

SALIERI, ANTONIO (1750–1825), dramatic composer, was born at Legnano, Italy, August 19, 1750. In 1766 he was taken to Vienna by a former "Kapellmeister" named Gassmann, who introduced him to the emperor Joseph, and fairly prepared the way for his subsequent success. His first opera, *Le Donne Letterate*, was produced at the Burg-Theater in 1770. On Gassmann's death in 1774, he received the appointment of Kapellmeister and composer to the court; and on the death of Bonno in 1788 he was advanced to the dignity of "Hofkapellmeister." He held his offices with honour for fifty years, though he made frequent visits to Italy and Paris, and composed for many important European theatres. His *chef d'œuvre* was *Tarare* (afterwards called *Azur, Re d'Ormus*), a work which was preferred by the public of Vienna to Mozart's *Don Giovanni*, though it is, in reality, quite unworthy of comparison with that marvellous inspiration. It was first produced at Vienna, June 8, 1787, and strangely enough, considering the poverty of its style, it was revived at Leipsic in 1846, though only for a single representation. His last opera was *Die Neger*, produced in 1804. After this he devoted himself to the composition of church music, for which he had a very decided talent. Salieri lived on friendly terms with Haydn, but was a bitter enemy to Mozart, whose death he was suspected of having produced by poison; but no particle of evidence was ever forthcoming to give colour to the odious accusation. He retired from office, on his full salary, in 1824, and died at Vienna May 7, 1825. None of Salieri's works have survived the change of fashion. He gave lessons in composition both to Cherubini and Beethoven; the latter dedicated to him his Three Sonatas for Piano-forte and Violin, *Op. 12*.

SALII. See MAES.

SALISBURY, or NEW SARUM, a city and municipal and parliamentary borough, the county town of Wiltshire, England, is situated in a valley at the confluence of the Upper Avon, the Wily, the Bourne, and the Nadder, on the Great Western and South Western Railways, 80 miles west-south-west of London. The city at the beginning was regularly laid out by Bishop Poore and still retains substantially its original plan. In the centre is the market-place, a large and handsome square, from which the streets branch off at right angles, forming a series of quadrangles facing a thoroughfare on each side, and enclosing in the interior a space for courts and gardens. The streams flowed uncovered through the streets till the visitation of cholera in 1849 led to their being arched over. The cathedral of St Mary was originally founded on the hill fortress of Old Sarum by Bishop Herman, when he removed the see from Sherborne between 1075 and 1078. The severe drought in 1834 caused the old foundations to be discovered. Its total length was 270 feet; the nave was 150 feet by 72, the transept 150 feet by 70; and the choir was 60 feet in length. In 1218 Bishop Poore procured a papal bull for the removal of the cathedral to New Sarum. For this various reasons have been given,—the despotism of the governor, the exposure to high winds which drowned the voice of the officiating priest, the narrow space for houses, and the difficulty of procuring water. Until the Reformation service still continued to be performed in the old church. A wooden chapel of St Mary was commenced at New Sarum in the Easter-tide of 1219, and the foundations of the new cathedral were laid by Bishop Poore, 28th April 1220. It was dedicated at Michaelmas 1258, the whole cost having amounted to 40,000 marks, or £26,666. The cloisters, of great beauty, and the late Early English chapter-house were added by Bishop Walter de la Wyle (1263–74). The tower from near the ridge was built in the Decorated style by Bishop Wyville about 1331,

and the spire was added between 1335 and 1375. It is the highest in England (404 feet), and is remarkable both for its beauty of proportion and the impression it conveys of lightness and slenderness. The chapel built by Bishop Beauchamp (1450–82), that built by Lord Hungerford in 1476, and the fine campanile were all ruthlessly demolished by the architect James Wyatt, 1782–1791. The cathedral as a whole is a unique specimen of Early English, having the advantage of being practically completed as it now stands within a remarkably short period. For lightness, simplicity, grace, and unity of design it is not surpassed in England. It is in the form of a Greek or double cross, and comprises a nave of ten bays with aisles and a lofty northern porch; two transepts, one of three and the other of two bays, while both have eastern aisles for chapels; a choir of three bays with aisles; a presbytery of three bays with aisles; and a lady-chapel of two bays. The total length of the building is 449 feet, the length of the nave being 229 feet 6 inches, of the choir 151 feet, and of the lady-chapel 68 feet 6 inches, while the principal transept has a length of 203 feet 10 inches, and the eastern transept of 143 feet. The width of the nave is 34 feet 4 inches, and of the principal transept 50 feet 4 inches. The library, built by Bishop Jewel (1560–71), contains about 5000 volumes and several MSS. of great interest. In the close, occupying an area of half a square mile, and possessing a finely-shaded mall, are the episcopal palace, an irregular structure begun by Bishop Poore but of various dates, the deanery house, and other buildings. The three parish churches are St Martin's, with square tower and spire, and possessing a Norman font and portions of Early English in the choir; St Thomas's (of Canterbury), founded in 1240 as a chapel to the cathedral, and rebuilt in the 15th century, a handsome building in the Perpendicular style; and St Edmund's, founded as the collegiate church of secular canons in 1268, but subsequently rebuilt in the Perpendicular style and lately restored at a cost of £6000. The residence of the college of secular priests is now occupied by the modern ecclesiastical college of St Edmund's, founded in 1873. St John's chapel, founded by Bishop Bingham (1228–46), is now occupied by a dwelling-house. There is a beautiful chapel attached to the St Nicholas hospital, founded in the reign of Richard II. The poultry cross, or high cross, an open hexagon with six arches and a central pillar, was erected by Lord Montacute before 1335. In the market-place is Marochetti's statue to Lord Herbert of Lea. The principal secular buildings are the court-house, the market-house, the Hamilton Hall, the county jail, and the theatre. Among the specimens of ancient domestic architecture still remaining may be mentioned the banqueting hall of J. Halle, wool merchant, built in 1470, and Audley House, belonging also to the 15th century, and repaired in 1881 as a diocesan church house. There are a large number of educational and other charities, including the bishop's grammar school, Queen Elizabeth's grammar school, Talman's girls' school, the St Nicholas hospital, founded in the reign of Richard II., and Trinity hospital, founded by Agnes Bottenham in 1379. At one time the city possessed woollen and cutlery manufactures, but these have now declined; and, although the manufacture of hardware and of boots and shoes is still carried on, it is on its shops for the supply of the neighbouring villages and its agricultural trade that it now principally depends. The population of the city and municipal borough (area 616 acres) in 1871 was 12,903, and that of the parliamentary borough (area 676 acres) 13,839; in 1881 the numbers were 14,792 and 15,680.

Salisbury and its neighbourhood are remarkably rich in relics of antiquity. To say nothing of Old Sarum and the scanty ruins of

the royal palace of Clarendon, Milford Hill and Fisherton are two of the richest fields in the country for palaeolithic implements. In the Blackmore Museum Salisbury possesses one of the finest collections of prehistoric antiquities in England; its splendid gathering of objects from the mounds in the New World is probably unsurpassed. The fortress of Old Sarum (*Searobyrig*, i.e., Sear-borough, probably "the dry city"; *Sarisberic* in Domesday) is of very early date, and was undoubtedly held by the Belgæ before it became an important fortress of the Romans (*Sorbidunum*). It occupied a conical mound rising abruptly from the valley, and its fosse and ramparts, which still remain, are about a mile in circumference. Various Roman roads branched out from it in different directions. Near it Cynric won a great victory over the Britons in 552. It was burned and sacked by Swend in 1003. In the great plain beneath William the Conqueror in 1070 reviewed his army after his victories; and it was here that he took the oath of fealty from all English landholders on the completion of Domesday in 1086. Old Sarum continued to have the privilege of returning two members to parliament until 1832, although latterly not a single house remained within its limits. New Sarum grew up round the new cathedral founded in the 13th century. In 1227 it received from Henry III. a charter conferring on it the same freedom and liberties as Winchester. The duke of Buckingham was executed at Salisbury in 1484. During the Civil War it was held alternately by both parties. Salisbury first sent members to parliament in 1295, and various parliaments have been held there. The Redistribution Act of 1885 deprived it of one of its two representatives.

See *Description of Salisbury Cathedral*, 1719 and 1787; Rawlin, *Salisbury*, 1718; M. E. Walcott, *Memorials of Salisbury*, 1865; W. Henry Jones, *Faeti Ecclesie Sarisberienensis*, 1879; W. Henry Jones, *Diocesan History of Salisbury*, 1880.

SALISBURY, ROBERT, EARL OF. See CECIL.

SALIVA, SALIVARY GLANDS. See NUTRITION.

SALLEE. See RABAT.

SALLUST (86–34 B.C.). Sallust is the generally accepted modern form of the name of the Roman historian Caius Sallustius Crispus. 86 B.C. was the year of his birth, and the old Sabine town of Amiternum at the foot of the Apennines was his birthplace. He came of a good plebeian family, and entered public life at a comparatively early age, obtaining first the quaestorship, and then being elected tribune of the people in 52 B.C., that year of political turbulence in which Clodius was killed by Milo. Sallust was opposed to Milo and to Pompey's party and to the old aristocracy of Rome. From the first he was a decided partisan of Caesar's, and to Caesar he owed such political advancement as he attained. Unless he was the victim of violent party misrepresentation, he seems to have been morally worthless. In 50 B.C. the censors exercised their power of removing him from the senate on the ground of gross immorality. A few years afterwards, however, no doubt through Caesar's influence, he was restored to his position, and in 46, in which year Caesar was for the third time consul, he was praetor, and was with Caesar in his African campaign, which ended in the decisive victory of Thapsus over the remains of the Pompeian party and in the suicide of Cato. Sallust remained for a time in Africa as governor of the province of Numidia, which, it would seem, Caesar gave him as a reward for good service. It was said that he enriched himself at the expense of the provincials, but the charge, as far as we know, was never substantiated, though it was tendered highly probable by the fact that he returned to Rome the following year a very rich man, able to purchase and lay out in great splendour those famous gardens on the Quirinal known as the "horti Sallustiani," which became subsequently an imperial residence. He now retired from public life and devoted his leisure to letters, for which he had always had a taste, and certainly considerable ability. The fruits of his industry have come down to us in the shape of a history of the famous Catiline conspiracy, of an account of the war with Jugurtha, and of some fragments of a larger work—"histories," as the Romans called them, "memoirs," as we should style them. His history of the Catiline conspiracy

was his first published work; it is the history of the memorable year 63, when Cicero as consul baffled and confounded Catiline by making all men believe that he was an arch-conspirator against the liberties of his country, who, under specious pretexts of relieving poverty and distress, was really aiming at making himself a tyrant and a despot. Sallust adopts the view which was no doubt the usually accepted one, and he writes accordingly as a political partisan, without giving us a clear insight into the causes and circumstances which gave Catiline a considerable following, and led many to think that his schemes were more respectable than those of a mere wild revolutionist. He does not explain to us at all adequately what Catiline's plans and views were, but simply paints the man as the deliberate foe of all law, order, and morality. Catiline, it must be remembered, had been of Sulla's party, to which Sallust was opposed. There may be truth in Mommsen's suggestion that he was particularly anxious to clear his patron Caesar of all complicity in the conspiracy. Anyhow, the subject was quite one to his taste, as it gave him the opportunity of showing off his rhetoric at the expense of the old Roman aristocracy, whose degeneracy he delighted to paint in the blackest colours. His history, again, of the war with Jugurtha, though a valuable and interesting monograph, is not a satisfactory performance. We may assume that he had collected materials and put together notes for it during his governorship of Numidia. Here too we find him dwelling on the feebleness of the senate and of the aristocracy, and dropping too often into a tiresome moralizing and philosophizing vein, his besetting weakness, but altogether failing us in those really important details of geography and even chronology which we naturally look for in the historians of military operations and campaigns. In all this Sallust is no better than Livy. Of his *Histories*, said to have been in five books, and to have commenced with the year 78 B.C. (the year of Sulla's death), and to have concluded with the year 66, we have but fragments, which are, however, enough to show the political partisan, who took a keen pleasure in describing the reaction which followed on the dictator's death against his policy and legislation. It is unfortunate that the work has not come down to us entire, as it must have thrown much light on a very eventful period, embracing the war against Sertorius, the campaigns of Lucullus against Mithradates of Pontus, and the victories of the great Pompey in the East. A few fragments of his works were published for the first time from a manuscript in the Vatican early in the present century. We have also two letters (*Two epistolae de Republica ordinanda*) addressed to Caesar, letters of political counsel and advice; which have been commonly attributed to Sallust, but as to the authenticity of which we must suspend our judgment.

The verdict of antiquity was on the whole favourable to Sallust as an historian and as a man of letters. In certain quarters he was decried; his brevity was said to be obscure and his fondness for old words and phrases, in which he is said to have imitated his contemporary Cato, was ridiculed as an affectation. Tacitus, however, speaks highly of him (*Ann.*, iii. 80); and, to do him justice, we must remember that he struck out for himself almost a new line in literature, as up to his time nothing of much value had been done for Roman history, and his predecessors had been little better than chroniclers and annalists of the "dry-as-dust" type. Sallust aimed at being something like a Roman Thucydides, and though he falls far short of the great Greek historian, and drifts now and again into mere rhetoric and pedantry, we may at least congratulate ourselves on the possession of his *Catiline* and *Jugurtha*, and we must feel that fortune has been unkind in depriving us of his larger work, his *Histories*.

SALMASIUS, CLAUDIUS (1588–1653), in the vernacular SAUMAISE, the most distinguished classical scholar of his day, was born at Semur-en-Auxois in Burgundy, April 15, 1588. His father, a counsellor of the parliament of Dijon, gave him an excellent education, and sen

him at the age of sixteen to Paris, where his promise excited the especial interest of Casaubon. After hardly overcoming his father's opposition, he proceeded in 1606 to the university of Heidelberg, nominally to be initiated into jurisprudence under Godefroy, but in fact entirely devoted to classical studies. The atmosphere of the place probably had its influence in inducing him to embrace Protestantism, the religion of his mother; and his first publication was an edition of a work by Nilus Cabasilas, archbishop of Thessalonica, against the primacy of the pope, with a similar tract by Barlaam. The Latin translation of these works, although apparently assigned to Salmasius on the title page, is not by him. In 1609 he edited Florus, with notes compiled in ten days. In the following year he returned to France, and nominally pursued the study of jurisprudence to qualify himself for the succession to his father's post, which he eventually lost on account of his religion. Nothing important proceeded from his pen until 1620, when he published Casaubon's notes on the *Augustan History*, with copious additions of his own, equally remarkable for learning and acumen. In 1623 he married Anna Mercier, a Protestant lady of a distinguished family; and in 1629 he produced his *magnum opus* as a critic, his commentary on Solinus's *Polyhistor*, or rather on Pliny, to whom Solinus is indebted for most of his materials. Greatly as this work may have been overrated by his contemporaries, it is still a monument of stupendous learning and conscientious industry. Salmasius learned Arabic to qualify himself for the botanical part of his task, and was so unwilling to go to press without having consulted a rare treatise by Didymus that the third part of his commentary, *De Herbis et Plantis*, did not appear in his lifetime. He was now ostensibly as well as actually devoted to philology, and foreign universities vied with each other in endeavouring to secure his services. After declining overtures from Oxford, Padua, and Bologna, he closed in 1631 with a proposal from Leyden, offering an entirely honorary professorship, with a stipend of two thousand (afterwards raised to three thousand) livres a year, merely to live in Holland and refute the *Annals* of Baronius. This latter stipulation he never fulfilled. Shortly after his removal to Holland, he composed, at the request of Prince Frederick of Nassau, his treatise on the military system of the Romans, which was not published until 1657. Other works followed, mostly philological, but including a denunciation of wigs and hair-powder, and a vindication of moderate and lawful interest for money, which drew down upon him many expostulations from lawyers and theologians. It prevailed, however, with the Dutch Church to admit money-lenders to the sacrament. His treatise *De Primatu Papæ* (1645), accompanying a republication of the tract of Nilus Cabasilas, excited a warm controversy in France, but the Government declined to suppress it. Notwithstanding his Protestantism and the opposition of the papal nuncio, he had already been made a royal counsellor and a knight of St Michael, and great offers had been made to induce him to return, which, suspecting that he was to be charged with the composition of a panegyric on Richelieu, he honourably declined.

In November 1649 appeared the work by which Salmasius is best remembered, his *Defensio Regia pro Carolo I.* His advice had already been sought on English and Scotch affairs, and, inclining to Presbyterianism or a modified Episcopacy, he had written against the Independents. It does not appear by whose influence he was induced to undertake the *Defensio Regia*, but Charles II., low as his exchequer was, defrayed the expense of printing, and presented the author with £100. The first edition was anonymous, but the author was universally known. A French translation which speedily appeared under the

name of Le Gros was the work of Salmasius himself. This celebrated work, in our day principally famous for the reply it provoked from Milton, even in its own added little to the reputation of the author. Salmasius injured his character for consistency by defending absolute monarchy, and knew too little of English history and politics to argue his cause with effect. He deals chiefly in generalities, and most inappropriate illustrations from Biblical and classical history. Not caring sufficiently for his theme to rise to the heights of moral indignation, he is as inferior to Milton in earnestness as in eloquence and the power of invective. Milton had, no doubt, a great advantage in encountering a personality, at whose head vituperation could be launched, while Salmasius is fighting abstractions and indicting a people. But the reply to Milton, which he left unfinished at his death, and which was published by his son in 1660, is insipid as well as abusive. Until the appearance of Milton's rejoinder in March 1651 the effect of Salmasius's work was no doubt considerable; and it probably helped to procure him the flattering invitation from Queen Christina which induced him to visit Sweden in 1650. Christina loaded him with gifts and distinctions, but upon the appearance of Milton's book was unable to conceal her conviction that he had been worsted by his antagonist. Milton, addressing Christina herself, ascribes Salmasius's withdrawal from Sweden in 1651 to mortification at this affront, but this appears to be negated by the warmth of Christina's subsequent letters and her pressing invitation to return. The claims of the university of Leyden and dread of a second Swedish winter seem fully adequate motives. Nor is there any foundation for the belief that Milton's invectives hastened his death, which took place on September 3, 1653, from an injudicious use of the Spa waters. He was at the time engaged upon his reply to Milton; this he does not seem to have reckoned among the MSS. which, feeling that he had expressed himself with undue asperity, he directed his wife to burn after his decease. He left several sons, but his posterity did not attain the third generation.

Nothing, to modern ideas, can seem more singular than the literary dictatorship exercised by a mere classical scholar, who shone principally as a commentator, and whose independent work, though highly respectable, evince no especial powers of mind. Salmasius was far enough from being a Grotius, a Leibnitz, or even a Casaubon. As a commentator and verbal critic, however, he is entitled to very high rank. His notes on the *Augustan History* and Solinus display not only massive erudition but massive good sense as well; his perception of the meaning of his author is commonly very acute, and his corrections of the text are frequently highly felicitous. His manly independence was shown in many circumstances of his life, and the general bias of his mind was liberal and sensible. He was accused of sourness and sullenness of temper; but the charge, if it had any foundation, is extenuated by the wretched condition of his health. His biographer Clément enumerates seven classes of disorders which pursued him throughout his life, and which render his industry and productiveness the more extraordinary. Papillon catalogues eighty books published by Salmasius himself, or from his MSS., or to which he contributed notes; eighteen manuscripts which he himself saw in the library of M. de la Mare; forty-three more mentioned by others; ninety-three works with MS. notes by Salmasius, which should now be in the National Library of France; and fifty-nine books projected or contemplated.

The life of Salmasius was written at great length by Philibert de la Mare, counsellor of the parlement of Dijon, who inherited his MSS. from his son. Papillon says that this biography left nothing to desire, but it has the capital fault of never having been printed. It was, however, used by Papillon himself, whose account of Salmasius in his *Bibliothèque des Auteurs de Bourgogne* (Dijon, 1745) is by far the best extant. There is an *éloge* by Clément prefixed to his edition of Salmasius's *Letters* (1656), and another by Morisot, inserted in his own *Letters*. Clément's notice contains many interesting facts, but it is marred by an extravagant admiration for its subject, perhaps excusable if he really believed that his hero was born in 1596, and edited Florus at thirteen. It is remarkable, however, that Clément passes over the *Defensio Regia* almost without notice, whether from feeling that it was unworthy of Salmasius, or because discussion of the subject was discouraged in Holland during the existence of the English Commonwealth. (R. G.)

SALMON. It will be convenient to consider this in connexion with the other members of the great family of fishes to which it belongs. See SALMONIDÆ.

SALMONIDÆ. The distinguishing features of this family of fishes are described in technical language in the article ICHTHOLOGY (vol. xii. p. 693), and it is unnecessary to repeat the definition. The most conspicuous of the external characteristics is the presence of two dorsal fins, of which the anterior is well developed and supported by the usual jointed bones known as fin-rays, while the posterior is thick and fleshy, rounded in outline, and destitute of rays. The posterior fin is thus a rudimentary organ, and it is commonly called the adipose fin. There are two other families of fishes which resemble the *Salmonidæ* in the arrangement of the dorsal fins—the *Percopsidæ* and *Haploctenidæ*; but the former consists of only one species, found in the United States, and the latter is confined to the southern hemisphere. Amongst British fishes a Salmonid can be always recognized by its dorsal fins.¹

The *Salmonidæ* retain the open communication of the air-bladder with the intestine, and the original posterior position of the pelvic fins,—features which characterize the division of *Teleostei* known as *Physostomi*. In the great assemblage of bony fishes known as *Physoclisti*, these features are lost in the adult condition. It is known that in all cases the air-bladder develops in the young fish as an outgrowth or diverticulum from the intestine; and it is obvious from a survey of Vertebrates in general that the posterior limbs belong originally to the neighbourhood of the anus. It follows therefore that in these features the *Salmonidæ*, and all the *Physostomi*, are more similar to the early ancestors of the bony fishes than are those species in which the air-bladder is closed and the pelvic fins have an anterior position.

In the *Salmonidæ* the characteristic Teleostean pseudo-branchia is present. This organ is the diminished remnant of the series of gill-lamellæ belonging to the posterior face of the hyoid arch, as the pseudobranchia in Elasmobranchs is the rudiment of the series of gill-lamellæ belonging to the posterior face of the mandibular arch.² The bones known as maxillæ form portion of the boundary of the upper jaw in *Salmonidæ*; in many fishes they are excluded from the jaw margin by the backward prolongation of the premaxillæ. There are no scales on the head in this family, and there are no fleshy filaments or "barbels" in the neighbourhood of the mouth as there are in many bony fishes—for example, the Cod, in which a single short barbel is attached beneath the lower jaw. The pyloric appendages, caecal diverticula of the intestinal tube immediately behind the stomach, are nearly always present in considerable numbers. In the female Salmon the oviduct, the tube connecting the ovary with the exterior, is wanting; the eggs when ripe escape from the surface of the ovary into the abdominal cavity and pass thence to the exterior through a pair of apertures in the body wall situated one on each side of the anus; these apertures are the abdominal pores. In the male salmon there is a duct to the testis, and the semen is extruded through it in the usual way. Fertilization takes place outside the body, the spermatozoa and eggs uniting in the water.

Distribution.—*Salmonidæ* are found both in the sea and in fresh water. Most of the marine species inhabit the deeper parts of the ocean. Many of the freshwater forms pass a portion of their lives in the littoral parts of the sea, ascending rivers when adult every year in order to deposit

their spawn; that is to say, many species are anadromous. Some are confined entirely to fresh water. The *Salmonidæ* are, with the exception of one species indigenous to New Zealand, peculiar to the temperate and arctic regions of the northern hemisphere. Fossils belonging to the family are found in strata of Mesozoic age. *Osmerus* occurs in the greensand of Ibbenbüren, and the schists of Glarus and Licata. *Mallotus villosus*, indistinguishable from the living Capelin, occurs abundantly in clay in Greenland, the geological age of the bed being unknown. *Osmeroides acrognathus* and *Aulolepis* are fossil genera occurring in the chalk near Lewes in Sussex, and were probably deep-sea Salmonoids. The introduction of certain species into new areas by human agency, which has been effected recently, and is still going on, will be described in another section.

Synopsis of Genera.

The following five genera include British species:—

1. *Salmo*, Artedi (Salmon and Trout). Scales small. Cleft of mouth wide; maxilla extending backward to below or behind the eye. Dentition well developed; conical teeth on the jaw bones, on the vomer and palatines, and on the tongue; none on the pterygoid bones. Anal fin short, with fourteen or fewer rays. Pyloric appendages numerous. Ova large. Dark transverse bands, known as "parr marks," present on the sides of the body in the young stages of life.
2. *Osmerus*, Cuv. (Smelts). Scales of moderate size. Cleft of the mouth wide; maxilla long, extending to or nearly to the hind margin of the orbit. Dentition well developed; teeth on the maxilla and premaxilla smaller than those on the mandible; transverse series of teeth on the vomer, several of which are large and fang-like; a series of conical teeth along the palatine and pterygoid bones; strong fang-like teeth on the front of the tongue, several longitudinal series of smaller ones on its posterior part. Pyloric appendages short and few in number. Ova small.
3. *Coregonus*. Scales of moderate size. Cleft of mouth small; maxilla rather short, not extending back beyond the orbit. Teeth minute, or absent altogether. Anterior dorsal fin with few rays. Pyloric appendages numerous. Ova small.
4. *Thymallus*, Cuv. (Graylings). Similar to *Coregonus*, but having a long anterior dorsal with many rays. Small teeth on jaws, vomer, and palatine bones.
5. *Argentina*, Cuv. Scales rather large. Cleft of mouth small; maxilla not extending to below the orbit. Teeth wanting on jaws; minute teeth on the head of the vomer and fore part of the palatines; series of small curved teeth on each side of the tongue. Dorsal fin short, in advance of the pelvic. Pyloric appendages few or in moderate numbers. Ova small. The most conspicuous peculiarity of this genus is the flattening of the sides to plane surfaces bordered by keeled ridges, so that the transverse section of the fish is hexagonal.

The following eleven genera include no British species:—

6. *Oncorhynchus*, Suckley (*Ann. Lyc. Nat. Hist.*, 1861). Similar to *Salmo*, except that the anal fin has more than fourteen rays.³
7. *Brachymystax*, Günther. Intermediate between *Salmo* and *Coregonus*.
8. *Lucioperca*, Günther. Migratory trout from North America.
9. *Plecoglossus*, Schlegel. Body covered with very small scales. Cleft of mouth wide; maxilla long. Dentition feeble; premaxilla with few small conical teeth. Ends of mandibles separate at the chin, the mucous membrane between them forming folds and pouches. Tongue very small, with minute teeth.
10. *Retropinna*, Gill. Similar to *Osmerus*.
- 11 and 12. *Hyoomesus*, Gill, and *Thaleichthys*, Girard, are allied genera.
13. *Mallotus*, Cuv. (Capelin). Scales minute, somewhat larger along the lateral line and along each side of the belly. In mature males these scales become elongate, lanceolate with projecting points. Cleft of mouth wide; maxilla very thin, lamelliform, extending to below middle of eye. Dentition very feeble; teeth in single series. Pyloric appendages very short, few. Ova small.
14. *Salax*, Cuv. Body elongate, compressed, naked, or with small, exceedingly fine deciduous scales. Head elongate and much depressed, terminating in a long, flat, pointed snout. Cleft of mouth wide. Jaws and palatine bones with conical teeth, some of those on premaxilla and mandibles being enlarged; no teeth on vomer; tongue with single series of curved teeth. Anterior dorsal fin far behind ventral, in front of anal; adipose small. Pseudo-branchiæ well developed; air-bladder none. Alimentary canal quite straight; pyloric appendages none. Ova small.

¹ It is interesting to observe that a peculiarity of the dorsal fins is often a family character among the bony fishes. Thus the species of the Cod family (*Gadidæ*) have usually three separate dorsal fins similar in shape and size. The *Blenniidæ* are characterized by the presence of a continuous dorsal fin extending almost the whole length of the back. The *Chupeidæ* or Herrings all have a single triangular dorsal fin in the middle of the back.

² This at least is the view till recently accepted by most morphologists; its correctness is questioned by Anton Dohrn.

³ This is the generic distinction adopted by Dr Günther. Suckley's original diagnosis was the prolongation of both jaws in the males.

15. *Microstoma*, Cuv. Body elongate, cylindrical, covered with large thin silvery scales. Cleft of mouth very small; premaxilla very small; maxilla very short and broad. Eye very large. Narrow series of very small teeth in the lower jaw and across the head of the vomer; no other teeth. Dorsal fin short, inserted behind the ventrals, but before the anal; adipose fin present in most young specimens, frequently absent in old ones. Pseudo-branchiæ well developed; air-bladder large. Pyloric appendages absent; mucous membrane of stomach with numerous large papilla. The genus is allied to *Argentina*.

16. *Bathylagus*, a genus of deep sea Salmonoids discovered by the "Challenger" in the Atlantic and Antarctic Oceans at depths of 1950 and 2040 fathoms.

Species.

1. Genus *Salmo*. The difficulty of defining and distinguishing the species of this genus is considerable, and much diversity of opinion on the subject exists among ichthyologists. Many of the species are extremely variable, so that some individuals of one resemble the more aberrant individuals of another; the species are seldom separated by conspicuous differences. The individuals of a given species vary considerably with age and sex, and also with habitat and external conditions. Many of the species are capable of breeding together and producing fertile offspring. The characters which are most constant, and on whose differences the distinction of species chiefly rests, are as follows:—(1) the form of the preoperculum (the horizontal breadth of this bone at its lower portion is always small in the young, but in the adult it is greater in some species than in others); (2) width and strength of maxillary in adult; (3) size of teeth; (4) arrangement and permanence of vomerine teeth; (5) form of caudal fin; (6) pectoral fins; (7) size of scales; (8) number of vertebrae; (9) number of pyloric appendages.

In all the species of *Salmo* there are teeth in the vomer. In the *Salmons* proper and in the *Trouts* there are, in the young, teeth both on the head and body of that bone, but in some species on the body only; some of the teeth on the body are deciduous, and are in most of the species shed at an early age. In the *Charrs* there are teeth on the head of the vomer but none on the body of the bone at any period of life, and none of the vomerine teeth are deciduous. The species of true *Trout* are confined to fresh water, and are not migratory. In accordance with these peculiarities some zoologists have divided the genus *Salmo* into three subgenera,—*Salmo sensu restricto*, *Fario*, and *Salvelinus*. But modern authorities retain only two subdivisions,—the subgenera *Salmo*, including migratory *Salmon* and non-migratory *Trout*, and *Salvelinus*, the *Charrs*.

A. Subgenus *Salmo*.—A vast number of species of *Salmo* have been described; in the *Brit. Mus. Cat.* Dr Günther distinguishes fifty-two, of which seven are confined to the British Islands and four are found both in the British Islands and other parts of the world. Mr Day on the other hand considers that all the indigenous *Salmon* and *Trout* of the British Islands belong to two species, *Salmo salar* and *Salmo trutta*,—*Salmo levenensis* and *Salmo fario* being varieties of the latter; the rest of the described British species he considers as local varieties or subspecies of these.

(1) *Salmo salar*, L. (the *Salmon*). B. 11-12; D. 14; A. 11; P. 14; V. 9; L. lat. 120; L. transverse $\frac{22-26}{12-14}$; Vert. 59-60; Cæc. pyl. 53-77. Attains to a length of 4 to 5 feet; female mature at a length of about 15 inches. Preoperculum with a distinct lower limb and with the angle rounded. Head of vomer subpentagonal, as long as broad, toothless; the body of the bone with single series of small teeth which are gradually lost from behind forwards so that older examples only have from one to four left. Hind part of body elongate and covered with relatively large scales. Young with about eleven dusky transverse bars on the sides; half-grown and old specimens silvery, with small black spots in small number; spawning males with numerous large black and red spots, some of the red spots confluent into more or less extensive patches, especially on the belly. An anadromous species, inhabiting temperate Europe southwards to 43° N. lat.; not found in Mediterranean; in Asia and America southwards to 41° N. lat.

No varieties of *Salmo salar* are recognized in Europe, but in North America there occurs one *Salmonoid* which is considered by different authorities either as a variety or a sub-species, viz., *Salmo salar*, var. *sebagi*, L. lat. 115. Body and dorsal and caudal fins with subquadrangular or subcircular black spots. Is non-migratory and occurs in some of the lakes of Maine and New York in the United States; these lakes have no communication with the sea. This form is called variously the *Landlocked Salmon* or the *Schoodie Salmon*.

¹ In the formula usually preceding the diagnosis or description of a species of fish, B=number of branchiostegal rays; D=number of rays in dorsal fin; P=ditto in pectoral fin; A=ditto in anal fin; V=ditto in ventral fin; L. lat.=number of scales along the lateral line; L. transverse=number of scales in the oblique transverse row of the widest part of the body, the numbers above and below the line in the fraction being those of the scales above and below the lateral line respectively.

The true *Salmo salar* on the American shore of the Atlantic is sometimes called the *Pénobscot Salmon*.

(2) *Salmo trutta*, Fleming; *Salmo eriox*, Parnell (*Fishes of Firth of Forth*) (Sea-*Trout*, *Salmon-Trout*, *Bull-*Trout**). B. 11; D. 13; A. 11; P. 15; V. 9; L. lat. 120; L. transverse $\frac{24-28}{12-14}$; Vert. 59-60; Cæc. pyl. 49-61. Attains to a length of about 3 feet; female mature at a length of 10 to 12 inches. Head of vomer triangular, as broad as long, toothless, body of the bone with a longitudinal ridge armed with a single series of teeth, which are deciduous; generally only the two or three anterior ones found in examples of more than 20 inches in length. Silvery, sometimes immaculate, usually with more or less numerous X-shaped spots; spots on the head and dorsal fin round and readily disappearing. Young (parr) with nine or ten dusky cross bars; grilse with top of dorsal and pectoral and with hind margin of caudal black. A migratory species, occurring in the rivers falling into the Baltic and German Ocean; numerous in Scotland, less frequent in English and Irish rivers.

(3) *Salmo cambricus*, Donov. (*Brit. Fishes*) (the *Sewen* of Couch, *Salmon Peal*). B. 10-11; D. 14; A. 11-12; P. 16; V. 9; L. lat. 120-125; L. transverse $\frac{27}{12-14}$; Vert. 59; Cæc. pyl. 39-47. Attaining to a length of 3 feet; female mature at a length of from 12 to 13 inches. Preoperculum with a distinct lower limb, with the angle rounded and with the hind margin convex or undulated, subvertical. Head of vomer triangular, broader than long, toothless in adult examples, armed with a few teeth across its hinder margin in young ones; body of the bone with a sharp longitudinal ridge, in the sides of which the teeth are inserted, forming a single series, and alternately pointing to right and left. In pure-bred specimens these teeth are lost in the grilse state, so that only the two or three anterior remain in specimens more than 12 or 13 inches long. Fins of moderate length; caudal fin forked in parr stage, slightly emarginate in grilse, truncate in mature specimens. This species loses the parr marks very early, when only 5 to 6 inches long; it is then bright silvery. Greenish on the back, with few small round black spots on the head and sides. This coloration remains nearly unaltered during the further growth of the fish, but the spots become more irregular, indistinctly X-shaped. An anadromous species, occurring in rivers of Norway, Denmark, Wales, and Ireland. Mr Day (*Fishes of Great Britain*) considers this form as merely a variety of *Salmo trutta*.

(4) *Salmo fario*, L. (*Trout*). Dr Günther distinguishes two varieties:—

(a) *Salmo fario gaimardi*; *Salmo gaimardi*, Cuv. and Val.; *Salmo trutta*, Gaimard (*Voy. Isl. and Groenl.*, Atl. Poiss., pl. 15, fig. A). D. 13-14; A. 11-12; P. 14; V. 9; L. lat. 120; L. transverse $\frac{27}{12}$; Cæc. pyl. 33-46; Vert. 59-60. Largest specimen observed, 15 inches; female mature at a length of 7 or 8 inches. Head of vomer triangular, small, broader than long; vomerine teeth in a double series sometimes disposed in a zigzag line, persistent throughout life. Sides with numerous round or X-shaped black spots; upper surface and sides of the head and the dorsal, adipose, and caudal fins usually with crowded round black spots; dorsal, anal, and ventral with a black and white outer edge. Found in Iceland, North Britain, Ireland, Scandinavia.

(b) *Salmo fario ausonii*; *Salmo ausonii*, Cuv. and Val. (the common *River-*Trout**). Formula as in a, but Vert. 57-58. Attains to a length of 30 inches; female mature at a length of 8 inches. A non-migratory species, inhabiting numerous fresh waters of Central Europe, Sweden, and England, and rivers of the Maritime Alps.

The following forms are peculiar to the British Islands:—

(5) *Salmo levenensis*, Walker (*Wern. Mem.*, i. p. 541) (Loch Leven *Trout*). D. 13; A. 11; P. 14; V. 9; L. lat. 118; L. transverse $\frac{22}{12}$; Cæc. pyl. 68-80; Vert. 59. Maximum length 21 inches. Teeth moderately strong; the head of the vomer triangular with a transverse series of two or three teeth across its base; the teeth of the body of the vomer form a single series and are persistent throughout life. Upper parts brownish or greenish olive; sides of the head with round black spots; sides of the body with X-shaped, sometimes rounded, brown spots. Dorsal and adipose fins with numerous small brown spots. A non-migratory species, inhabiting Loch Leven and other lakes of southern Scotland and northern England. This species is considered by Mr Day as a variety of *S. trutta*.

(6) *S. brachypona*, Günther; *S. eriox*, Parnell (*Fish. Firth of Forth*). D. 13; A. 10-11; P. 14; V. 9; L. lat. 118-128; L. transverse $\frac{27}{12}$; Cæc. pyl. 45-47; Vert. 59. Preoperculum with scarcely a trace of lower limb. Teeth rather strong; those of the vomer in double series, but in zigzag line. Most of them are lost in specimens 17 inches long, only a few of the anterior remaining. Sides of the body with X-shaped or ocellated black spots, some red spots along and below the lateral line; dorsal fin with round black spots. Dorsal, anal, and ventral fins with a white and black outer margin in young examples. A migratory species, from the rivers Forth, Tweed, and Ouse. According to Mr Day, it is identical with the *White Salmon* of Pennant and *Salmo albus* of Cuv. and Val.,

all of them being considered by Day as a variety, *S. albus*, of *Salmo trutta*.

(7) *S. gallivensis*, Günther. An anadromous species from Galway, distinguished by the acutely pointed but not elongate snout, broad convex head, small eye, feeble teeth, feeble maxillary and mandible, and by extremely thin and short pyloric appendages, which are not longer than one inch nor thicker than a pigeon's quill. According to Day a variety of *S. fario*.

(8) *S. feroc*, Jard. and Selby (*Edinb. New Philos. Journal*, 1835, xviii.). A non-migratory species inhabiting the large lochs of the north of Scotland and several lakes of the north of England, Wales, and Ireland. Preoperculum crescent-shaped, the hinder and lower margins passing into each other without forming an angle. According to Day a variety of *S. fario*.

(9) *S. orcadensis*, Günther, from Loch Stennis in Orkney.

(10) *S. stomachicus*, Günther (the *Gillaroo*). From lakes of Ireland. Thick stomach. Feeds on shells (*Limnæus*, *Ancylus*).

(11) *S. nigripinnis*, Günther. Non-migratory species inhabiting mountain pools of Wales, also Lough Melvin, Ireland.

Day mentions also the following varieties of *S. fario*:—*S. cornubiensis*, Walb., Artedi; Swaledale trout, from Swaledale, Yorkshire; and Crassapill trout, from Loch Crassapill, Sutherlandshire.

Many species of *Salmo* exist which are confined to limited areas in the continent of Europe. An account of these is given in the *Brit. Mus. Catalogue*, which also contains references to the literature. One of these, *S. macrostigma*, Duméril, is a non-migratory form occurring in Algeria, and is the southernmost species of the Old World. Three non-migratory species exist in the rivers belonging to the basin of the Adriatic. In the Alpine lakes of central Europe five species are known, which resemble in habits the forms found in British lakes, ascending the streams which feed the lakes, in order to spawn. Two of these species inhabit the Lake of Constance, one the Lake of Geneva. *Fario argenteus*, Cuv. and Val., found in the Atlantic rivers of France, is considered by Dr Günther a distinct species, by Mr Day as a synonym of *S. trutta*. One migratory species is known from the Eidfjord river in Norway; two land-locked species from Lake Wener in Sweden.

The species of *Salmo* belonging to the Pacific Coast of North America have been described by Richards in *Faun. Bor. Amer.*, by Suckley in *Nat. Hist. Washington Territory*, and by Girard in *Proc. Acad. Nat. Sc. Philad.* Only one species need be mentioned here, and that on account of the importance it has acquired in connexion with the work of the United States Fish Commission:—

Salmo irideus, Gibbons (*Proc. Cal. Ac. Nat. Sc.*, 1855, p. 36); *Salar iridea*, Girard (*Proc. Acad. Nat. Sc. Philad.*, 1856, p. 220 and *U. S. Pac. R. R. Explorer—Fish*, p. 321, pl. 73, f. 5, and pl. 74) (the *Californian*, *Mountain*, or *Rainbow Trout*). B. 10; D. 14; A. 14; L. lat. 140. Caudal deeply emarginate. Body and dorsal and caudal fins with numerous small black spots. A non-migratory species in rivers of Upper California.

For the same reason as in the preceding case, the following species of the eastern slope of the North American continent is introduced:—

Salmo namaycush, Penn (*Arct. Zool.*, ii. p. 139), Cuv. and Val. (xxi. p. 348) (Lake *Trout*). B. 11-12; D. 13-14; A. 12; V. 9; L. lat. 220. Preoperculum very short, without lower limb; head very large. Teeth strong; those on the vomer persistent throughout life, and in single series. Inhabits all the great lakes of the northern part of North America.

B. Subgenus SALVELINUS:—

Salmo alpinus, L. (the *Charr*, *Yarrell*, *Brit. Fishes*, 3d ed.). D. 13; A. 12; P. 13; V. 10; L. lat. 195-200; Vert. 59-62; Cæc. pyl. 36-42. Body slightly compressed and elongate. Length of head equal to height of body in mature specimens and two-ninths or one-fifth of total length; maxillary extends but little beyond the orbit in the fully adult fish. Eye one-half, or less than one-half, of the width of the interorbital space. Teeth of moderate size. Inhabits lakes of Scandinavia, Scotland (Helier Lake, Hoy Island, Orkneys; Sutherlandshire, Loch Roy, Inverness-shire), and probably Iceland.

S. killinensis, Günther (*Proc. Zool. Soc.*, 1865, p. 699). D. 14-15; A. 13; P. 13; V. 9; L. lat. 180; Vert. 62; Cæc. pyl. 44-52. Head, upper parts, and fins brownish black; lower parts with an orange-coloured tinge in the male; sides with very small, light, inconspicuous spots. Anterior margins of the lower fins white or light-orange coloured. Loch Killin, Inverness-shire. Considered by Mr Day as a variety of *S. alpinus*.

S. willughbyi, Günther (*Proc. Zool. Soc.*, 1862, p. 46, pl. 5); *Charr*, Willughby (*Hist. Pisc.*, p. 196), Penn (*Brit. Zool.*), and *Yarrell* (*Brit. Fish.*, 3d ed.) (the *Charr* of Windermere). D. 12-13; A. 12; P. 13-14; V. 9-10; L. lat. 165; Vert. 59-62; Cæc. pyl. 32-44. Sides with red dots; belly red; pectoral, ventral, and anal with white margins. Lake of Windermere; Loch Bruich (Scotland). Considered by Mr Day as a variety of *S. alpinus*.

S. perisii, Günther (*Ann. and Mag. Nat. Hist.*, 1865, p. 75);

Torgoch, Willughby (*Hist. Pisc.*) and Penn (*Brit. Zool.*) (the *Torgoch* or *Red Charr*). D. 13; A. 12; P. 12; V. 9; L. lat. 170; Vert. 61; Cæc. pyl. 36. Sides with numerous red dots; belly red in the mature fish; pectoral, ventral, and anal with white margins. Lakes of North Wales (Llanberis). Considered by Mr Day as a variety of *S. alpinus*.

S. grayi, Günther (*Proc. Zool. Soc.*, 1862, p. 51). D. 13; A. 12; P. 13-14; V. 9; L. lat. 125; Vert. 60; Cæc. pyl. 37. Sides with scattered light-orange coloured dots; belly uniform silvery whitish, or with a light-red shade; fins blackish. Lough Melvin, Ireland. Considered by Mr Day as a variety of *S. alpinus*.

S. colii, Günther (*Proc. Zool. Soc.*, 1863) (Cole's *Charr*, Couch, *Fish. Brit. Isles*). D. 14; A. 12; P. 13; V. 9; L. lat. 160; Vert. 63; Cæc. pyl. 42. Bluish black above; sides silvery with scattered light-salmon coloured dots; belly reddish; fins black, the anal and the paired fins with a reddish tinge, the anal and ventrals with a narrow whitish margin. A small species 7 to 8 inches long from Loughs Eske and Dan, Ireland. Considered by Mr Day as a variety of *S. alpinus*.

The above are all the British species. *S. umbra*, L. (*Syst. Nat.*), Cuv. and Val. D. 12; A. 12-13; P. 14; V. 9; L. lat. 200; Vert. 65; Cæc. pyl. 36. Commonly called in French *Ombre Chevalier*. Lower parts whitish or but slightly tinged with red. Lakes of Constance, Neuchâtel, and Geneva. Considered by Mr Day as identical with *S. alpinus*. Other species have been described from lakes in Europe and Asia, but are imperfectly known; for an account of them see Günther's *Catalogue*.

The following American species of *Charr* is one of those cultivated by the American Fish Commission:—

S. (Salvelinus) fontinalis, Mitch. (*Trans. Lit. and Phil. Soc.*, New York, i. p. 435), Cuv. and Val. (xxi. p. 266) (Brook *Trout*). B. 12; D. 12; A. 10; L. lat. 200; Cæc. pyl. 34. No median series of teeth along the hyoid bone. Preoperculum short in longitudinal direction, with the lower limb very indistinct. Rivers and lakes of British North America, and of the northern parts of the United States. Introduced in Britain.

2. Of the genus *Osmerus* only three species are described in the *Brit. Mus. Cat.*, one of which is British:—

Osmerus eperlanus, Lacép., Linn. (the *Smelt*; Fr., *Éperlan*; Scotch, *Sparling* or *Spirling*). B. 8; D. 11; A. 13-16; P. 11; V. 8; L. lat. 60-62; L. transverse $\frac{1}{4}$; Cæc. pyl. 2-6; Vert. 60-62. Height of body much less than length of the head, which is a quarter or two-ninths of the total length to base of caudal fin. Snout produced. Vomerine teeth and anterior lingual teeth large, fan-like; posterior mandibular teeth larger than the anterior ones, which form a double series, the inner series containing stronger teeth than the outer one. Back transparent, greenish; sides silvery. Adult size 10 or 12 inches. Coasts and numerous fresh waters of northern and central Europe.

Osmerus viridescens, Lesueur, another species scarcely distinct from *O. eperlanus*, but with scales a little smaller, occurring on the Atlantic side of the United States.

Osmerus thaleichthys, Ayres, occurs abundantly in the Bay of San Francisco.

3. Of *Coregonus* forty-one species are described in the *Brit. Mus. Cat.* Four species are found in Britain:—

C. oxyrinchus, Kröyer, Linn., Cuv. and Val. (xxi.). Called the *Houting* in Holland. B. 9; D. 14; A. 14-15; L. lat. 75-81; L. transverse $\frac{2-1.2}{12}$; Vert. 58. Snout produced, with the upper jaw protruding beyond the lower, and in adult specimens produced into a fleshy cone. Length of the lower limb of operculum $\frac{1}{4}$ to $\frac{1}{2}$ times that of the upper. Pectoral as long as the head without snout. Found on coasts and in estuaries of Holland, Germany, Denmark, and Sweden. Captured recently (three specimens only) in Lincolnshire, near Chichester, and at the mouth of the Medway.

C. clupeioides, Lacépède; *C. pennantii*, Cuv. and Val. (the *Gwyniad* of Lake Bala, Schelly of Ullswater, Powan of Loch Lomond; sometimes called the *Freshwater Herring*). B. 9; D. 14-15; A. 13-16; L. lat. 73-90; L. transverse $\frac{1}{4}$; Cæc. pyl. 120; Vert. 38/20. Snout with upper jaw not produced. Pectoral larger than the head. Fins black or nearly so. Lakes of Great Britain.

C. vandesius, Richards (*Faun. Bor. Amer.*); *C. albula*, Cuv. and Val. (the *Vendace*). D. 11; A. 13; V. 11; L. lat. 68-71; L. transverse $\frac{1}{8}$; Vert. 56. Castle Loch, Lochmaben in Dumfriesshire.

C. pollan, Thompson (*Proc. Zool. Soc.*, 1835), Cuv. and Val. (the *Pollan*). D. 13-14; A. 12-13; V. 12; L. lat. 80-86; L. transverse $\frac{1}{4}$; Vert. 60-61. Two jaws of same length. Teeth if present very minute. Bluish along the back, silvery along the sides and beneath. Usual length of adults 10 to 11 inches, maximum 13 inches. Ireland, in Loughs Neagh, Erne, Derg, Corrib, and the Shannon.

Thirty-seven species of *Coregonus* have been distinguished besides these four. Some are migratory; but the greater number are inhabitants of large lakes. The anadromous species are confined to the Arctic Sea, and the greater number belong to the coast and

ivers of Siberia. Several distinct species occur in the lakes of Sweden; a few are found in the lakes of Switzerland and central Europe. *C. hiemalis* is peculiar to the Lake of Constance. Several species inhabit the great freshwater lakes connected with the river St Lawrence of North America, and the lakes farther to the north. One of these is cultivated by the American Fish Commission.—*Coregonus clupeaformis*, Mitchell, Dekay (*New York Fauna, Fish*), Cuv. and Val., Agassiz (*Lake Superior*) (the Shad Salmon, Freshwater Herring, Whitefish). D. 12; A. 14; L. lat. 76-77; L. transverse $\frac{2}{3}$. The snout is pointed, and there is an appendage to the ventral fin which is half as long as the fin itself. Length of adult 11 to 13 inches. Lakes Erie and Ontario.

4. Only one species of *Thymallus* occurs in the British Islands:—*Thymallus vulgaris*, Nilsson; *Thymallus oxilifer*, Cuv. and Val. (the Grayling; French, *L'Ombre*; Italian, *Temelo*). B. 7-8; D. 20-23; A. 18-16; P. 16; V. 10-11; L. lat. 75-85; L. transverse $\frac{2}{3}$; Cæc. pyl. 22; Vert. 39/22. Length of head two-ninths or one-fifth of total length to base of caudal; posterior dorsal rays somewhat produced in adult. Grows to 15 inches in length. A freshwater fish, common in many of the rivers of England, introduced into some of those of southern Scotland; absent from Ireland. It is widely distributed in central and northern Europe, occurring in Lapland, Sweden, Lake of Constance, the Isar, and the Danube. Adult size about 15 inches.

Thymallus albianus, Cuv. and Val. (*Θυμαλλος*, EL., xiv. 22), occurs in Lago Maggiore. One species has been described from Siberia, and two are known inhabiting Lake Michigan and the waters of British North America.

5. Of Argentina four species are described in the *Brit. Mus. Cat.*, namely:—*Argentina silus*, Nilsson, occurring off the north-west coast of Norway, *Argentina sphyrena*, L., from the Mediterranean. *Argentina hebridica*, Nilsson, found on the coasts of Norway and Scotland, and *Argentina tioglossa*, Cuv. and Val. According to Mr Day, two of these, *A. sphyrena* and *A. hebridica* are identical, the species ranging from the coast of Norway and east and west shores of Scotland to the Mediterranean. The following is the formula of *A. hebridica*, Nilsson, according to Günther:—D. 9-11; A. 13 (12); P. 13-14; V. 11; L. lat. 52-53; Cæc. pyl. 14-20; Vert. 52. The scales with minute spines.

6. The species of *Oncorhynchus* are all anadromous, and are confined to American and Asiatic rivers flowing into the Pacific. *O. ginnat*, Richardson = *O. chouicha* occurs in the river Sacramento, and is cultivated by the American Fish Commission.

7, 8. For *Brachymystax* and *Lucioperca*, see p. 221 above.

9. *Plecoglossus* comprises small aberrant freshwater species abundant in Japan and the island of Formosa.

10. *Retropinna* contains but one species, *R. richardsoni*, which is known as the New Zealand Smelt. It is common on the coasts of New Zealand, ascending estuaries. Like *Osmerus eperlanus*, it is landlocked in fresh water in some localities.

11, 12. The species of *Hypomesus* and *Thaleichthys* occur on the Pacific coast of North America. *Thaleichthys pacificus*, Girard, is caught in vast numbers in the neighbourhood of Vancouver Island; it is extremely fat, and is used as a torch when dried, and also as food. It is called locally the Eulachan or Oulachan.

13. Of *Mallotus* only one species is described by Günther:—*Mallotus villosus*, Cuv. and Val., Müll. (the Capelin; French, *Capelan*). B. 8-10; D. 13-14; A. 21-23; P. 18-20; V. 8; Cæc. pyl. 6; Vert. 63. Brownish on the back, silvery on the sides. Operculum silvery with minute brown dots. Shores of Arctic North America and of Kamchatka.

14. Of the genus *Salanx* two species are known:—*Salanx chinensis*, Günther, Osbeck, which is common on the coast of China and called "Whitebait" at Macao, and *Salanx microdon*, Bleeker, from the rivers of Jeddo.

15. *Microstoma*.—*M. rotundatum*, Risso, is marine and occurs in the Mediterranean; it is not anadromous. It is the only species of the genus known, unless the *Microstomus grönlandicus*, described by Reinhardt, from the Sea of Greenland, really belongs to this genus.

16. For *Bathylagus*, see p. 222 above.

Life History of the Salmon and Allied Species.

Up to a period not many years past, when our knowledge of the breeding and life history of the salmon and kindred species was based entirely on desultory observations of the fish in their natural conditions, there existed a great deal of uncertainty and diversity of opinion on the subject. Within the last twenty or thirty years the extensive practice of salmon-culture has removed nearly all obscurity from the phenomena, and the history of Salmonoids is now more accurately known than that of most other fishes.

The salmon proper, *Salmo salar*, breeds in the shallow running waters of the upper streams of the rivers it ascends. The female, when about to deposit her eggs, scoops out a trough in the gravel of the bed of the stream. This she effects by lying on her side and plunging into the gravel by energetic motions of her body. She

then deposits her eggs in the trough; while she is engaged in these operations she is attended by a male, who sheds milt over the eggs as the female extrudes them, fertilization being, as in the great majority of *Teleostei*, external. The parent fish then fill up the trough and heap up the gravel over the eggs until these are covered to a depth of some feet. The gravel heap thus formed is called a "redd." The period of the year at which spawning takes place in the British Isles, and in similar latitudes of the northern hemisphere, varies to a certain extent with the locality, and in a given locality may vary in different years; but, with rare exceptions, spawning is confined to the period between the beginning of September and the middle of January.

The eggs of *Salmo salar* are spherical and non-adhesive; they are heavier than water, and are moderately tough and elastic. The size varies slightly with the age of the parent fish, those from full-sized females being slightly larger than those from very young fish. According to rough calculations made at salmon-breeding establishments, there are 25,000 eggs to a gallon; the diameter is about a quarter of an inch. It is usually estimated that a female salmon produces about 900 eggs for each pound of her own weight; but this average is often exceeded.

The time between fertilization and hatching, or the escape of the young fish from the egg-membrane, varies considerably with the temperature to which the eggs are exposed. It has been found that at a constant temperature of 41° F. the period is 97 days; but the period may be as short as 70 days and as long as 150 days without injury to the health of the embryo. It follows therefore that in the natural conditions eggs deposited in the autumn are hatched in the early spring. The newly hatched fish, or "alevin," is provided with a very large yolk-sac, and by the absorption of the yolk contained in this the young creature is nourished for some time; although its mouth is fully formed and open, it takes no food. The alevin stage lasts for about six weeks, and at the end of it the young fish is about $\frac{1}{4}$ inches long. During the next period of its life the young salmon is called a "parr," and is distinguished by the possession of a number of dark transverse marks along the sides, known as "parr marks." These marks occur in the young stage of many species among the *Salmonidæ*. The parr doubles its length in about four months.

The great majority of parr remain in fresh water for two years after hatching, at the end of which time they are about 8 inches in length. The second spring after they are hatched they develop a coating of bright silvery scales which completely conceals the parr marks, and they pass into a stage in which they are known as "smolts." The smolt is similar to the adult salmon in all respects except size, and the young salmon, as soon as the smolt stage is reached, migrates down the rivers to the sea.

The above facts have been established within recent years by accurate observation and experiment. Not very long ago it was a disputed question whether the parr was the young salmon or a distinct species of fish. That the former view was correct was first experimentally proved by Mr John Shaw, gamekeeper to the duke of Buccleuch, Drumlanrig, Dumfriesshire, who in 1833 isolated several parrs in a pond, and found that in April 1834 they changed into smolts; an account of this experiment was published in the *Transactions of the Royal Society of Edinburgh*. The question is now of merely historical interest, for at the present time large numbers of parr are hatched at various fish-hatching establishments every season. By observation at these establishments, the knowledge of the history of the parr and the migration of the smolt which had been gained by the study of the fish in their natural conditions has been rendered more accurate and complete.¹ It has been conclusively ascertained that some parr become smolts and migrate to the sea in the spring following that in which they were hatched, while the great majority remain in the parr stage until the second spring, and a few do not attain to the smolt condition until the third year. The male parr when only 7 or 8 inches in length is often sexually mature, the milt being capable of fertilizing the ova of an adult female salmon.

The migration of smolts to the sea takes place in all rivers at about the same time of the year, viz., between March and June. Sometimes the smolts are observed descending in large shoals. Formerly angling for the descending smolts was a recognized sport, but their capture is now illegal. It is the opinion of the most competent authorities that the smolts increase with wonderful rapidity in size and weight when they reach the sea, and then return to the rivers after a few months, during the same year, as "grilse," which name is given to sexually mature salmon up to a little over 5 lb in weight. It is surprising that a smolt weighing only a few ounces should increase to 3 or 4 or even 6 lb in about three months. Nevertheless it has been proved by actual experiment that this is the fact. At Stormontfield, in May 1855, 1300 smolts were marked by cutting off the adipose fin, and 22 of these

¹ The first important series of experiments on the growth and life history of the salmon was made at the salmon-hatchery of Stormontfield near Perth in 1862 and some previous years. The results are detailed in a work entitled *Stormontfield Experiments*, 1862.

were recaptured the same summer as grilse, weighing from 3 lb upwards. It might be supposed that some smolts do not return as grilse till the summer following the year of their descent, the time of their stay in the sea being variable, as is the period spent by parr in the rivers. But all the evidence is against this supposition; grilse never commence ascending till late in summer; if they had been more than a year in the sea, some would probably ascend early in the season, as do the larger salmon. At the same time it must be borne in mind that a fish which remained in the sea a year after descending as a smolt might not be recognized as a grilse, having reached the size of a small salmon.

The grilse, after spawning in autumn, return again to the sea in the winter or following spring, and reascend the rivers as mature spawning salmon in the following year. Both salmon and grilse after spawning are called "kelts." The following recorded experiment illustrates the growth of grilse into salmon:—a grilse-kelt of 2 lb was marked on March 31, 1858, and recaptured on August 2 of the same year as a salmon of 8 lb.

The ascent of rivers by adult salmon is not so regular as that of grilse, and the knowledge of the subject is not at the present time complete. Although salmon scarcely ever spawn before the month of September, they do not ascend in shoals just before that season; the time of ascent extends throughout the spring and summer. A salmon newly arrived in fresh water from the sea is called a clean salmon, on account of its bright, well-defined appearance; during their stay in the rivers the fish lose the brilliancy of their scales and deteriorate in condition. The time of year at which clean salmon ascend from the sea varies greatly in different rivers; and rivers are, in relation to this subject, usually denominated early or late. The Scottish rivers flowing into the German Ocean and Pentland Firth are almost all early, while those of the Atlantic slope are late. The Thurso in Caithness and the Naver in Sutherlandshire contain fresh-run salmon in December and January; the same is the case with the Tay. In Yorkshire salmon commence their ascent in July, August, or September if the season is wet, but if it is dry their migration is delayed till the autumn rains set in. In all rivers more salmon ascend immediately after a spate or flood than when the river is low, and more with the flood tide than during the ebb.

In their ascent salmon are able to pass obstructions, such as waterfalls and weirs of considerable height, and the leaps they make in surmounting such impediments and the persistence of their efforts are very remarkable. In a great many rivers anadromous Salmonoids have been excluded from the upper reaches by artificial obstructions, such as dams and weirs, constructed for the purpose of utilizing the water of the stream, or to obtain water power, or simply to facilitate the capture of the fish. Other rivers have been rendered uninhabitable to salmon by pollutions. The state of the Thames within the boundaries of London has since the beginning of the present century excluded Salmonoids entirely from the river; but every season salmon and grilse are taken in or near the Thames estuary, and there is no doubt that if the water could again be rendered moderately clear, and if fish-ways were provided at the impassable weirs, the upper waters of the Thames would again be frequented by salmon and migratory trout.

The life history of *Salmo trutta* and *S. cambricus* is very similar to that of *Salmo salar*. The river trout, *S. fario*, makes a redd in the shallower parts of streams in the same manner as the salmon, the only difference being that the mound of gravel forming the redd is smaller, the egg lying from one to two feet below the surface. The breeding period of the trout varies in different rivers, within the limits of September and March.² The number of eggs produced by each female is about 800 for every pound of the parent's weight; about 40,000 of the eggs make a gallon, so that they are considerably smaller than those of *S. salar*. The trout of Loch Leven, *S. levenensis*, ascend the streams feeding the loch, in order to spawn, at the end of September and beginning of October. The habits of other species of lake trout are similar to those of *S. levenensis*.

The charrs differ from lake trout in the fact that they do not ascend streams in order to spawn, but form their redds in the gravelly shallows of the lakes they inhabit. The spawning period of the charr of the Cumberland lake district is from the beginning of November to the beginning of December. The eggs of the charr have been found to hatch in from 60 to 90 days, the great majority in 70 days, at an average temperature of 40° F. The American species, *S. fontinalis*, breeds at about the same time as *S. fario*; its eggs are only half the size of those of the latter.

The smolt, *O. eperlanus*, is a gregarious fish and exhibits regular migrations in most estuaries. It is common in the Solway, the Firth of Forth, the rivers of Norfolk, and the estuary of the Thames. In most places where it is found it remains in the fresh and brackish water from August until May, spawning about the month of April, and afterwards descending to the sea for the

summer. At Alloa on the Forth smolts are taken in large numbers by seine nets in spring, before and during the spawning period. There is a regular fishery for them at the same season on the Solway Firth and in Norfolk. The food of the smolt consists chiefly of young fish, especially young herrings, and crustaceans. The eggs are small, yellowish in colour, and adhesive, not adhering by the surface merely as is the case with those of the herring, but each egg possessing a short thread the end of which becomes attached to planks, stones, or other solid objects in the water. According to Mr Day the eggs are deposited near the high-water mark of spring-tides, so that they must be exposed to the air during the ebb. The smolt when in the sea is largely eaten by the picked dog-fish (*Acanthias vulgaris*). The species is absent from the southern coast of England and from Ireland, the smolt recorded as occurring on those coasts being probably the atherine (*Atherina*), often called the sand-smelt. *O. eperlanus* is abundant on the coast of Finland, and also is common there in freshwater lakes, in which it remains all the year round. It is also common on the Atlantic coast of France. It is of interest to note that the smolt in Britain and on other coasts, when not confined to fresh water, is, in its migration, intermediate between anadromous *Salmonidæ*, which ascend to near the sources of rivers, and such fish as the herring, which approach the shore to spawn but do not usually enter rivers. The smolt as a rule ascends estuaries only as far as the region of brackish water.

The various species of *Coregonus* resemble the charr in their habits, spawning in the autumn in the shallows of the lakes they inhabit; their ova are small, and, as mentioned in *PISCICULTURE* (q.v.), are non-adhesive and of almost the same specific gravity as fresh water, so that they are semi-buoyant.

The grayling, *Thymallus vulgaris*, is in Britain exclusively fluviatile; in Scandinavia it is found also in lakes. It is met with chiefly in clear streams with sandy gravels or loamy beds. It was introduced not many years ago into the Tweed by the marquis of Lothian, and thrives there. It is absent from the Thames, but is common in most of the rivers of England and Wales—e.g., the rivers of Yorkshire, the Severn, and the Wye. It is absent from Ireland. It feeds on insects and their larvae, crustaceans, and small molluscs. It breeds in April and May, depositing its ova on the surface of the gravel in the shallows, not in a redd. The ova are smaller than those of the trout, and vary in colour from white to deep orange, and they hatch from the twelfth to the fourteenth day after extrusion. The fry grow to 4 or 5 inches in length by August, and by the following autumn to 9 or 10 inches.

Salmon Fishery Legislation.

In England and Wales the common law is that every person has an equal right to fish for salmon in the sea and in navigable tidal rivers, while the proprietors of the soil on the banks of rivers which are not navigable have the exclusive right of fishing in them. The erection of stake-nets, or other fixed engines for the capture of salmon in estuaries or on the sea-coast is necessarily incompatible with the maintenance of the public right of fishing, and has therefore from very early times been regarded as illegitimate. There has consequently been a constant conflict between legislation and private interest over this point. By Magna Charta all fishing weirs were abolished except on the sea-coast, but the object of this seems to have been rather the protection of the freedom of navigation than the advantage of the salmon fisheries or the maintenance of a public right. In later times fixed engines were repeatedly declared illegal and their erection prohibited by statute. Finally in 1861 they were definitively abolished in all cases except where legal right to maintain them could be conclusively proved. The Salmon Fishery Act of 1861, of which the prohibition just referred to was one of the clauses, was based upon the report of a royal commission appointed in 1860 to inquire into the condition of the salmon fisheries, and it forms the basis of the regulations at present in force, all previous legislation being by it expressly abolished and superseded. It prohibited the capture of unclean and unseasonable salmon, made a uniform close season for England and Wales, ordained a weekly close season of forty-two hours, provided for the erection of fish-passes and regulated the use of fishing weirs on non-navigable rivers, vested the central authority of the salmon fisheries in the Home Office, and provided for the appointment of inspectors. In 1863 an Act was passed prohibiting the exportation of salmon during the close time. In 1865, as it was found useless to legislate without machinery to enforce the law, an Act was passed to constitute fishery districts under the control of local boards of conservators appointed by the magistrates in quarter-sessions. These boards were empowered to enforce a licence duty on fishing implements used in public waters. One or two minor salmon fishery Acts were passed in succeeding years, but the next important piece of legislation on the subject was the Act of 1873, the two most important provisions of which are (1) that fishermen in public waters for every £50 of licence duty which they pay elect a member of the