sea, partly in fresh water, breeding in the latter. Fish which thus ascend rivers to spawn are called “ anadromous.” It may be briefly defined as of silvery coloration, with small black spots usually confined to the side above the lateral line, with the teeth on the shaft of the vomer disappearing in the adult, with 18 to 22 gill-rakers on the first branchial arch, with 11 or 12 well- developed rays in the dorsal fin, 110 to 125 scales in the lateral line, and 11 or 12 (exceptionally 13) between the latter and the posterior border of the adipose fin. The young, called “parr” or “samlet,” characterized by a smaller mouth, the maxillary bone not extending much beyond the vertical of the centre of the eye, the presence of an alternating double or zigzag series of teeth on the shaft of the vomer, the presence of dark vertical bars on the sides of the body, together with more or less numerous small red spots, is hatched in the spring, and usually remains for about two years in the rivers, descending at the third spring to the sea, where it is known as “smolt.” In the sea it soon assumes a more uniform silvery coloration and from this state, or “ grilse,” develops its sexual organs and re-enters rivers to breed, after which operation, much emaciated and unwholesome as food, it is known as “ kelt,” and returns to the sea to recuperate. It has now been ascertained by the investigations instituted in Norway by K. Dahl that the smolts, immediately after leaving the rivers, make for the open sea, and do not return to the coast until they have reached the grilse stage. Thus specimens measuring between 8 and 18 in. hardly ever fall into the hands of the angler.

The salmon inhabits the North Atlantic and its tributary waters. It is known to extend as far north as Scandinavia, Lapland, Iceland, Greenland and Labrador, and as far south as the north-west of Spain and the state of Connecticut. It ascends the Rhine as far as Basel. There are land-locked forms in Scandinavia and in Canada and Maine, which are regarded by some authors as distinct species (5. *hardinii* from Lake Wener, 5. *sebago* from Sebago Lake in Maine, 5. *ouananiche* from Lake St John, Canada and neighbouring waters). These non- migratory forms are smaller than the typical salmon, never exceeding a weight of 25 lb, the ouananiche, the smallest of all, rarely weighing 7½lb and averaging 3½. Although spending their whole life in fresh waters, the habits of these fish are very similar to those of the sea salmon, ascending tributary streams to spawn in their higher ranges, and then returning to the deep parts of the lakes, which are to them what the sea is to the anadromous salmonids.

The salmon 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 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 lsles, 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 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 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 1¼ in. long.

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 8lb.

The ascent of rivers by adult salmon is not so regular as that of grilse, and the knowledge of the subject is not 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-fed 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.

We reproduce here, with additions, Professor Noel Paton’s summary (published first in the 10th edition of this *Encyclopedia)* of observations on the life-history of the salmon. Important advances in our knowledge of the life-history of the salmon have been made through the investigations of Professor F. Miescher on the Rhine at Basel, of Professor P. P. C. Hoek in Holland, of Mr Archer as lessee of the river Sands in Norway and as inspector of salmon fisheries for Scotland in conjunction with Messrs Gray and Tosh, and of a number of workers in the laboratory of the Royal College of Physicians of Edinburgh. With regard to the *food* of salmon, the enormously rapid growth of smolts to grilse and of salmon from year to year shows that they feed in the sea. In a few months a smolt will increase from a few ounces to 4 or 5 lb; while Archer’s weighings of 16 salmon which had been marked and recaptured in the following year showed an average gain of 36%, reckoned on from kelt stage to kelt stage. During the season of 1895 Tosh, at Berwick-on-Tweed, opened between March and August 514 fish, and found food in the stomachs of 76, or over 14% of the whole. As to the nature of the food, it was found to be as follows:—

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| --- | --- | --- |
| Herring | . 36 or | 47% |
| Crustacea, amphipods, &c. | • i4 ,, | 18% |
| Sand eels ..... | • 11 ,, | 14% |
| Haddock and whiting | . 8 „ | 10% |
| Feathers and vegetable matter . | . . 7 ,, | 9% |

Excluding the feathers and vegetable matter, which are not really of the nature of food, all the material found in the stomach was of marine origin. Hoek, out of 2000 fish examined by him, found 7 with food in the stomach, and, curiously enough, 4 of these were taken on the same day. In each case marine fish constituted the food. As to where salmon go to feed in the sea, our information is still very deficient, but the prevalence of herring in the stomach would seem to indicate that they must follow the shoals of these fish which approach the coast during the summer months. While there can be no doubt that salmon feed in the sea, the question of whether they feed in fresh water has been much debated. It is difficult for the popular mind to conceive of an active fish like the salmon subsisting for several months without food, and the fact that the fish so frequently not only takes into its mouth but actually swallows worms and various lures has still further tended to confirm many people in the conviction that salmon do feed in fresh water. In discussing the question it is well clearly to understand what is meant by feeding. It is the taking, digesting and absorbing of material of use in the economy in such quantities as to be of benefit to the individual. Accepting this definition, it may at once be said that all the evidence we possess is entirely opposed to the view that salmon feed when in fresh water. Miescher examined the stomachs of about 2000 salmon captured at Basel, about 500 m. from the mouth of the Rhine, and in only two did he find any indication of feeding. These two fish were male kelts. One contained the remains of a cyprinoid fish, and the other had a dilated stomach with an acid secretion, but no food remains. Hoek, who, as already stated, examined about 2000 fish, found food of marine origin in 7, but in none food derived from fresh water. Of the 132 stomachs of salmon from the estuaries and upper waters of Scottish rivers examined in the laboratory of the College of Physicians not one contained any food remains. The stomach of salmon captured in fresh water is collapsed and shrunken. Its mucous membrane is thrown into folds, and it contains a small amount of mucus of a neutral reaction. The intestine, which usually contains numerous