartan general, Pausanias, commanded the united forces of Greece in the famous battle of Plataea. All this implies a distinct recognition of Sparta as the head of Greece. The Persian War over, Athens under Cimon and Pericles developed extraordinary energy and took Sparta's place. Sparta indeed seems to have retired upon her laurels, and it was not, without reluctance and much urgent pressure that she embarked in the Peloponnesian War, which, after twenty-eight years of hard fighting, ended in the overthrow of the Athenian empire and the capture of Athens by Lysander in 405. Sparta contributed greatly to the final result by despatching an able officer, Gylippus, to the relief of Syracuse in 414, when the city was on the point of surrendering to the Athenian armament. It was the decisive success of Gylippus in Sicily which turned the scale against Athens. The crushing blow of Ægospotami in 405, which annihilated her fleet and left her defenceless, and the subsequent surrender of the city transferred the supremacy of Greece once more to Sparta, but not for much more than thirty years. Sparta's policy was ungenerous and short-sighted; it consisted in establishing little oligarchical factions under Spartan control in the Greek cities, and soon degenerated into a tyranny which became utterly odious. All Sparta's worst qualities came out during this period: "autonomy," which had been her watchword throughout the war against Athens, became a dead letter under her rule; and the freedom of city life, so dear to a Greek, was crushed out under her officials and commissioners, whom she thrust on a number of Greek cities. Still more did she disgust all the better men of Greece by concluding, after a series of intrigues for her own selfish ends, a peace with Persia in 387, known as the peace of Antalcidas, the Spartan through whom it was negotiated. It was a dishonourable peace for Greece, as its effect was to facilitate Persian intervention in Greek affairs and make the king of Persia the arbiter of Greek disputes and differences. Meanwhile Athens was recovering herself; the tables were soon turned on Sparta, and her maritime

power collapsed before the united action of Athens and Persia. In the Peloponnesus Sparta was still supreme, but Thebes, she felt, might become a dangerous rival and must be humbled. She insisted that the townships of Boeotia must be "autonomous" and independent of Thebes, and so contrived to pick a quarrel with that state, which to Sparta's cost had at that time the famous Epaminondas, the greatest, perhaps, of Greek generals, among her leading citizens. In 371 came Sparta's crushing defeat at Leuctra, a blow from which she never really recovered, though her courage and military discipline long survived it. But her prestige was gone. Epaminondas carried the war into the heart of Laconia and penetrated to Sparta itself. His victory at Mantinea in 362 gave independence to Messene, and Sparta was now politically ignored by her old allies.

From this time Sparta almost drops out of Greek history. She took no part in the struggle against Macedon; no Spartan soldier stood by the side of the Athenians and Thebans at Chaeronea. She seems to have sunk into political apathy; very possibly she may have had to concentrate all her remaining strength and energy in keeping down her Helots and the native population of Laconia. When Alexander was winning his victories in Asia, she intrigued feebly against Macedon, and she would take no part in the congress of the Greek states at Corinth which declared Alexander "Leader of the Greeks."

She appears once again, but as not much more than the ghost of her former self, in the 3d century B.C., attempting vainly in 281 to unite Greece against the Macedonian Antigonos, and repulsing Pyrrhus from her walls in 272, Spartan women working at the city's defence, and a few Spartan warriors driving back the formidable soldier-king. There was still the old spirit about her, but the number of her citizens is said to have dwindled down to 700, and in her last days, with a wealthy few in the midst of a poor and needy people, Sparta had shrunk into the narrowest and feeblest of oligarchies. In the latter half of the 3d century B.C., in the days of the Achæan league, a vigorous but unsuccessful attempt at internal reforms and a restoration of the old discipline of Lycurgus was made by two of her kings, Cleomenes and Agis. She sank finally, we know not how, under the degrading dominion of a sort of robber chief, Nabis, who fastened his tyranny upon her by the support of emancipated slaves and mercenaries of the lowest class. Her best citizens were put to death or banished, and she was debased into a refuge of pirates and robbers. Nabis and his vile gang were put down by Philopœmen in the name of the Achæan league, and Philopœmen completed his work by razing the walls of Sparta and abolishing her old institutions. Rome simply looked on, knowing well that she was mistress of the situation, and let matters drag on till 146, when she captured Corinth, and closed the page of Greek history. (W. J. B.)

SPARTACUS, the leader of a formidable insurrection of slaves against Rome in the 1st century B.C., was a Thracian by birth, and perhaps a descendant of the kings of Panticapœum whose name he bore. He served in the Roman army, but seems to have deserted, for we are told that he was taken prisoner and sold as a slave. Destined for the arena, he, with a band of his fellow-gladicators, broke out of a training-school at Capua and took refuge on Mount Vesuvius (73 B.C.). Here he maintained himself as a captain of brigands, his lieutenants being Crixus and Enomæus, who like himself had been gladicators. Their numbers soon swelled through the accession of runaway slaves and desperados from the neighbourhood. A hastily-collected force of 3000 men under Claudius endeavoured to besiege and starve out the rebels, but the latter clambered down the precipices and put the Romans to

flight. Swarms of hardy and desperate men now joined the rebels, and when the prætor Publius Varinius took the field against them he found them entrenched like a regular army on the plain. But they gave him the slip, and when he advanced to storm their lines he found them deserted. From Campania the rebels marched into Lucania, a country better suited for guerilla warfare. Here, in spite of the commands and entreaties of Spartacus, the slaves committed excesses of lust and cruelty. Varinius followed him, but was defeated in several engagements and narrowly escaped being taken prisoner. Spartacus, whose heart was "where his rude cottage by the Danube lay," now endeavoured to push northward. His object was to cross the Alps and allow the slaves, who were mostly Thracians, Germans, and Gauls, to disperse to their homes. But intoxicated by success his wild followers refused to listen to him; their thoughts were all of plunder, and their track was marked by the devastation of Italy. Vola, Nuceria, Thurii, Metapontum, were sacked with every circumstance of savage cruelty. In this serious position of affairs the senate despatched both consuls against the rebels (72 B.C.). The German slaves under Crixus, who had separated from the rest, were defeated and cut in pieces at Mount Gargarus in Apulia by the prætor Arrius. But Spartacus overthrew both consuls, one after the other, and then pressed towards the Alps. Cassius, governor of Cisalpine Gaul, and the prætor Manlius flung themselves in his way at the head of 20,000 men, but were trampled under foot. Freedom was within sight, but with fatal infatuation the slaves declined to abandon Italy. Spartacus led them against Rome, but their hearts seem to have failed them, for the capital was not attacked. Spartacus then occupied the port of Thurii and tried to procure supplies of iron and bronze, probably through the pirates. He also endeavoured by means of the herds of horses captured in southern Italy to form a body of cavalry. The conduct of the war against Spartacus, together with eight legions, was now committed to the prætor Marcus Crassus. He restored discipline by decimating the first troops that ran before the enemy. In the next battle Spartacus was worsted and retreated towards the straits of Messina, intending to cross into Sicily, where he would have been welcomed by fresh hordes of slaves; but the pirates who had agreed to transport his army proved faithless. Crassus endeavoured to shut in the rebels by carrying a ditch and rampart right across the peninsula, a distance of 32 miles. But on a wintry night Spartacus forced the lines, and once more Italy lay at his feet. Disunion, however, was at work in the rebel camp. The Gauls and Germans had again drawn off from the main body. Crassus attacked and destroyed them. Spartacus was now fain to secure a retreat into the mountains of Petelia (near Strongoli in Calabria), and succeeded in inflicting a reverse on the pursuing army. But his men refused to retreat farther, and in a pitched battle which followed soon afterwards the rebel army was annihilated. Spartacus, who had stabbed his horse before the battle began, fell sword in hand. A body of the rebels which had escaped from the field was met and cut in pieces by Pompey, who, with his usual knack of reaping where other men had sowed, claimed and received the credit of having put an end to the war (71 B.C.). Six thousand slaves, who had not found a soldier's death, were crucified along the high road from Capua to Rome.

A history of the war against Spartacus has to be pieced together with much uncertainty from the vague, scrappy, and somewhat discrepant accounts of Plutarch (*Crassus*, 8-11), Appian (*Bell. Civ.*, i. 116-120), Florus (ii. 8 [iii. 20]), Livy (*Epit.*, xcv., xcvi., xcvi.), and Sallust (fragments of the *Histories*). Sallust's description seems to have been full and graphic, but unfortunately only a few fragments of it remain.

SPECIES. In logic the term "species" is applied to any group of individuals agreeing in some common attribute or attributes, and included along with other groups in a higher category, that of "genus," which comprehends the fewer and more general attributes in which all agree and ignores those in which they differ. The application of these terms in logic is thus purely relative; any genus, however large, may be but a species of a still larger genus. But in arranging the innumerable objects of the natural sciences the naturalist finds it necessary to restrict the terms "species" and "genus" to the two lowest groupings and to distinguish the higher aggregates by special terms, as "family," "order," "class," &c. Early writers had but a loose conception of many different "kinds" of animals and plants, and spoke only of species and genus in their purely logical relations, with varying breadth of content. The term "species" was limited to its natural history usage in the end of the 17th century by John Ray. His conception of "specific characters" rested, not only on close and constant resemblance in outward form, but also on the likeness of offspring to parent, a considerable measure of variability being, however, recognized. Amongst subsequent authors this conception of common descent or parentage became more and more prominent, while the progress of successful definition of species made the limits of their variability seem always narrower and of less importance; and in this way the useful working conception of the tolerable definiteness of species gradually crystallized into the absolute dogma of their fixity. Then Linnæus in his *Philosophia Botanica* gave the aphorism "species tot sunt diversæ, quot diversæ formæ ab initio sunt creatæ" (we reckon just as many species as there were forms created at the beginning), which was generally accepted. Buffon's obstinate rejection of the Linnæan classification was associated with a belief in the modifiability of species, and showed some foresight of the doctrine elaborated soon afterwards by LAMARCK (*q.v.*). The general acceptance of this dogma was, however, effected by the influence of Cuvier; its overthrow dates only from the publication of Darwin's *Origin of Species* (1859), of which the argument need not be here repeated. (See EVOLUTION, MORPHOLOGY.) The genealogical conception of species was thus established more firmly than ever, though cleared from its former associations; in Haeckel's phrase, the species is the whole succession of organisms which exhibit the same form in the same environment. The rash generalization, that distinct species are to be recognized by their incapacity for the production of fertile hybrids, was next overthrown, while closer study has cleared away the notion of the equal definiteness of all specific forms. We now know that, while many forms, like the pearly nautilus or the Venus's fly-trap, do indeed exhibit the most perfect specific definiteness, the demarcation of equally definite species in other genera is rendered impossible by the existence of the most complete series of transitional forms, and the number of the species defined thus comes to depend simply on the personal equation of the systematist, on his predilection for "lumping" or "splitting," as the case may be. Thus, for example, the number of described German species of hawkweed (*Hieracium*) has ranged from 300 for one author, through 106 for another and 52 for a third, to less than 20 for a fourth. Similar instances of variable genera are afforded by the willows and the brambles, and many other common forms. This wide variability, as might be expected, seems to be more prevalent among the lowest forms of life, and the classical example of the relativity and variability of species has been furnished by Haeckel's beautiful monograph on the calcareous sponges (*Monographie der Kalkschwämme*, Jena, 1872), in which he offers twelve distinct arrangements of

the same set of forms from various points of view, among which the two most nearly conventional propose respectively 21 genera and 111 species and 39 genera and 289 species. All such variable forms are in fact species in the making, which become definite in proportion as certain varieties become especially adapted to their environment, and become isolated by the dying out of the intermediate forms. With these limitations, however, the working usefulness of the morphological conception of species remains undiminished. The want of any absolute standard of specific difference is largely made up by practical experience and common sense; and the evolutionary systematists are less in danger than were their predecessors of either exaggerating or understating the importance of mere varieties. (See VARIATION.)

SPECIFIC GRAVITY. See HYDROMETER, vol. xii. p. 536 sq.

SPECTACLES are flat glasses, prisms, spherical or cylindrical lenses, employed to detect and correct defects of the eyes. They are made usually of crown glass or rock crystal ("pebbles"), the latter being somewhat lighter and cooler to wear. They are mounted in the well-known rigid spectacle frame when for continuous use,—eye-glasses being preferable where they are worn intermittently, and hand-glasses or lorgnettes where they are required to supplement temporarily the spectacles usually worn, or where, as with extreme shortness of sight, no glass could be employed with comfort for any length of time.

Preserves.—Preserves are used to conceal deformities or to protect the eyes in the many conditions where they cannot tolerate bright light, such as ulceration and inflammation of the cornea, certain diseases of the iris, ciliary body, choroid, and retina. They are made of bluish, "smoked," or almost black coloured glass, and are of very various shapes, according to the amount of obscuration necessary.

Prisms.—Prisms are of great value in cases of double vision due to a slight tendency to squinting, caused by weakness or over-action of the muscular apparatus of the eyeball. Prisms deflect rays of light towards their bases. Hence, if a prism is placed in front of the eye with its base towards the nose, a ray of light falling upon it will be bent inwards, and seem to come from a point further out from the axis of vision. Conversely, if the base of the prism is turned towards the temple, the ray of light will seem to come from a point nearer the axis, and will induce the eye to turn inwards, to converge towards its fellow. In cases of myopia or short-sight owing to weakness of the internal recti muscles, the eyes in looking at a near object, instead of converging, tend to turn outwards, and so double vision results. If a suitable prism is placed in front of the eyes the double vision may be prevented. These prisms may be combined with concave lenses, which correct the myopia, or, since a concave lens may be considered as composed of two prisms united at their apices, the same effect may be obtained by making the distance between the centres of the concave lenses greater than that between the centres of the pupils. Again, to obviate the necessity for excessive convergence of the eyes so common in hypermetropia, the centre of the pupil should be placed outside the centre of the corrective convex lenses; these will then act as prisms with their bases inwards. Where, on the other hand, there is no tendency to squinting, care must be taken in selecting spectacles that the distances between the centres of the glasses and the centres of the pupils are quite equal, otherwise squinting, or at any rate great fatigue, of the eyes may be induced.

Spherical Lenses.—Biconcave, biconvex, and concavo-convex (meniscus) lenses are employed in ophthalmic practice in the treatment of errors of refraction. Until recently these spherical lenses were numbered in terms of their focal

length, the inch being used as the unit. Owing principally to differences in the length of the inch in various countries, this method had great inconveniences, and is now giving place to a universal system, in which the unit is the refractive power of a lens whose focal length is one metre. This unit is called a "dioptric" (usually written "D"). A lens of twice its strength has a refractive power of 2 D, and a focal length of half a metre, and so on.

Concave lenses are used in the treatment of myopia or short-sight. In this condition the eye is elongated from before backwards, so that the retina lies behind the principal focus. All objects, therefore, which lie beyond a certain point (the conjugate focus of the dioptric system of the eye, the far point) are indistinctly seen; rays from them have not the necessary divergence to be focused in the retina, but may obtain it by the interposition of suitable concave lenses. Concave lenses should never be used for work within the far point; but they may be used in all cases to improve distant vision, and in very short-sighted persons to remove the far point so as to enable fine work such as sewing or reading to be done at a convenient distance. The weakest pair of concave lenses with which one can read clearly test types at a distance of 18 feet is the measure of the amount of myopia, and this fully correcting glass may be worn in the slighter forms of short-sight. In higher degrees, where full correction might increase the myopia by inducing a strain of the accommodation, somewhat weaker glasses should be used for near work. In the highest degrees the complete correction may be employed, but lorgnettes are generally preferred, as they can be removed when the eyes become fatigued. It must be remembered that short-sight tends to increase during the early, especially the school, years of life, and that hygienic treatment, good light, good type, and avoidance of stooping are important for its prevention.

Convex Lenses.—In hypermetropia the retina is in front of the principal focus of the eye. Hence in its condition of repose such an eye cannot distinctly see parallel rays from a distance and, still less, divergent rays from a near object. The defect may be overcome more or less completely by the use of the accommodation. In the slighter forms no inconvenience may result; but in higher degrees prolonged work is apt to give rise to aching and watering of the eyes, headache, inability to read or sew for any length of time, and even to double vision and internal strabismus. Such cases should be treated with convex lenses, which should be theoretically of such a strength as to fully correct the hypermetropia. Practically it is found that a certain amount of hypermetropia remains latent, owing to spasm of the accommodation, which relaxes only gradually. At first glasses may be given of such a strength as to relieve the troublesome symptoms; and the strength may be gradually increased till the total hypermetropia is corrected. Young adults with slighter forms of hypermetropia need glasses only for near work; elderly people should have one pair of weak glasses for distant and another stronger pair for near vision. These may be conveniently combined, as in Franklin glasses, where the upper half of the spectacle frame contains a weak lens, and the lower half, through which the eye looks when reading, a stronger one.

Anisometropia.—It is difficult to lay down rules for the treatment of cases where the refraction of the two eyes is unequal. If only one eye is used, its anomaly should be alone corrected; where both are used and nearly of equal strength, correction of each often gives satisfactory results.

Presbyopia.—Where distant vision remains unaltered, but, owing to gradual failure of the accommodative apparatus of the eye, clear vision within 8 inches becomes impossible, convex lenses should be used for reading of such

a strength as to enable the eye to see clearly about 8 inches distance. Presbyopia is arbitrarily said to commence at the age of forty, because it is then that the need of spectacles for reading is generally felt; but it appears later in myopia and earlier in hypermetropia. It advances with years, requiring from time to time spectacles of increasing strength.

Cylindrical Lenses.—In astigmatism, owing to differences in the refractive power of the various meridians of the eye, great defect of sight, frequently accompanied by severe headache, occurs. This condition may be cured completely, or greatly improved, by the use of lenses whose surfaces are segments of cylinders. They may be used either alone or in combination with spherical lenses. The correction of astigmatism is in many cases a matter of considerable difficulty, but the results to vision almost always reward the trouble.

Convex spectacles were invented towards the end of the 13th century, perhaps by Roger Bacon. Concave glasses were introduced soon afterwards. Airy, the astronomer, about 1827, corrected his own astigmatism by means of a cylindrical lens. Periscopic glasses were introduced by Dr W. H. Wollaston. (A. BR.)

SPECTROSCOPY. The spectroscopy is an instrument which separates luminous vibrations of different wave-lengths, as far as is necessary for the object in view. It consists of three parts,—the collimator, the prism or grating, and the telescope. The collimator carries the slit through which the light is admitted and a lens which converts the diverging pencil of light into a parallel pencil. The pencils carrying light of different wave-lengths are turned through different angles by the prism or grating, which is therefore the essential portion of the spectroscopy. The telescope serves only to give the necessary magnifying power, and is dispensed with in small direct vision spectroscopes. For a description of the different kinds of prism used, see OPTICS; and for an explanation of the action of the grating, see UNDULATORY THEORY. The most important adjustment in the spectroscopy is that of the collimator. Especially in instruments of large resolving power it is essential for good definition that the light should enter the prism or fall on the grating as a parallel pencil. For a method allowing an easy and accurate adjustment for each kind of ray, see an article in *Phil. Mag.*, vol. vii. p. 95 (1879).

Prisms are nearly always used in the position of minimum deviation, but, if the collimator is properly adjusted, this is by no means a necessary condition for good definition. Prisms as generally cut, with an isosceles base, give the greatest resolving power in the position of minimum deviation, but the loss in resolving power is not great for a small displacement. The dispersion and magnifying power of a prism can be considerably altered by a change of its position, and a knowledge of this fact is of great value to an experienced observer. The use of a prism in a position different from that of minimum deviation is, however, a luxury which only those acquainted with the laws of optics can indulge in with safety.

Lord Rayleigh has given the theory of the spectroscopy under OPTICS, and shown on what its resolving power depends. There is no connexion between resolving power and dispersion, any value of resolving power being consistent with any value of dispersion. To obtain large resolving power with small dispersion requires, however, the use of inconveniently large telescopes and prisms or gratings. It is easy, on the other hand, to obtain small resolving power together with large dispersion.

The following definitions would be found of general use if adopted. **Resolving Power.**—The unit resolving power of a spectroscopy in any part of the spectrum is that resolving power which allows the separation of two lines differing by the thousandth part of their own wave-length or wave-number,—the wave-number being the number