rivers 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 clupeiformis,* 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 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.

1. Only one species of Thymallus occurs in the British Islands :—

*Thymallus vulgaris,* Nilsson ; *Thymallus vexillifer,* Cuv. and

Val. (the Grayling; French, *L'Ombre*; Italian, *Temelo).* B. 7-8 ; D. 20-23 ; A. 13-16 ; P. 16 ; V. 10-11 ; L. lat. 75-85 ; L. transverse ; 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 æliani,* Cuv. and Val. *(ϴύμαλλος,* Æl., 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.

1. Of Argentina four species are described in the *Brit. Mus. Cat.,* namely:—*Argentina situs,* Nilsson, occurring off the north-west coast of Norway, *Argentina sphyræna,* L., from the Mediterranean, *Argentina hebridica,* Nilsson, found on the coasts of Norway and Scotland, and *Argentina lioglossa,* Cuv. and Val. According to Mr Day, two of these, *A. sphyræna* 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 Gunther:—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.
2. The species of Oncorhynclius are all anadromous, and are confined to American and Asiatic rivers flowing into the Pacific. *0. quinnat,* Richardson—*O. chouicha* occurs in the river Sacra­mento, and is cultivated by the American Fish Commission.
3. , 8. For Brachymystax and Luciotrutta, see p. 221 above.
4. Plecoglossus comprises small aberrant freshwater species abundant in Japan and the island of Formosa.
5. Retropinna contains but one species, *R. richardsonii,* 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.
6. , 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.
7. 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. 68. Brownish on the back, silvery on the sides, Operculum silvery with minute brown dots. Shores of Arctic North America and of Kamchatka.

1. 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.
2. 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.
3. 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 Sal monoids 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 ploughing 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 shells 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 arc 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 11/4 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.