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PART II.

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VOLUME II.

HANDBOOKS—PART II.

FISH CULTURE.

ZOOLOGY AND FOOD FISHES.

THE UNAPPRECIATED FISHER FOLK: THEIR ROUND OF LIFE AND LABOUR.

THE SALMON FISHERIES. ANGLING IN GREAT BRITAIN.

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HANDBOOKS—PART II.

CONTENTS.

FISH CULTURE

BY

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DEPUTY SURGEON-GENERAL, AND COMMISSIONER FOR INDIA TO INTERNATIONAL FISHERIES EXHIBITION

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FISH CULTURE.

FISH culture comprises several objects, the chief of which are an augmentation in the number, and an improvement in the breed of the fishes of a district, country, or even of the ocean, by means of direct cultivation, not only of the finny tribes but also of the food upon which they subsist. It likewise embraces whatever facilitates their ascent and descent of rivers, rendered necessary for spawning purposes to continue the race, or for nutriment to maintain the life of the individual. Many of these subjects appear to have received more consideration in ancient than in modern times, and up to a recent period, in distant countries, as China, than in more civilized Europe.

The Chinese are commonly credited with having been the people who first turned their attention to fish culture, collecting and disseminating the spawn, and artificially rearing fry which they employed for the purpose of stocking every available piece of water. The Egyptians likewise in times past must have taken considerable pains in this occupation, but it has been surmised that their earlier vivaria were of two kinds, sacred and profane, the occupants being destined for either the altar or the table. The boundaries of ancient Egypt are well known, and the conformation of the barren deserts on its east and west show but little alteration: but her population must have largely diminished, for we are assured by Diodorus that 1700 Egyptians were born on the same day as Sesostris, which would represent a population that could not be less than 34,000,000. The agricultural resources of the country would have been far too small to supply sufficient food for such multitudes, and a fish diet must have been largely partaken of. At that period fish culture was extensively practised, and the ruling powers and the ruled vied with each other in augmenting the fish supply in all the numerous tanks, lakes, canals, and rivers of the country. Lacépède computed that Lake Mœris alone might have produced 18,000,000,000 fish of two feet long each.

In the Roman republic fish culture was carried on for the purpose of augmenting the general food supply, and Belonius observes that the waters of the Propontis were more profitable for the fishes they produced, than a similar extent of the best land could have been by its pasturages and its harvest. Lucullus, we are told, dug large trenches or canals from his fish ponds to the sea in the vicinity of his house at Tusculum, in the Gulf of Naples. Fresh-water streams ran down the canals to the sea, and up them sea-fish which spawn in fresh water or anadromous forms, ascended to deposit their ova. When these fish had entered, the gates at the exit of the canals were closed, and while their eggs were developing into young and growing to an eatable size, the parents which had spawned were being employed as food. Varro observed that there existed two forms of stews, the one supplied by fresh, the other by salt water—In the first, advantage being taken of springs and the conformation of the ground, constituted the poor man's pond, whereas none but the rich could enjoy the proceeds of a sea preserve: this latter being pleasing to the eye but expensive to the owner and better adapted to empty his purse than satisfy his appetite. But in time some individuals who had studied fish culture to advantage made large fortunes by salt water vivaria. Roman authors have left us detailed accounts of how their various stews were formed, subdivided and supplied with water; how exotic fishes were sometimes brought from long distances; how their sea ponds were usually stocked from the neighbouring ocean; and lastly, how they obtained fish spawn in the sea which they successfully reared in rivers and lakes. While the high admiral Optalus under Claudius brought from the Carpathian Gulf vast supplies of the hitherto unknown fish, Scarus, and deposited it along the coast from Naples to Ostia, where he continued to cruise about and inspected the fishermen's nets for five years, during which period he suffered none of the species to be captured.

The discovery of how to artificially fecundate fish ova has been claimed for many different persons, in various ages, and in widely separated countries. In the fifteenth century a monk named Dom Pinchon appears to have practised it, breeding and rearing fishes in wooden boxes through which a stream of water flowed. The bottom of these boxes he lined with sand or gravel, while their ends were protected by wicker basket-work. Stephen Ludwig Jacobi, a wealthy landed proprietor, residing at Hohenhausen, a small town in Westphalia, as early as 1758 appears likewise to have made many experiments respecting the artificial breeding of salmon and trout, adopting much the same plan as Dom Pinchon, except that he secured both the upper surface and ends of his troughs with fine gratings and deposited them in the stream at a suitable depth leaving the eggs to be naturally hatched. He gave an account of his discovery in a letter to Buffon, which was deemed so important that the British Government granted him a pension.

Lacépède, writing at the commencement of this century, deplored the loss of fish-ponds in France, remarking that formerly they produced large returns, but had then ceased to yield anything, so that much evil and no good has attended their abolition. In Germany the landowners make more by their carp and pike than many agriculturists obtain in Great Britain from their sheep and cattle kept in a similar space. In this country stews were attached to most large houses in the country, and every monastic establishment, but with the emancipation from fasts and greater facilities of transit from place to place the necessity for these vivaria diminished or almost disappeared. It is only now that meat is becoming so expensive, and likewise fish, due to pollution of waters and too much license having been permitted to fishermen and poachers, that the necessity appears to have arisen for some remedy for the present dearth of the finny tribes.

To the French Government is due the credit of first turning fish culture in Europe into practical channels. In 1842 they commenced their experiments, and in 1848 the establishment at Huningue came into existence near the Rhine and the Rhone canal, while it possessed springs in the vicinity which could be utilised for the incubation of fish eggs. Here but comparatively few of the ova were hatched, for when the eyes of the embryo became visible, showing that they might travel with comparative safety, they were distributed to wherever it was considered they could be turned to the best account. When this establishment first commenced work, the rivers and lakes of France were exceedingly deficient in fish, but by a distribution of about 20,000,000 ova annually they became restocked.

In Great Britain, as already remarked, the Government appear to have been one of the first in Europe to appreciate the importance of Jacobi's re-discovery of how to artificially impregnate fish ova. In 1837 Mr. John Shaw succeeded in fecundating and hatching salmon eggs, also in rearing the young; while Gottlieb Boccius asserted that he had successfully reared young trout at Chatsworth and Uxbridge as early as 1841. The Galway salmon fisheries were restocked by Messrs. Ashworth by means of artificial propagation in 1854. In Scotland the establishment of Stormontfield was commenced in 1853 on the Tay, the rental of that river in 1828 being £14,574, but which gradually diminished until 1852, when it had decreased to £7,953. In 1858, the rental rose to £11,487, and in 1862 it had reached the value it had in 1828. This rise not being due to increased value of salmon in the market, but to augmented numbers of fish in the river.

As animal food becomes dearer, and the price of fish augments, it is remarkable how British fisheries have been treated, and the slight amount of statistical evidence which has been collected and made public, while no Government official is now engaged on the artificial propagation of fish, or in experiments upon how to augment the supply of this necessary article of food. In fact, the British Government respecting freshwater fisheries, is now behind almost every country, in that it gives no assistance to the fish culturists, and keeps up no establishments of its own in order to maintain the necessary number of fish in our waters.

In Norway pisciculture commenced about 1850.

In Germany, artificial fish breeding has become extensively disseminated in all parts of the country, while their natural propagation is carefully tended. Likewise the cultivation of fish ponds is assuming an importance they have not had since the abolition of monastic establishments.

In Italy, lagoons appear to be somewhat extensively employed by the fish culturists, who capture young fry in the sea and rear them in these large vivaria.

In Greece the state maintains twenty-four establishments for fish culture, the principal being in lagoons, and the captives being disposed of while in a fresh condition.

In the United States of America a Fish Commission was first appointed in 1871, to investigate the alleged diminution of food fishes along the sea coast and in the lakes, and if this proved to be the case, to suggest the proper method for restoring the supply. The next year an additional feature was ingrafted, namely, that of the propagation and actual multiplication of the food fishes. Subsequently a large proportion of the various States, satisfied with the excellent work being carried on, organised State Commissions for the purpose of looking after the interests of their waters, and of co-operating with the United States Commission towards the accomplishment of a common end.

In 1879 the Congress authorized the construction of a special steam vessel of 484 tons, to serve as a floating station for the hatching of shad and other useful food fishes.

Professor Spencer Baird, when reviewing the impoverished condition of their fisheries, and the measures which he deemed advisable, observed: "What are now the remedies to be applied, to recover from this lamentable condition of the American fisheries? These are twofold: one consists in the enactment and enforcement of legislation protecting what we have, and allowing natural agencies to play their part in the recovery; the other consists in the application of the art of the artificial propagation of the fish. Either alone, in some circumstances, will answer a very good purpose; the two combined constitute an alliance which places at our command the means of recovering our lost ground to a degree which, but for the experience of the last ten years, would hardly be credible."

The active field work of the Commission, observed the Commissioner in 1875, now embraces almost the entire year. The hatching of shad, *Alosa sapidissima*, continuing from March until August; of Californian salmon, *Salmo quinnat*, from June until November; of Penobscot salmon from June until March or April; of landlocked salmon, *Salmo salar* variety, from September until March; and of white fish, *Coregonus albus*, from October until March. Since then cod and other tribes have been added to the species of fish artificially propagated.[1]

The far-famed Columbia river, where the abundance of its salmon has been a theme for astonishment among those who have witnessed it, began to show signs of decreased supply. The canners took alarm, and petitioned for legislation, to be accompanied, if possible, by artificial propagation, and in 1876 a permanent station for this purpose was opened on the McCloud river.

In the Sacramento river, observed Professor Spencer Baird, the catch has increased in five years from five millions to fifteen millions of pounds, and has brought up the supply to more than its pristine condition of abundance, by planting about two millions of young fish every year. In the Rogue River, Oregon, where salmon had for nearly twenty years been taken in large numbers and salted, a visible diminution became apparent in the season 1877–1878, and it was decided, in consequence, to commence their artificial propagation.

In the Dominion of Canada, Mr. S. Wilmot originated fish culture, and under his management the work is largely carried on. He states that some hundred millions of young salmon have been artificially hatched and distributed in the waters of the Dominion during the last few years, and now (1882) Government hatcheries are constantly being erected. It has been clearly demonstrated in this Dominion, by Mr. Wilmot and others, that by artificial propagation and a fair amount of protection all natural salmon rivers may be kept thoroughly stocked with this fish, and rivers that have been depleted through

[1] In Mr. Brown Goode's paper on the Fishery Industries of the United States he enumerates 27 species or varieties of fish artificially hatched in that country.

any cause, brought back to their former excellence. In Restigouche river, where no obstructions existed, but spearing and netting were relentlessly pursued, the number of salmon had so decreased, that in 1868 anglers only took 20 and the commercial yield was merely 37,000. A salmon hatchery was then inaugurated, and a little protection afforded to the fish, and in 1878 one angler alone, out of hundreds that were fishing in the river, killed in 16 days with his single rod 80 salmon, 75 of which averaged over 26 lbs. each; while in that one division (not counting local and home consumption) net fishermen took 500,000 lbs., a result largely brought about by artificial cultivation. Also in the Saguenay River the scarcity of salmon had become so great that there were no lessees; a hatchery was built, and the state of things wonderfully changed, so much so that in 1878 from the great numbers of salmon taken in the tidal waters they became a drug in the market, and were selling as low as 3 cents a pound, and angling in the tributaries was most excellent.

The Canadian fisheries report for 1882 shows a very large increase of salmon in the rivers, where artificially bred fry were planted; and the returns from the Restigouche, and Gaspe, up to the first half of the season of 1883, give an almost unprecedented catch of fish by anglers. On the Restigouche, at the Metapedia pools, 300 salmon were taken in one week, averaging 22½ lbs. Three miles higher, 56 fish, average weight 23 lbs:—Farther up a party of four rods killed 190 salmon, 23¼ lbs. average:—At Indian House, Wilmot's pool, four rods in two weeks caught 180 fish, all very large, one a forty-pounder:—Another party in same pool killed 55 salmon:—In six pools still further up-river, 386 salmon were taken by 14 rods in a fortnight's time: in one of the above pools, 36 salmon were killed by three rods in one day:—On this river a large salmon hatchery has been in operation for several years:—At Gaspe another hatchery is in operation, where in 1882 the report shows an increase over former years; but in 1883 the catch has been threefold over 1882.

In Japan the Government have taken steps towards carrying on a complete system of fish culture, for the purpose of restocking rivers which appeared to have become depleted. The first stations established were those at Yuki, Kanagawa Ken, and at Shirako, Saitamo Ken in 1877. At either of those stations, 30,000 fish can be raised. In 1879 the number of establishments was augumented to five; and at Shiga Ken, which has an abundant supply of water at 54° Fah. in the summer, there is a capacity of raising any number of fish: lake trout were introduced, and there were 40,000 fish 18 months old in good condition, as well as 250,000 young fry. Unable to obtain a sufficient supply of meat, the fish are fed on a mixture of the chrysalides of silk worms and wheat-flour. Equal portions are ground up together in a coffee mill, the mixture is boiled for fifteen minutes and then allowed to cool, subsequently it is pressed through a fine wire sieve. Hatching fish is said to have been first adopted by Aodo two hundred years ago, and the Daimio of that time made rules for the protection of the fish and fry which are in force to this day.

Our Freshwater Fisheries.

Our inland waters may be roughly divided into those found in rivers, canals, lakes, broads and ponds: while in rivers we have such as are rapid and clear, or else sluggish and more or less muddy. In these various localities we find different varieties of fish, which may be classed into game-species, as salmon, trout, and their allies; and secondly, coarse fish, as perch, carp, pike, &c. In the foregoing enumeration shad are omitted as well as flounders and lampreys, which ascend into fresh waters from the sea.

Although in some localities rivers and their piscine inhabitants still continue in an almost primitive condition, in the vast majority of cases in Great Britain and Ireland artificial causes, often due to augmented population, have led to changes which have entirely altered what was the former aspect of affairs. For although in sparsely inhabited places where the local demand is small, and the means of transport to cities difficult, man in his efforts rarely occasions any undue decrease in the finny tribes inhabiting the fresh waters, yet as population augments a very perceptible change ensues. Land becomes more cultivated and better drained, towns spring up on the river banks which may possibly in olden time have been the natural highway of the country: first surface drainage, next sewerage, become emptied into its course, and, finally, manufactories rise, the owners of which find it cheaper to use the river as the receptacle for their poisons than to dispose of it in pits and other innocuous ways. Thus fish become destroyed, or their health affected, as well perhaps as whoever or whatever partakes of these polluted waters. Mines in a similar way may be drained into streams, weirs may be constructed to span its course, immoderate netting and poaching practices may be legalised, and one or all of the foregoing causes may occasion a diminution in the stock of fish. The water, instead of providing an augmented supply of food to an increasing population, becomes, as years roll on, more and more depleted of fish, and either legislative aid must be invoked to remedy what the legislature itself has to a considerable extent occasioned, by first tolerating and subsequently legalising flagrant abuses: or else the rivers must by artificial means be annually supplied with fish from elsewhere, to compensate for the unnatural depletion which is being carried on by man.

The question may be asked whether our fresh-water fisheries are in an impoverished state?—if any apparent diminution is not due to increased facilities of transport causing fish to be now distributed over a wider expanse of country than was formerly possible? Due to the absence of statistics, any investigation into these questions is difficult but not impossible, and I purpose adverting to the condition of the salmon fisheries, as being the most valuable in our fresh-waters, and consequently those best known.

The first fact that strikes the investigator is that salmon have been exterminated from the Stour, the Itchen, the Medway, the Avon, and the Thames, in England. In Scotland the Fifeshire Leven no longer contains salmon; in the Tay district the Almond, Ericht and Dighty are ruined, due to pollutions, while many other rivers are greatly injured. In Ireland, from Wicklow Head to Rossan Point, nearly every river in the county Down has, owing to pollutions, been destroyed as a salmon producer. The foregoing instances are adduced to prove entire destruction in some localities.

It has been asserted that in ancient times the supply of salmon was so abundant that, in indentures of apprenticeship, a proviso was usually inserted that the apprentice should not be compelled to eat salmon more than three days in the week. In Coursell's 'History of Gloucester' it is stated that "it was a standing condition of apprenticeship that the apprentice should not be obliged to eat salmon more than thrice a week." This proviso is alluded to as existing at Worcester, Newcastle, and elsewhere, while the Cromwellian trooper, Captain Franks, writing of Stirling, remarked that the burgomasters, as in many other parts of Scotland, are compelled to re-enforce an ancient statute that commands all masters and others not to force or compel any servant or an apprentice to feed upon salmon more than thrice a week. At Inverness, a century later, Burt tells us salmon sold at one penny a pound.

We are however reminded that it is difficult to compare the price charged a century since to what obtains in the present time, because so many disturbing influences have occurred. Pennant, in 1776, tells us that to pay the expenses of the salmon fisheries in the river Tweed, it would have been necessary to capture 208,000 salmon annually, an amount which must have far exceeded the supply in the present day. If however for the sake of argument it were admitted that there is no diminution in the number of our fresh-water fishes, he would be a bold individual who asserted that our rivers and other fresh waters are as fully stocked as the sustenance in those waters could maintain.

Some of our fishes have seriously decreased in number, and our fresh-water fisheries require more attention than they now receive in order to render them the food producers they ought to be. But, prior to considering artificial propagation, it will be necessary to advert to what kinds of fishes we possess which are worth increasing, and what are the characters of their eggs.

Divisions of Fishes.

Our fresh-water fishes are divisible into the river or fluviatile and lacustrine or lake species, while our marine fishes may be considered as shore or littoral, and pelagic or sea forms, these last being again subdivided into such as are generally found near the surface, at greater or mid-depths, and abyssal residents. Fishes which frequent fresh water may be permanent residents therein, as carp; anadromous, or merely visitants from the ocean for the purpose of depositing their spawn, generally leaving their young to be reared there, as salmon and shad; catadromous, or such as reside in fresh water, visiting the littoral zone or sea to deposit their spawn, as eels, the young of which ascend our rivers in order to be reared.

BREEDING OF FISHES.

Fishes are diœcious animals, the sexes being present in different individuals, although in some exceptional instances hermaphrodites have been recorded. A few are monogamous; but the majority are polygamous. Among the bony fishes breeding takes place on one of the following plans, (1) the eggs may be hatched within the female organs as seen in the oviparous blenny; or (2), as in the majority of these fishes, the eggs having been extruded by the female, are subsequently fertilized by the male, the milt of the latter being brought into contact in the water with the hard roe of the female. Simple, however, as this process may appear, there are many interesting questions respecting breeding which demand the attention of the fish culturist, such as what is the size of the eggs, whether the fresh-water forms deposit theirs in stagnant, semi-stagnant places, or running streams; or do those of the sea species float, as of the cod, sink, as of the herring, attach themselves by tendrils, as the gar pike, or by adhesive mucus as in lump suckers?

The forms which produce the greatest number of eggs are often those which live in large communities, spawning once annually, as the cod; from a 21 lb. example of which 12 lb. of roe were obtained, while Buckland found that 7½ lb. of roe contained 6,867,000 ova; which, if the proportions were the same in each, would give the enormous number of about 11 millions of eggs in a 21 lb. cod-fish. A perch gives from 20,000 to 28,000: mackerel at 1lb. 86,120, at 1⅛ lb. 546,681 eggs. From a brill of 4 lb. 239,775, from a plaice of nearly 5 lb. 144,600, from a flounder of about

$1\frac{1}{2}$ lb. 1,357,400, from a sole of 1 lb. 134,000. Among the Salmonidæ the eggs are generally comparatively large, the number which each salmon produces being estimated at about 900 for every lb. of its weight; but they may exceed this, as one of 20 lb. contained 27,850. This variation in size is perhaps, partially at least, due to the age and size of the parent, thus in the report of the United States Fish Commission on the McCloud river, California, it was observed in 1878 that the parent salmon were unusually small, their average weight being under 8 lb. This small size was stated to be undoubtedly caused in whole or in part, by the fishing at the canneries on the Sacramento, where the 8-inch meshes of the innumerable drift nets stopped all the large salmon, and let all the small ones through. The eggs when taken proved to be at least a third smaller than those of most previous years, and the average number to the fish was about 3,500 against 4,200 in the previous year. Possibly fry reared from eggs of salmon fertilised by the milt of the parr would be rather a small race. Similarly at Sir James Gibson Maitland's fish-hatching establishment at Howietoun, the Lochleven variety of the common trout at 4 or 5 years old produced eggs 32 of which filled one length of a glass grill in the hatching boxes; but such as were obtained from 6 year old fish, 27 or 28 eggs occupied the same amount of space. Livingston Stone observes[1] that American trout living in spring water develop smaller ova than such as reside in brooks. Although fish producing smaller eggs may have proportionately more in comparison with their weight, young reared

[1] He likewise considers that "large eggs are the result of keeping the breeders in water that warms up in the spring and summer. It is true, if it becomes too warm, say above 70°, it is injurious; but water that stands at 65° in the summer will make larger eggs than water at 55°, and very cold spring water will always develop small eggs" (p. 183).

from such ova are neither so large nor grow so quickly as such as are derived from eggs produced by older fish, and it has appeared to me that such may be one cause of how some races of fish may deteriorate.

From a $21\frac{1}{2}$ lb. carp, 1,310,750 eggs were obtained; from a $16\frac{1}{2}$ lb. example, 2,059,750: from a roach $\frac{3}{4}$ lb., 480,000; of $10\frac{1}{2}$ ounce, 81,536: a tench of $2\frac{1}{2}$ lb. contained 383,252. Herring, from 20,000 to 30,000 eggs. The foregoing figures show that a great margin must be allowed to be present in the number of the eggs produced in each variety of fish, owing to the size and age of the parents, the character of the water in which they reside, and other physical conditions. The great numbers produced by some forms are evidently intended for the purpose of counterbalancing the enormous waste which must necessarily occur under some natural conditions, but they may be insufficient to supply the deficiency caused by man.

The places where fish eggs are deposited are exceedingly various. Thus the ovum of the cod, which possesses no oil-globule, floats in sea-water until the young emerge, consequently the micropyle is at the under surface, the milter is below the spawner and the milt ascends: in the herring the ova sink to the bottom, where by means of a glutinous secretion they become attached to seaweeds, rocks, and other objects. One form of sea-sucker (*Lepidogaster*) affixes its eggs to the inside of an old shell, as a butterfly does to a leaf: the gar-fish has filaments springing from the outer covering of its ova which enables them to adhere together in a mass, or attach themselves to contiguous objects, possibly with a view to prevent their sinking into the mud. Anadromous forms appear to deposit their eggs in pieces of running water, but in different ways; thus, the smelt attaches its ova by a filament to planks, stones or posts near high-water level; the grayling deposits its ova in the bed of rivers; the salmon and trout cover their eggs with sand and gravel: while other fishes, in fresh water, spawn in muddy ponds or slowly flowing rivers, where the eggs of the salmonidæ would never, as a rule, arrive at maturity. The ova of the perch are about the size of poppy-seeds, and instead of being deposited separated one from another, as in the salmonidæ, have them adherent together by a glutinous substance with stringy bands or mesh-work, much resembling frog spawn. The perch selects a spot where rushes, reeds, or grass grows in the water, or else seeks a piece of wood, or some hard substance, against which she rubs herself or presses, until one end of the band of ova has become attached, and then, gently swimming away, the eggs are voided. The stickleback, whether marine or fresh water, forms nests for the reception of its eggs. The river bull-head deposits its spawn in a hole it forms in the gravel, and quits it with reluctance. In tufted-gilled fishes, as the pipe, or horse-fish, the male performs the function of hatching the eggs, which for that purpose are deposited, and remain up to the period of the evolution of the young, attached between the ventral fins, as in *Solenostomus*, a form of pipe-fish; in tail pouches in horse-fishes; or merely in rows, as in *Nerophis*.

A problem requiring solution is why the floating eggs of marine fishes are not cast ashore to perish. Generally they are not deposited too close in shore, while waves move floating substances very slowly. The wind does them no injury, as they protrude but little above the surface, and not at all during storms. They float about, scattered or singly, and many animals eat them; but their transparency is some protection.

Mr. Ryder, in the United States, has made some exceedingly interesting observations upon the mechanical conditions affecting the development of fish ova, some of which are as follows. Among salmon, charr, coregoni, and smelts, he found an abundance of oil-drops imbedded in the vitellus, but most abundant under the germinal disk ; as the specific gravity of this oil is less than that of water, their aggregation underneath the disk tends to keep the latter directed constantly upwards. If the egg is turned, the buoyancy of the oil-drops at once turns the vitellus within the yolk membrane, and brings it to rights with the germinal disk looking upwards. Another type of egg is seen in cusk, crab-eater, Spanish mackerel, and moon-fish. In all the egg is kept buoyant, due to the presence of a single large oil-sphere, situated at a point almost exactly opposite the germinal disk, which is constantly inverted, or carried on the lower face of the vitellus, thus acting exactly the reverse, as observed among the salmonidæ. No oil-drop exists in the egg of the cod,[1] but the specific gravity of the vitellus is so slight that it behaves exactly like the foregoing—the germinal disk being constantly directed downwards. In the egg of the white perch (*Morone Americana*), which is adhesive and fixed, a very large oil-sphere is imbedded in the vitellus, which controls the position of the latter, and keeps the disk inverted, and on the lower side of the vitelline globe, while the free uncovered portion of the latter is always directed upwards, at least during the early stages. The shad has an unusually large water space around the vitellus, between the latter and the egg-membrane ; but the egg is not adhesive, and its specific gravity is greater than

[1] Because the eggs of the cod-fish float it must not be taken for granted that those of all the family do so. The United States expedition have found the eggs of the hake and the young at 100 to 200 fathoms' depth.

that of the water in which it is immersed. There exists a constant disposition of the germinal disk to arrange itself at the side of the vitellus when viewed from above, though there is no oil in the vitellus to influence its position. In the plectognath (*Aleuteres*), a cluster of oil-drops is imbedded at one side in its yelk or dentoplasm, while its germinal matter or protoplasm is relatively large in amount. In the Cyprinodont (*Fundulus*) and the pipe-fish (*Syngnathus*), the oil-drops appear uniformly distributed and imbedded in the superficial portions of the yelk next to its external surface. This brings the deposits of oily matter into close proximity to the vessels traversing the vitellus. The function of these oils, aside from their buoyant tendencies, as in these last cases, is not clear; and, beyond the fact that they are evidently absorbed together with the remainder of the yelk, we know little of their nutritive properties. Perhaps in the process of physiological decomposition these oils of fish embryos develop heat.

But it does not appear as if fishes were invariably able to extrude their eggs without extraneous assistance; thus, Carbonnier and others have recorded how, in the gold carp, the male, or sometimes two or more of that sex, have acted as accoucheurs to the female. One heavy in spawn has been observed being rolled like a cask upon the ground for a distance of several mètres, and this process has been continued without relaxation for two days, until the exhausted female, which had been unable to recover its equilibrium for a moment, had at last evacuated her ova. It has been observed of the lampern, or river lamprey, that while breeding, one twists its tail around another, these two fishes being invariably of opposite sexes, and that the ova and milt are discharged at this time. It is likewise remarkable that, should conger eels be kept some time in an aquarium, the female appears to die at spawning time, as if due to the absence of the male from assisting in the extrusion of the eggs. It is thus seen that it does not follow that fishes must extrude their ova when such have arrived at a certain period of development, a subject of some importance, especially in the salmon family. Thus, at Howietoun, it has been found that retardation is possible, if the ripe fish, whether male or female, is placed in a box with smooth sides, and through which a current of water passes.

Salmon enter suitable rivers for breeding purposes in varying numbers throughout the year, unless impurities have annihilated the breed, as in the Thames. At certain times, as during the cold season, they deposit their fertilised eggs in nests or redds, subsequently descending to the sea in a miserable condition, many of the males succumbing from exhaustion, while at these periods their flesh is positively unwholesome.

Experiments have been made as to whether, should salmon eggs be deposited within tidal influences, they would hatch; or should the young come forth, whether they could live, as (due to droughts, pollutions or artificial obstructions) ascent might be rendered all but impracticable. Investigations have shown that if salmon ova are deposited within tidal influences, salt water is fatal to the fertilising property of the milt or to the life of the impregnated egg. In Canada, Mr. Wilmot finds that there is no necessity for salmon ascending rivers to breed, or obtain access to fresh water, as he finds that they can be caught at sea about May, and impounded in ponds into which the tide ebbs and flows, until they become ripe in October or November, when they are artificially spawned directly from these salt-water vivaria, and the eggs deposited in fresh-water troughs in the hatcheries. Mr. Wilmot considers the young, thus reared, stronger than from ova obtained from rivers. Mr. Livingston Stonè tried catching salmon early in the season in the McCloud river, and, by confining them, to have a large number ready at the spawning season. But they mostly died after a week or two. Some were placed in large plank boxes anchored in the river, and having great apertures to insure a good circulation of water; others in large pens in the bed of the streams, or in ponds on shore, supplied with a constant stream of river water. The imprisoned fish spent their whole time in efforts to escape, but day after day they died; the more caught, the more were lost. Since then, better results have been obtained.

The eggs of salmon are small, round, elastic bodies of a clear white, pink, or coral colour, possessing a tough outer coat, as may be ascertained by throwing one on the ground, from whence it will rebound without breaking. This strength and elasticity must be a very important property, considering where these eggs are to be deposited, and what an amount of pressure they may have normally to undergo. For the young are hatched in localities not where a strong current would wash them away, but in small and often almost mountainous streams, where the water is pure, shallow, and passes over a gravelly bed in which the redd can be constructed, while deep pools in the vicinity allow the breeding fishes to retire into them for rest.

The milt, soft roe, or seminal fluid of the male, is of a thick milky appearance, which under the microscope is found to consist of innumerable microscopic organisms termed spermatozoa or zoösperms, resembling a small head with an elongated tail-like posterior portion. During the period of their existence they are extremely active, in constant motion and restless activity. If placed in water, the term of their existence is rapidly cut short, although a good deal depends upon the temperature at which this is done ; but the duration of their active lives in this situation has been computed by different investigators at to thirty minutes, but two to two-and-a-half would appear to be nearer the truth. These spermatozoa are naturally living in an alkaline fluid, composed partly of phosphates and partly of other constituents, and here they will live for days, even after leaving the fish ; if, however, water is added, these spermatozoa are rapidly killed. M. Vrasski kept them alive six days in a tightly corked bottle, whereas they died in two minutes in water after having been removed from the fish. These experiments have been turned to practical account in the artificial spawning of fish.

The egg or ova has on its surface a microscopic orifice, termed the micropyle, which is usually considered to be for the purpose of allowing the entrance of the spermatozoa, without which it would be unfertilized and barren. These eggs as extruded are soft, and rapidly absorb, through the micropyle, water or spermatozoa or other substances, and thus fill up the interspace between its strong elastic outer and its delicate inner covering. After this absorption is over, it is impossible for the ova to be fertilised. It has been computed that, this absorbing power in trout eggs lasts thirty minutes ; but this is probably a maximum. If, therefore, trout eggs are mixed with milt in water, it is evident that, unless fertilisation rapidly takes place, the spermatozoa will have perished. On the other hand, if no water is employed, but sufficient milt stirred about and among the eggs, theoretically the probability would seem to be in favour of the absorption of the vivifying principle, and facts fully bear out in practice the accuracy of this supposition. I have already alluded to the great variation in the size of the eggs due to the age of the fish ; but the general computation in Scotland is as follows: Salmon, 25,000 to the gallon; Lochleven trout, 30,000; brook trout, 40,000; American brook trout or charr, 80,000.

The spot where the salmon redd is to be formed in the river or stream having been selected, the female lies on her side, and by rapidly working her tail to and fro, fans up the gravel until she gradually sinks into a kind of trough, the male remaining near, and ready to give battle to any intruder. For this purpose his lower jaw is furnished at this period with an offensive weapon in the shape of cartilaginous hook-like process. The female, waited upon by the male, now deposits her eggs in the trough which she has constructed; these are fertilised by the male, and subsequently covered by gravel to some feet in depth, the whole forming a redd. But although each female fish is provided with many hundreds of eggs, the proportion of such as are hatched, or ever arrive at maturity, is very small, being computed at one in nineteen. For, as might be anticipated, eggs deposited in running streams are very liable to escape the fertilising influences of the milt, and to be carried away by the current, or overwhelmed in mud; some become uncovered, others are eaten by hungry fish in the vicinity. Even if safely deposited in suitable redds, they still have their enemies to contend with: not only may floods prematurely sweep everything away, but during the continuance of such, spawning fish are unable to avail themselves of their usual breeding-grounds, as they are too deep in the water. They consequently may have to drop their eggs in the stream, where they will become lost or covered with mud, or else push higher up to where there will be more chance of their redd being left uncovered, and the ova perishing from drought when the floods subside; while severe seasons of drought may occasion most disastrous results. Irrespective of the season, the eggs have numerous water enemies, as the fresh-water shrimp, the larva of the May-fly, and even some birds, as the dabchick, ducks and swans, while the vole or water-rat joins in their destruction.

ARTIFICIAL SALMON AND TROUT CULTURE.

With such a large mortality among the eggs of the salmonidæ left to hatch in our rivers and streams, it became obvious that a great gain would probably accrue were the ova collected and hatched artificially in properly constructed houses, where an uniform temperature would be maintained and their enemies be kept at bay. In this position the artificial collection and fertilisation of eggs became one of the chief objects of the fish culturist, and the views of Dom Pinchin and Jacobi, already referred to, had an additional value.

One, if not the first, experimenter in Great Britain was Mr. Shaw of Drumlanrig, who, in 1836, collected salmon ova from the natural spawning-beds and hatched it artificially; and in January 1837 captured a male and female salmon in the Nith, pressed from them roe and milt, which he deposited in beds prepared for the purpose, and here he raised the fry. In 1842 two fishermen in a valley in the Vosges, named Remy and Gehin, again ascertained how fish naturally spawned, distinctly showing how it was possible to restock impoverished fisheries, and increase the fish-supply in almost any piece of water. Their discoveries would possibly have led to but little result, had it not been that, in 1848, M. de Quatrefages advocated, before the Academy of Science at Paris, on theoretical grounds, the artificial propagation of fish, and this brought to notice the discovery of the two Vosges fishermen. After prominent attention had been attracted to the subject, especially by M. Coste in France, and Messrs. Frank Buckland and Francis Francis in England, establishments for the artificial propagation and dissemination of fish sprang into existence in many quarters. Some succumbed after ephemeral careers, while a few flourished, and still continue to do so. By far the most important at the present time is Sir James Gibson-Maitland's Howietoun establishment near Stirling, from the breeding-ponds of which upwards of 156 gallons of trout and charr eggs were collected last year, while over a million fry, besides 2,900,000 eyed ova, were distributed. A model of this establishment is in the Exhibition. In some countries this direct means of increasing the food supply has been deemed worthy of Government aid and support; in others, as in the United Kingdom, it is left to the unaided enterprise and exertion of private individuals and local societies. In 1848 a labourer in Norway, being obliged to keep at home with a bad leg, used to pass his time by going to the river-side to catch the fish. Observing how the trout spawned, he, assisted by his wife, obtained a pair of fish, and expressed the milt and ova into water, and then placed such in sheltered spots in streams where no trout previously existed. Subsequently the eggs hatched and did well.

Fish Hatching, Rearing, and Breeding Establishments.

In selecting water for a fish, or rather trout-cultural, establishment, considerable care is necessary, or irreparable mischief may occur. For a cessation of the supply when the weather is hot may be disastrous to the young fish; and, similarly, a freshet may do great or even irremediable mischief, unless suitable provision for such an occurrence has been made. Consequently, the intending fish-culturist has to be careful to examine the proposed locality as to whether the water supply during the hottest and driest period of the year would be sufficient for his wants, because its value to him is only in proportion to the supply at this time. Likewise, the heat of the water should be investigated at the warmest period of the year, and a natural trout-stream be selected if possible; also the possibility of pollution obtaining access should be ascertained, but a moderate amount of lime or iron is not necessarily an obstruction. Spring water, having an even flow with a low temperature, as from 41° to 45°, and free from animal and vegetable life, is often most suited to the hatching of eggs, and also producing a hardy and firm-flaked young fish.

Having obtained suitable water in an eligible situation, the next consideration is how to construct the ponds, and in determining this, the aspect, soil and other local circumstances have to be taken into account. But there must be three main considerations: the hatching department, the nursery, and the establishment for those which in time are to supply the market, or be the progenitors of future broods. Water which suits one of these requirements is not always suitable to the other—that from hot and cold springs, being deficient in animal and vegetable life, may be well adapted to hatch ova in, but not to feed young or adult forms; while brook-water full of life, even if charged with sediment, will be suitable to the young and old fish, but not to eggs; and it is better to be more careful respecting the supply to the eggs and young than to the old fish, as the latter are not quite so sensitive to changes.

The various buildings and ponds are best kept as compact as possible, and should be securely locked against all except those who have business inside, while strangers should be invariably accompanied by some of the regular establishment. Unless the various places are strictly kept under lock and key, the experiments of hybridisation are liable to be interfered with, and their consequent value liable to doubt. The ponds are safest if constructed by excavation, as dams are always liable to accident, while they must not be too large ; and, if practicable, a fall at the head of each pond is desirable, but this must be constructed in accordance with the water supply, and if such is plentiful and cold, the shape is of little consequence. If the water is small in quantity and liable to become heated, the pond should be deep and narrow ; while it should be possible to draw off the water, in order to repair or clean the pond, or make any necessary alterations in the fish which it contains.

Spawning-beds may be constructed at the upper end of the breeding-pond, or head of a pond where breeding-fish are confined ; this consists of a narrow channel down which a good stream flows, and which should have a gravel bed ; this channel should lead down very gradually to the deepest part of the breeding-pond. In such channels the breeding-fish may be netted for the purpose of obtaining the spawn artificially. Mr. Ainsworth, in the United States of America, conceived the ingenious idea of setting the trout to spawn naturally, while he could secure the eggs by means of covering the bottom of the channel or race with fine wire-cloth screens, of about ten meshes to the inch, made of zinc or of galvanised or painted iron wire ; these wire screens forming the floor of wooden frames or trays, which fit into the width of these races, but being raised about a quarter of an inch above the gravel bed of the race, so as to ensure a good circulation from below as well as from above. A second set of wooden frames or trays, similarly fitting the entire width of the race, and having a coarse wire-screen forming its floor, is placed immediately above the frames just described; but the wire netting is about two or three meshes to the inch, sufficiently strong to sustain two inches in depth of coarse gravel from three-quarters to two inches in diameter, in order to permit the ova readily to pass through. These upper boxes have handles, in order to allow their being raised and removed every few days during the spawning season. The trout spawns into the coarse gravel on the upper tray, and as the mother fans up this gravel with her tail, as she naturally does after depositing her eggs, they become driven through the coarse wire-netting which forms the floor of the tray, and consequently drop into the one beneath, where the wire-netting flooring is too fine to allow them to pass. On the upper tray having been removed, the eggs are found in the lower tray and taken to the hatchery. Due to the rather considerable descent of the eggs to the lower tray, when a current of water ascends from below, it would seem not improbable that impregnation from the male would possibly be in a rather small percentage. Mr. A. S. Collins has improved upon Mr. Ainsworth's process by substituting an endless apron (plate I, figs. 1, 2, 3) in place of the fixed wire-cloth in the lower tray, and which passes over rollers at either end of the tray, and which has small wooden cross-bars placed transversely at intervals. These cross-bars are supported by, and, when the rollers are turned, slide upon an inch square strip of wood nailed to the inside of the tray. A similar strip, one inch above, supports the upper tray. The cross-bars keep the eggs from being carried down by the current, as well as maintaining the wire-cloth upon the full stretch. By using two bevelled cog-wheels the front roller can be turned by a handle. As the roller is turned forwards, the wire-cloth, forming the endless apron, moves with it, and the eggs, as they reach the end of the roller, fall off. In front of this roller a pan is placed, and receives the eggs as they fall, and the pan with the contained eggs can be removed at will. This prevents the necessity of even the hands being placed in the water, while the spawning fish are not disturbed.

At the intake of the fish-ponds a gate must exist, permitting the water to be entirely shut off should such a necessity arise; while the outlet must be of sufficient dimensions to allow the passage of all the water of the highest possible flood height, making great allowance for the clogging of the screens, or even a wide channel may be advisable, should there be danger of too great a rush of water. Some prefer planks as the best material for forming the inlets and outlets, others use stone or bricks laid in cement.

For the purpose of cutting off the fish in a pond from obtaining access to the stream above or below, screens are necessary, and which are generally constructed of copper or galvanised iron, having very small apertures, and which are securely fixed into the frames, which completely fill the channel of the outlet or intake, especial care being taken that it reaches to the bottom. Livingston Stone recommends 18 threads to the inch for the smallest fry, 4 threads to the inch for yearlings, and 2 to the inch for two-year olds. To obviate clogging of the screens from descending débris, a frame may be built out in front of the screen.

Irrespective of the ponds constructed for the reception of the fish, buildings will be necessary for the hatching and rearing of the eggs, unless they are left incubating in boxes in the open waters. The water supply is a very important consideration; that from stagnant ponds, boggy grounds, or marshes is evidently unsuitable, but each case has to be decided by local circumstances as already remarked. Some prefer obtaining that for the supply of the hatching-house from a clear lake from which a stream flows, which should be taken a short distance below its outlet and with an intervening rapid, which charges it with air. From such sources the amount and also the temperatures are comparatively even, and sediment and other deleterious influences are generally absent. Or brooks supplied by springs, which are of sufficient capacity to ensure a constant supply at a moderate temperature, even during the hottest day. If, however, this water is to be used for young fish, after the absorption of the umbilical sac or yolk, it should previously flow for a long distance over an open channel. Pure spring-water possesses many advantages; thus, at Howietoun, it is obtained at about a mile from the hatchery, to which it is led by underground pipes, having settling ponds every four hundred yards, and this obviates the necessity of employing filters, while the temperature of the water is very equable. River water, if clear, may be employed, but it is liable to drought as well as to flood, and often carries down ice in winter, or leaves, sticks, and other débris.

The site of the hatching-house should be selected near to where a good head of water may be obtained, while the size of the building must correspond to the amount of work which it is proposed to carry on within. The walls should, if possible, be very substantial, and a considerable slope should be present from the upper to the lower end, in order that the hatching-troughs may be placed in a stair-like sequence (plate I, fig. 6), the front one being slightly below that from which it receives its supply of water. In very cold climates it is advised that, in order to prevent the formation of ice, the house may be constructed partially underground or on the lee of a bank. As a rule, the room keeps comparatively warm and of a much higher temperature than the outer air.

The supply reservoir is most important, and should be constructed of the most durable material and best workmanship. All descriptions of dirt and débris should be kept out, light likewise should be excluded. In some places it is necessary to dam streams in order to obtain the requisite head of water ; but there must always be a danger, especially if the dam exceeds two feet in height, of its giving way.

The conduit along which water is conducted from the supply reservoir to the hatching-house has to be especially considered, its duties being most responsible, as should it fail, the death of all the ova may result. Some fish-culturists recommend that it should be capable of carrying twice or even thrice the amount required, in order that the water may be aërated while in transit; while it may be constructed of wood charred along the inside, in order to prevent the generation of fungus there. The conduit may be open or covered at the top, and, if the latter, the intake had better be guarded by a screen, to prevent the intrusion of any foreign bodies which might choke the pipe. Owing to the injury caused to the eggs of salmonidæ by deposits of sediment, which, if left undisturbed, kills the embryo, or causes it to be weak or even deformed if hatched, great attention has generally to be paid to the filtering of the water. Some springs, such as the one employed at Howietoun, are sufficiently clear for filters being unnecessary ; but in others, although apparently clear, still sediment is being deposited, which, if it does not destroy the embryo, is considered to often occasion many deformities.

Where filtering is required the water from the conduit may be conveyed into a tank termed the settling tank where the heavier dirt subsides. A conduit conveys water from the upper part of this tank to the hatching house, where filtering can be carried on in several ways. Some make the water pass through a bed of gravel, but usually flannel filters are preferred, and these consist of flannel fitted into a light wooden frame-work which slides into grooves placed for the purpose along the inside of the filtering-tank, and which slide is at an angle of about 45,° having the lower end up stream; should the filtering trough be about 18 inches deep, the top of the filter ought not to be above 15 or 16 inches in height or it will occasion a slight heading of the water; care must be taken to keep these filters clean, changing them when necessary. Having passed through as many filters as are deemed requisite, a communication some inches below the surface leads the water into the head or water-supply trough which lies side by side and goes across the hatching-house, and at right angles are the hatching-troughs, usually placed in pairs, with an intermediate space to allow the attendant sufficient room to obtain access to the eggs. Water passes from this distributing trough into the upper of the hatching troughs, which latter are long and shallow, being from 6 to 8 inches deep, and from 8 to 12 wide, having a short portion at the upper end, where the water enters, screened off by a piece of perforated wire screen, and a similar screen at the lower end; these should be carefully fitted in to prevent fry escaping or anything but water passing. These troughs may be constructed of various materials, as slate, stone, pottery or wood; and should the latter be selected, odorous forms must be excluded, being fatal both to eggs and young fry. The cheapest and apparently best material is wood thoroughly charred, which process renders it free from fungus, besides having a purifying effect on the water. These troughs are arranged in flights so that a fall exists between one trough and the next, as shown in Slack's hatching grill (see plate I., fig. 6). Should the water be deficient in aëration short ones should be employed. A light, loose, wooden cover should be furnished for each, in order to exclude light and enemies to the ova and fry.

When artificial hatching of the eggs of the salmonidæ was first commenced, they were almost invariably laid down upon clean gravel, a layer of which, about 1 inch to 1½ inch in depth, was laid evenly at the bottom of each trough, the size selected being that of a very small pea or even slightly less. The gravel was sifted to the required size, washed and even boiled.

Glass grilles, although expensive, are generally approved of, more especially when the questions of space and cost are less material than the raising of strong and healthy fry. They may be employed in troughs composed of any of the substances already alluded to, and are well adapted to those made of carbonised wood. A wooden frame (see plate II., fig. 8, illustrating the Howietoun plan, and the method of fixing the glass tubes, fig. 9) may be constructed to fit that portion of the trough where the eggs are to be hatched, and glass rods or tubes are fixed across the under surface of the entire length of this frame, which may be done by means of a strip of perforated galvanised network. A ledge of wood an inch deep prevents this frame of glass grilles sinking to the bottom of the trough, while a wooden catch keeps it from rising above the desired level, and this secures a current below the grilles as well as one above them. The eggs are distributed, by means of a feather along these rows of grilles, and any that are dead are immediately observable, irrespective of which the stream does not congregate them together in masses as is always to be feared unless mechanical obstacles intervene.

Livingston Stone remarks that simple charcoal or carbonised troughs are equally as efficacious as grilles and infinitely more economical. He considers the first to be the thing for business, and the second more suitable to the rich man's experiments.

Many other descriptions of hatching apparatus for eggs of salmonidæ have been employed with success;[1] some of them likewise effect a great economy in space, but it generally occurs that, if the amount of water is curtailed, weak young are the result. At Howietoun, where the average temperature of the water is from 41° to 45° Fah., Sir J. Gibson-Maitland is in favour of a supply of not less than ten gallons a minute to every 100,000 trout eggs, while, by increasing the flow during the latter stages of incubation, fully 99 per cent. can be hatched, and very nearly as successful results with the eggs of the salmon, the difference being probably due to the difficulty of obtaining perfect impregnation in the case of ova taken from wild fish.

The following apparatus for hatching the ova of Salmonidæ is exhibited at the Fisheries Exhibition by Mr. Oldham Chambers, its inventor. It consists (see plate IV., fig. 26) of a long box 6 feet or more in length, 18 inches in width, and 12 inches in depth.

The eggs are deposited on perforated zinc trays 15 inches long, with about two inches of water over each. The supply-pipe is fixed under the bottom of the box,

[1] Metal substances, unless sufficiently coated to prevent rust or absorption from their surfaces, are unsuitable.

and has T pieces inserted in it under the centre of each tray, in which are screwed rose-jets level with the inside bottom of the box: this causes a complete circulation and distribution of the water before it reaches the eggs. The inventor claims economy in construction, as well as in the quantity of water used; and as it is upon the underflow principle, great cleanliness to the eggs is the result. The whole of the wood work is coated with a silicated preparation which entirely prevents any fungoid growth.

In the United States, Canada, &c., wire trays are extensively used for hatching fish eggs, these may be fixed to light wooden frames which fit the troughs, and are coated with asphalt varnish in order to prevent fungus growing on the wood or the wire from rusting. The trays may be in single, double, treble, or even quadruple tiers. In the United States section are several models, to some of which I purpose referring.

GARLICK'S HATCHING-BOX patented in 1851.—A simple trough, of which the bottom is covered with pebbles, on which the eggs remain until hatched, the water entering through a spout above and passing out through an opening protected by wire-cloth at the lower end.

Length, 18 inches; width, 9 inches; depth, 6½ inches.

This is the first form of hatching apparatus used in the United States. It was adopted by Dr. Garlick, who may justly be called the father of fish-culture in America. Though simple, the results obtained by its use were very satisfactory.

ATKIN'S HATCHING-CRATE.—A frame of metal and wood with hinged cover, which incloses a nest of 9 egg-trays.

Length, 12 inches; width, 12 inches; depth, 7 inches.

This crate is used chiefly for hatching eggs of the salmonidæ. The trays are provided with corner strips of wood, which separate them slightly from each other to allow free circulation of water, though the spaces are not large enough to allow the escape of eggs. These crates can be placed either in the open stream or in ordinary troughs.

A section is shown of the Clark hatching-trough, invented in 1874. It is supported on wooden standards, showing two compartments complete. Each compartment contains a hatching-box, the bottom of which is perforated with holes and raised slightly above the bottom of the trough by means of wooden standards to allow the escape of water from beneath. Each hatching-box contains 12 trays of wire-cloth, on which the eggs remain during their development. A Clark trough usually contains 10 to 20 compartments, each being separated from the adjoining one by means of a partition, which is notched at the centre, and provided with a tin spout for conducting the water. The trough is placed at a slight incline, and the water, entering the first compartment, passes down through the trays of eggs out at the bottom of the hatching-box and up around its sides and ends on its way to the second compartment, all of the water passing through each box before it finally leaves the trough.

HOLTON HATCHING-BOX, invented in 1873, consists of a square wooden box, with a tin bottom sloping downward and inward toward the centre, where the inflow opening is situated. Just above this is a rectangular piece of tin, against which the water impinges as it enters, thus being deflected toward the sides. The box is provided with eleven trays of wire-cloth, each separated from the other by the wooden frame to which it is attached.

Eighteen inches square and 12 inches deep; outside measurement, including base and waste-trough, 22 inches square and 20 inches deep.

The water enters the buckets through a tube which extends from the top around the side to the inflow opening at the centre of the bottom, from which it passes up through the trays of eggs into a trough at the top which conducts it to the outflow spout.

This is one of the first forms of apparatus by which an upward current of water was utilized, and the inventor claimed for it many advantages over other systems. These boxes are often so arranged that the water passes through a series of 20 or more, each box being a trifle lower than the preceding one and the outflow of the first communicating with the feed-pipe of the second.

FERGUSON HATCHING-JAR (plate III., fig. 20), invented in 1876, consists of a cylindrical jar of glass, with a contraction near the base, which serves as a support to the 7 wire-cloth egg-trays which it contains. It has two circular openings on opposite sides; one at the bottom for admitting the water, which passes upward through the eggs and out through the second opening, which is situated at the top. Height, 12 inches; diameter, 8 inches.

For economy of water, the outflow-opening of one jar is connected with the inflow-pipe of the next by means of rubber tubing. By this means the water passes through an entire series of jars before it finally escapes. The jar is used chiefly for hatching eggs of the salmonidæ. It holds about four thousand salmon eggs or six thousand trout eggs.

BUCKSPORT HATCHING-TROUGH.—This is a section of a hatching-trough showing two compartments complete, with nests of trays. Each compartment contains a frame which is closed when in use, but can be opened for convenience in removing them.

Length, 31 inches; width, 15 inches; depth, 17 inches.

Employed by Charles G. Atkins, of Bucksport, Me., for hatching eggs of various species of salmonidæ.

The method employed by the Canadian Commissioner, Mr. Wilmot, differs in several details from the plans pursued in other countries, the varnished perforated tin trays which are used combining either to form a vehicle for conveying or else for hatching ova. When for the first purpose, they are covered with flannel or other suitable material; but if for hatching purposes they have their sides and bottom perforated. These tin trays are painted with paraffin varnish in order to prevent rust, and this is yearly renewed; their dimensions are 10 × 15 inches long, with a partition along the centre.

The trays are placed in the usual manner inside the hatching troughs, resting upon a wooden edge half an inch high, which prevents their reaching the floor of the trough, and thus permits a current of water passing below as well as through and over them. If necessary, these trays may be placed one above another in the troughs, thus economising space. Filters are not generally employed; but should any deposit be observed, the water at the inlet is shut off, and a plug removed from an opening at the lower end of the trough by which means the eggs are run dry; then by using a common watering-can the dirt is washed off and subsides through the perforated bottom of the tray, and becomes carried away by the underflow through the plug-hole already referred to. The plug-hole is surrounded by a circular screen of perforated zinc, this form being found most useful in preventing young fish from being carried by the current against this construction, and having their yolk sac forced inside the perforated orifices. The overflow pipe being thus unguarded, the water from the trough is received into a tin bucket, the upper half of which has perforated sides, in order to permit an easy escape of the water descending with it, while across its centre is a removable tray which breaks the force of the current, while the avelings obtain access into the space below it. Existing at the bottom of this bucket is an orifice secured by a cork, so that when opened it allows the imprisoned young fish to be removed, without handling, or injury of any kind, into any suitable place.

The eggs having been deposited in the trays, troughs, or whatever mode it has been decided to adopt, are left in the hatching-house to develop into young fish. They have to be kept in suitable water and left to mature, the following sources of danger being guarded against:—Sediment in the water, and living foes which have already been treated of; also fungi of which there exist two principal forms: the first has to be kept at bay by means of charring the wood, for, if it once commences, all the eggs will be lost, or the young when hatched will be sickly and worthless; it sometimes shows itself when the cause producing it is obscure. Dirty water will not invariably bring it, nor clean water keep it away. If eggs coalesce into masses they should be carefully examined, and the presence of fine threads floating among them shows fungus. Increasing current of water and shutting out all light are the best means for retarding its progress. The second form of fungus, known as byssus, is a product of decaying matter in the water, and is found in eggs which have perished and began to putrefy. It develops long tendrils, which it spreads out in every direction and causes the death of the eggs so touched; this renders it necessary to pick over the eggs, carefully removing such as are of a dull white, for they should not be allowed to remain above twenty-four hours in the troughs for fear of contaminating those in their vicinity.

There are other reasons which account for the dead eggs, thus such may be due to want of impregnation, which, although usually commencing to be seen a few days after being placed in the troughs, may not be observed for several weeks. Several plans are in use for removing dead eggs: as a bulb-syringe, or a miniature spoon, tweezers, or nippers made of fine steel wire. The time required for hatching trout eggs has been found by Seth Green, in the United States, to be that at 50° Fahr. they take 50 days; and every degree warmer or colder makes five days' difference in time, the warmer shortening, the colder lengthening it; also, if fish are hatched in 50 days, the yolk sac remains 30 more: if hatched in 70 days, the sac remains 45 more.

The normal period eggs take hatching is found, when the water is kept at about 44·10 degrees, to be as follows at Howietoun:—*Salmo fario*, 71 days; *S. levenensis*, 72; *S. fontinalis*, 73; *S. levenensis*, crossed by *S. salar*, 75; and *S. salar*, 77 days. But, as already observed, lowering temperature delays hatching, increasing it hastens such on.

ON OBTAINING OVA OF SALMONIDÆ.

There are three sources from whence the necessary supply of ova can be obtained, and these are either from fish living in a wild condition, robbing the redds in the rivers or streams, or else from such (as trout or charr) as are purposely kept in breeding ponds.

At Howietoun breeding fish are fed with clams, commencing in January and during the spring, in order to assist in developing the eggs, which commence ripening about October. If eggs are taken from late fish a whole summer is nearly gone before the yolk sac is absorbed, or a year all but lost. When clams are not to be obtained mussels, (*Mytilus*), may be employed, but they cause much additional labour in extracting the mollusc. They are scalded for this purpose.

The mode of spawning fish, similarly to every other occupation, requires time in learning, while the experienced and careful fish-culturist will obtain a larger supply of eggs from the ripe fish, and such will likewise be in a more favourable condition for hatching, than will an inexperienced or careless manipulator. Prior to the spawning season care should be taken that everything is in an efficient state and good working condition. As the spawning season comes on the colours of the male fish become brighter; the lower jaw of the male of the salmon and trout becomes furnished at its extremity with a cartilaginous hook; the proportion of the head to that of the body becomes apparently longer, and they commence to decline food. The female becomes larger, and distended with spawn, but does not assume such bright colours as the male, although like him she goes off her feed.

Salmon for breeding purposes must be captured in their natural haunts, which is often a proceeding of no little difficulty. If they have ascended small streams they may generally be readily obtained, but this is not so easy upon fords of larger rivers. The local difficulties and the exact period for commencing work are subjects upon which the best local advice should be acted upon; but even then sudden storms and atmospheric changes may render abortive the best laid plans. It has been observed that in this family, when in a wild state, the number of male fish captured in the breeding season is largely in excess of the females; whereas in breeding ponds, it appears among trout, as if the males do not live so long as those of the other sex, and consequently the females are the most numerous.

Salmon and trout generally resort to their breeding-grounds a few weeks prior to depositing their eggs, which process is usually completed between November and March.

Having captured what appears to be a breeding salmon in a suitable condition—such may be ascertained by exercising a little pressure along the abdomen, when milt from the male or some ova from the female will be extruded—occasionally in the latter sex a little coaxing is necessary, as she will not always yield it at the first pressure. If the ova are not quite ripe, the abdomen, though distended, will be felt hard and somewhat unyielding, whereas in ripe fish it is soft, and the ova can be felt moving under the pressure of the hand. It may be that ripe females are present but no males, and consequently it becomes necessary to consider whether females in this condition can be retained so for any length of time; in some localities they may be placed in small contiguous pools, or tubs, or such like conveniences, or even secured by means of a cord being tied around the tail. The same proceeding may be adopted for the male fish, while it is always desirable to retain one or two of this latter sex in reserve, or milt may be kept closely corked in a phial for several days until required, it having been found to be fertile up to the sixth day. At Howietoun it has been shown that among trout and charr the extrusion of milt or ova can be retarded by placing the fish in a smooth box through which a stream of water flows, thus apparently demonstrating that external pressure is necessary, and from a rough surface; in short, that mechanical assistance is required for the extrusion of the eggs. The apparatus for spawning fish is not very extensive:—A shallow tin or earthenware pan for receiving the eggs and milt, the latter being furnished with a depressed spout for the purpose of passing them into the tin carrying-can, this latter having a perforated lid. A jug for clean water is likewise required, and a dry cloth is useful for the purpose of securely holding the fish. A large salmon is a difficult object to keep steady, often requiring as many as three persons : some operators prefer to grasp the head of the fish between their knees.

The fish is held with its body somewhat sideways, its tail downwards, and its abdomen slightly turned towards the operator (plate IV., fig. 21), while the pan to receive the eggs is placed as near as possible to the vent. Gentle pressure is exercised on the fish, commencing from the ventral fins and passing downwards towards the vent. Should the eggs not appear it does not always follow that the fish is not ripe, and operations on it should be suspended for a few minutes, when it will sometimes prove more accommodating. If, however, it is not quite ripe it may be kept for a day or two, or even more, in a suitable place in order to allow the eggs to mature ; but force is never to be employed ; for if by such means immature eggs are extruded the produce will be valueless, and the old fish perhaps mortally injured. Having obtained ova or milt the fish should be gently retransferred to the water, and no deleterious consequences follow the operation.

On the Treatment of Ova.

There are two processes, either of which may be adopted when spawning winter fish, the moist or water plan, and the dry, so termed because, in the first or old process, some water is placed in the pan which receives the eggs as pressed from the fish ; for fish culturists used to consider that if the eggs and milt were mixed together in water the operator would be more closely following the natural process. The dry process, on the other hand, dispenses with water, the eggs being pressed directly into a dry pan; over these eggs the milt of the male is distributed, and the pan is now tilted at its ends and gently shaken; after giving the eggs and milt time to mix, water is poured in to the depth of two or three inches, and stirred with the hand, and allowed to stand until the ova harden or "frees," as the Americans term it, a period of from $\frac{1}{4}$ to $\frac{3}{4}$ of an hour, according to temperature, taking longest in cold water. For the eggs as extruded are soft, and adhere to whatever they come in contact with, evidently consequent upon the absorption which is going on through the micropyle. Water becomes gradually imbibed, and when the interspace between the outer and inner coat is filled, absorption, as a consequence, ceases, the egg no longer adheres to surrounding objects but frees itself, and is a hard, round elastic body. As soon as this is accomplished, more clean water is gently poured over the eggs, and when it is no longer discoloured they can be transferred from the receiving to the carrying-can, which transferring, however, should not take place too soon, while the eggs must be properly cleansed, or some effete milt will remain and cause injury to the eggs in the hatching boxes. The most fertilising milt appears to be such as is of medium consistence, neither very thin nor very thick.

Under the moist or water process the average success in fertilising eggs probably rarely exceeded fifty or sixty per cent., while it frequently was much less. M. Vrassky, in 1856, inaugurated the dry process for reasons already detailed, since which as much as ninety-five per cent. of successful eggs have been of no uncommon occurrence. When the labour of separating dead eggs in the incubating boxes is considered, and which has to be carefully done and each separately removed, it is a subject of great consequence even on the score of labour alone.

The variation in the colour of the eggs of trout can hardly be deemed hereditary, or due to the food which they consume, or to the colour of the flesh of the parents, as some observers consider ; for the Lochleven breed, reared in Sir J. Gibson-Maitland's ponds, of the same age, fed on the same food, and descended from the same stock, show pink, coral, yellow or white eggs.

The hardened eggs are now transferred to the carrying-can in the proportion of one third eggs to two-thirds water, and the whole removed to the incubating-house, where they are gently spread and distributed with the aid of a feather over the hatching-troughs. Trout eggs are similarly treated to those of the salmon, but are more readily handled, owing to their smaller size.

Grayling ova are more difficult to procure than those of the trout, owing to the brief period during which these fishes spawn, which generally commences about March or April ; the rivers where they reside are always liable to be in flood, and consequently no delay should occur in securing ova as soon as possible after the fish have resorted to the shallows to breed.

Other things being equal, the shorter the distance and smoother the conveyance between the spawning ground and the troughs, the greater are the probabilities of the eggs hatching in a satisfactory manner and producing a robust race of fish.

At the McCloud river, in order to transport *S. quinnat* eggs across the North American continent, they were packed in moss, which on arrival is washed and twice picked over very carefully. The outside packing is of sawdust, hay, or dried ferns; a layer of moss and one thickness of mosquito net are first placed for the eggs to rest on, and so all the way up.

Ova have been transported long distances with complete success, as from Europe to the Australian colonies, Canada and the United States, and likewise from the last two countries to Europe. In the year 1854 Mr. Youl's attention was first directed to this subject, and he came to the conclusion that, in order to convey salmon to Tasmania, the ova or small fry alone could be successfully carried through the tropics; but it was not until 1862 that a conclusive experiment was undertaken. Having seen in Paris moss used for packing salmon ova, and in which they travelled short distances with perfect safety after their eyes were developed, on March 4th, 1862, Mr. Youl packed some in moss within a wooden box, made of inch pine, and having its sides perforated: this he deposited in the centre of the ice in a vessel in which an experiment was being carried on. Contrary winds and misfortunes were met with, and on May 8th, the ice being very low, the box of ova came into sight, and nineteen living ova were found surviving. Nine days subsequently the ice had all melted, and the ova perished seventy-four days after leaving London. Experiments were tried in the Wenham Lake Ice-vaults in London, when it was conclusively shown that the hatching of salmon ova could be retarded to the 144th day. Since then eggs have been safely conveyed in ice to Tasmania and elsewhere; and the possibility of retarding hatching, even to so late as the 148th day, has been proved. This retardation of hatching has also been employed for the purpose of delaying the incubation of some forms of eggs, until sufficient room exists in the hatching-house for their reception, and thus several relays may be successively hatched in one operation.

Experiments were made in Austria (*Ö-U. Fischerei-Zeitung*, Vienna, 1880) by Max von dem Borne, respecting dry fertilisation of salmon ova (or such as had not been brought at all into contact with water), and their development thereby delayed, could be more readily transported than if brought into contact before their journey, and transported during the first condition of embryonic subdivision. Some salmon eggs and milt were transmitted from Basle together in a hog's bladder without the addition of any water. This was done twice, and with them at the same time a number of eggs treated and hatched in the ordinary manner. The journey lasted three days, and the temperature was high, in spite of which the dry packed eggs both times arrived in good condition and were of a beautiful red, while the eggs treated in the ordinary manner were almost all dead and of a very pale colour.

The best time at which to transport eggs is undoubtedly after the eye has become visible, when they may be sent in damp moss. At Huningue the mode used to be to take a wide-mouthed bottle at the bottom of which was placed thin layers of damp moss, above this a thick layer of eggs. Again a stratum of moss followed by another of eggs, and so on up to the top of the bottle, the neck of which was filled with damp moss. The bottle was tied over with a cover of paper full of fine holes in order to admit the air. One or more bottles were then closely packed in a box with damp moss, while an outer case, having an inside lining of wet moss, received the smaller box. In warm weather a little ice was mixed with the moss. Grayling eggs hatch so rapidly—as within three or four days after the appearance of the eyes in the eggs—that they are transported with the greatest difficulty.

Several plans for transporting the eggs of Salmonidæ are exhibited in the United States Section, and the plans may be summed up as defined by Livingston Stone, that they do not require much water but plenty of air, consequently, when hatched in wet moss, these conditions are supplied.

GREEN'S TRANSPORTATION-BOX (Model).—A wooden box containing eight cotton-flannel trays for holding the eggs.

Nine and one-half inches square; height, 11 inches.

Trays, 7 inches square, inside measurement.

In imitation of Clark's transportation box.

ATKIN'S TRANSPORTATION BOX (plate 4, fig. 25)—A wooden box containing four smaller boxes, in each of which 15,000 salmon eggs are placed upon layers of muslin.

The space between the larger and smaller boxes is filled with hay to prevent an unhealthy change of temperature, and the layers of eggs are separated from each other by wet moss. Eggs packed in this way can be sent several thousand miles with very satisfactory results.

MODEL OF ANNIN'S EGG-TRANSPORTATION BOX.—This apparatus consists of an outer case which contains a smaller one, surrounded by sawdust, to prevent loss of eggs from sudden change of temperature. The inner case is provided with eight trays, with cotton-flannel bottoms, for holding the eggs. The tops and bottoms of both the inner and outer boxes have small openings, by means of which the eggs can be kept moist, the water being thrown upon the top of the box and allowed to trickle through the eggs on its way to the bottom. There is a small ice-chamber between the tops of the outer and inner boxes, and the bottom of the outer box is provided with wooden strips, to prevent its coming in contact with the surface on which it rests, which would prevent drainage. Boxes of this pattern have been used by Mr. Annin for sending eggs of the brook-trout to Europe.

MATHER'S TRANSPORTATION CRATE.—A wooden box with a grating of the same material separating it into two compartments, the upper serving as an ice-chamber, while the lower contains thirteen cotton-flannel egg-trays. The ends of the four pieces which compose the frame of the tray extend an inch beyond the point of intersection to form an air-chamber on each of the four sides of the box, thus giving a free circulation. There is also a slight space between each tray, and a larger one at the bottom. A box similar to this one was used in sending salmon-eggs from America to Europe.

On opening a package of fish eggs, should they be packed in moss, the bulb of a thermometer ought to be inserted under several layers of eggs, being careful to admit as little air as possible, and should be left there covered over for about a quarter of an hour. Should the temperature be within 6° Fahr. of that of the water in the hatching-troughs, the eggs may be deposited in these; but should the difference be 6° higher or lower, the carrying-box should be drenched with water of intermediate degrees, so that the temperature may be gradually assimilated, and not until this is completed should the eggs be transferred to the hatching-troughs. If there is not sufficient time to unpack all the eggs on receipt, the carrying-boxes should be placed in a room of uniform temperature, but they should never stand in water. Eggs are not injured by exposure to air, provided they do not become dry, or warm, or freeze.

When the eggs are about to hatch they require considerable attention, for in some the process of emerging from the shell is more easily gone through than it is in others. Generally, if the eggs are small, it has been observed that the young emerge tail first, while in the larger ova they split down the line of the back, and the fish may frequently be seen with its head covered by a portion of the shell; this occasionally causes suffocation. Some come forth strong and lively, others weak and listless; and these weakly ones have not the chance of growing to a fine healthy trout that the more vigorous ones have. Occasionally a slight assistance is necessary, in order to assist the embryo from its shell. As the young begin to move about, care may be necessary that they do not congregate in too large numbers in one place: to prevent this, some fish-culturists insert screens. During the period the yolk sac remains unabsorbed, and which varies from three weeks to three months after hatching, according to the temperature of the water, these young fish, which are termed "Alevins," carry their food about with them, and are not difficult to keep alive if proper supervision is exercised.

Treatment of Young Fish.

While the hatching process is going on, the free use of the watering-can has been recommended to clear the bed of the trough of the numerous egg-shells. After a few days the Alevins seek dark places for hiding in. Some fish-culturists keep them in very shallow water with a strong ripple, others employ deeper water with a slow current. Now they seek every crevice, and push into any cavity they can find, and care has to be taken that no spot exists where they are able to find a hiding-place which will prove fatal to their existence. After the young fish have absorbed about half the yolk sac, they appear to require more air and follow the stream upwards, and great vigilance is necessary to see that they do not escape. But they avoid water which is disturbed, and doing this with a feather, or pouring in water, often has the desired effect of driving them elsewhere to seek a quieter spot. Alevins live a long time in water which is unchanged and has no current passing through, consequently at this period they can be transported with comparative ease.

At Howietoun the Alevins are fed for about a week or fortnight before the yolk is entirely absorbed; the food given being the yolk of nine eggs to one pound of beef, these are pounded together and pressed through a fine sieve.

After the umbilical sac has been absorbed is perhaps the most dangerous period for these fish, for up to then they have subsisted upon its contents; but the period has now arrived that means have to be adopted to feed these delicate little creatures until they are sufficiently grown to be able to feed themselves. After a short time the little fish commence attempting to spring out of the trough, demonstrating that they ought to be turned out into larger pieces of water. Now the young begin to seek subsistence for themselves, and instead of congregating appear more desirous to separate one from another; they commence to raise themselves off the ground and balance themselves in the water, as well as to take any food which is offered. When they begin feeding, they may have a meal twice on the second day, and subsequently four times daily for a couple of months, when by degrees the feeding times may be reduced to twice daily until the cold season sets in. These very young fish can only take the finest particles of food, and different fish-culturists have each their own views on the subject. Livingston Stone observes that young living perch and suckers would probably make the best possible food for the very young trout-fry, and could be obtained in vast quantities; but if artificial food is employed, he advises liver, and curd made from sour milk, mixed in about equal proportions, or, still better, with two parts liver and one part curds. The curd should be made as fine grained and moist as possible; while the liver should be reduced to the smallest possible particles, for which purpose he recommends grating the liver on a tin lemon or cheese-grater which has small holes not above one-tenth of an inch in diameter. This may be placed on a fine screen and thus fall through to the fish below. Or yolk of eggs boiled half-an-hour, and subsequently finely powdered, but this rapidly becomes stale if unconsumed. Curds or eggs alone will not be good food for the young fish, but liver may be employed without any addition. Their digestive powers are great, and there is more fear of over than of under-feeding the fish; but should the food be in too large pieces there is danger of their being choked. Care must be taken that no refuse food remains to putrefy. Professor Haack advises that when natural food is not present, the larvæ of gnats, and also of the Daphnia, Cyclops, &c., should be employed, and which can be skimmed off stagnant waters, as ditches, pools, &c., with a fine muslin skimmer. At Heningen, two children, at work twice a day, obtained sufficient to feed from twenty to thirty thousand young fish.

Unless the hatching-troughs are very large, the young fish will require thinning out, or they will be in excess of the necessary space. The fry will divide into two sets, the larger taking the best locality and driving off the weaker ones, which will herd by themselves, and, unless specially attended to, will not grow at the same rate as their stronger relatives. If very weak, they may be pressed against the lower screen. Should they commence dying, due to putrescence of the water consequent upon the subsidence of unconsumed food to the bottom, the best remedy is common earth, as shown by Livingston Stone.

If the fry are removed from the hatching-troughs, they should be located where there is a sufficient supply of fresh water and shade under which they can remain, and kept from foes and fungi. This can be effected in a rearing-box, ponds, or other suitable locality. In some places, so soon as the young fish have absorbed the yolk sac, they are turned into suitable spots in order to stock rivers; but it occasionally happens that the desired results are not fulfilled so completely as was anticipated. The fact possibly may be that the young were of weakly constitutions, and turning such fish into streams might perhaps only end in their dying there, or being eaten by their foes.

THE "THOROUGH" VASE (see plate 4, fig. 28), for the rearing of salmonidæ, as designed by Mr. Oldham Chambers, is to be seen in the Exhibition. It is circular in form, the water being admitted through a pipe passing round the inside of the vase about two inches under water; this pipe is pierced with holes at an angle of 45 degrees, the pressure of water gives a centrifugal motion to the current, thus causing the young fish to "head on" to the stream. As soon as the young fish have lost their umbilical sac, they are placed in the vase and fed with finely chopped liver, the peculiar motion of the water causes the food to be held in suspension longer than with most other forms of feeding apparatus.

The overflow passes through perforated zinc inserted in the bottom part of a tube, fixed in the centre of the vase to prevent a vortex, inside which is a standing waste-pipe, and, by lifting up the latter, the vase can be cleaned out in the space of two minutes, without endangering the lives of the fish, as they are all protected by the perforated zinc.

Another feature of great importance is the small amount of water consumed by the apparatus ; a stream not larger than a pencil is sufficient to keep 10,000 fry alive in a vase two feet diameter for several months.

Stocking Pieces of Water.

Should it be intended to stock pieces of water, Sir J. Gibson-Maitland observes that eyed eggs may be turned down into artificially and carefully constructed redds, scattered all over the district in close proximity to the best feeding grounds and ripples for the fry. Such absolute purity of the water flowing over the redds is not required for eyed ova as it is for the eggs prior to this period, still discoloured water should never be employed. It is also requisite that the redd be situated near a stream of less pure water, as the absence of fine particles, so necessary for the health of the embryo, is not satisfying to an active young trout of a few weeks old. A natural river temperature of 50° will, as a rule, produce ample food for the young fry. Prior to the absorption of the umbilical sac they should not be placed in ponds or muddy water. They will not bear much handling, but bear carriage very well : a 40-gallon tank being sufficient for the conveyance of about 15,000 which have been feeding for more than a month, except for very long journeys, when a supplementary small tank requires to be added, which altogether saves the necessity of handling the fry. They can be reared in small properly constructed ponds, and subsequently turned into deep water.

Pieces of water may be stocked with trout, for which purpose either eggs or young fish may be obtained from a breeding establishment. It is highly desirable, prior to receiving such, that a careful examination should be made that the nurseries do not contain their enemies, as bull-heads (*Cottus gobio*), which will eat them as rapidly as it can find them. At the Howietoun fishery it is suggested that streams with sediment in the water, or a liability to floods, are unsuited for depositing ova, and fry are recommended instead.

The time necessary for preparing young trout for transport varies from three or four days in the case of yearlings, to as many weeks for large examples. The yearlings are sufficiently strong to find their own food, thus avoiding the principal cause of mortality among fry, which is starvation. They soon accommodate themselves to new pieces of water. Two-year-olds succeed best where coarse fish or large fish already exist in the water. It has been found that there is no difficulty in conveying trout in iced water for any journey not exceeding twenty-four hours. That unless the water which is to be stocked is of similar temperature, some loss will arise from inflammation of the gills; they are consequently carried best in cold weather.

Many different plans are in use for conveying fry from one locality to another, several of which will be found in the United States Section.

CLARK'S FISH-TRANSPORTATION CAN.—A cylindrical tin can with 20 circular trays of perforated tin.

Diameter, 6 inches; height, 9 inches.

The trays rest one upon the other, a tube which extends from the top to the bottom of the can passing through the centre of each. The water is introduced through this tube, passes to the bottom, and up through the eggs, on its way to the outlet near the top of the can. Each tray will accommodate one thousand salmon.

Stone's conical transportation-box is a model 12 inches high, 11 inches in diameter at its base, and 6 at its top. It is a truncated cone of tin, with a perforated cover, capable of holding ice for reducing the temperature of the water in the can.

This can is used in transporting of various species of salmonidæ. Its principal advantages are derived from its peculiar shape, which, according to the inventor, facilitates the aëration of water. Cans of similar shape with the cone produced into a long funnel-shaped cover are frequently used.

STILLWELL'S AËRATING PUMP.—A tin tube, the lower end of which is incased in perforated tin to prevent the fish from being drawn into it. The spout is also provided with a covering of perforated tin, and the water, which is forced through, is broken into a great number of minute streams or jets, thus giving complete aëration.

This pump is used in aërating the water in which fish are transported, when it is not convenient to procure a fresh supply. In aërating, the pump is inserted in the mouth of the can, and the water is pumped up and forced through the perforated tin spout, falling back again into the can.

Irrespective of growing young salmon or trout for turning out into suitable waters for their breeding, some at least may be kept in ponds for the purpose of obtaining their eggs, or placed in suitable rivers in order to supply the market with food.

Space will not suffer me to enter upon the varying character of the trout,—how he thrives in large pieces of water where food abounds, and in his turn delights the angler in streams, the cook in the kitchen, and the reveller at his feasts; while the water which suits him best is accurately laid down in works of natural history. For the same reason must be omitted how to protect these fish from their enemies, whether of the poacher or vermin tribes. The finest yearlings I have personally seen are those shown by the Marquis of Exeter at the present Fishery Exhibition, and they were reared on liver: a 30 months' trout, by artificial feeding, at Huningen, attained to 3 lb. weight. Many substances are recommended for young trout, as the heart, liver, and lungs of animals killed for the market, English dog biscuits, dried ants' eggs, ground liver, and brains, horse-flesh, clams (*Pecten*), worms, and maggots, &c. Meat may be boiled and thus employed—three or four parts fresh meat, one part of common flour, the latter being stirred in. If the fish are properly fed, but little of the food goes to the bottom; should it putrefy there, mortality will most probably be occasioned. Diseased meat is poison to fish. Placing minnows in a trout pond has its advocates; while others consider that, as these fish eat the same description of food as young trout, it is unadvisable to locate them together.

As rivers become more polluted, due to the industries which are being carried on along their banks, it necessarily must come to pass that the fish contained therein will be injured, and perhaps the more delicate forms destroyed, unless pollutions are no longer poured into its course, and other means of destruction cease. Failing remedial measures, it becomes a consideration whether it would not pay, in a commercial point of view, to raise fish, more especially salmonidæ, in artificial streams and well-constructed ponds for this purpose.

In some parts of Germany brook trout are purchased when from only 5 or 6 inches in length, and often brought great distances and fattened. At the ponds they are sorted in accordance with years, and fed on the worthless cyprinoid fishes, which are conveyed in large numbers for this purpose from the Neckar, the Rhine, and the Maine; sometimes the fish, as food, being given alive, at other times dead, the last being found the most fattening. These latter are kept in ponds by themselves, and daily removed and killed for the salmonoids, who receive them dead, but quite fresh. Great care is taken that no remnants are left in the trout ponds, every portion being carefully removed daily.

Fish dealers at Frankfort-on-the-Maine, not having sufficient spring-water for feeding trout ponds, have large floating boxes in the river which are used for this purpose.

In autumn, when the water of the Maine is sufficiently cool, medium-sized fish are caught in the brooks, placed in these boxes, and well fed with live fish; and by the beginning of the next summer, when the river water becomes too warm for remaining, their weight has become doubled or trebled. In the trout ponds of Mayence, Würzburg, Heidelberg and elsewhere, the quantity of spring-water which supplies the feeding ponds is comparatively small. They are, however, kept clean, and especial care is taken that saturated leaves do not accumulate at the bottom. In the large establishment of Klein Brothers, in Alsace, irrespective of the natural food supplied by the Ill to the fish, horseflesh was exclusively used to supplement it. The horses before being slaughtered were carefully examined by veterinary surgeons, and the fish were fed in accordance with their size, the larger ones having the flesh chopped up into small pieces, while it was ground fine for the younger ones. In using this description of meat very great care has to be taken, or it may, if unwholesome, produce a widespread and fatal epidemic among the fish—in fact, in this way Herr Haack lost all his salmonoids, large and small, in one day.

Stocking with Fish from a Distance.

It is a subject well worthy of attention when about to procure fish from a distance, as to the race of trout, salmon, or other species which is to be introduced. For fishes, like other animals, are capable of having the stock improved, and in certain waters raised to a better standard ; thus trout eggs sent to Tasmania from Hampshire and Buckinghamshire developed into *Salmo ferox*. But although new stock may tend to improve local breeds of trout, experiments go to show that, where small but not malformed races exist, riparian proprietors had far better investigate the condition of the fish food-supply, the nature of the water in their streams, the geological formation of the soil, and other local surroundings, than solely rely upon the introduction of larger races. For if the character of the water and paucity of food[1] is the cause, sooner or later the new stock will deteriorate, and become indistinguishable from the original local breed in colour, form, or size. Should, however, food be plentiful and the water satisfactory, there can be no question but that some races grow faster and are superior to others : among these superior forms certainly the Lochleven trout must be classed. Not only are some races superior to others, but some fish under suitable conditions attain to a much larger size than their fellows, due, apparently, to their taking on cannibalistic propensities. This will be seen if a number of fry of a stunted race are transferred to

[1] The young of salmon eat food in large quantities which might be utilised for the subsistence of non-migrating trout or grayling.

localities where food is abundant and the space large, when some only among those which survive will grow to a large size. As we find the older and finer trout produce larger eggs than their younger relatives, while a few recently observed facts go to show that the progeny from these larger eggs grow more rapidly than those from the smaller ones, it appears as if we were commencing to dimly see how breeds could be permanently improved by keeping the breeders of different ages distinct in suitable ponds, so that the ova could be obtained from well-matured parents. This is done at Howietoun; and on this, I believe, greatly depends the marked success of that establishment. On the other hand, it seems to point out that by overfishing, and obtaining the young from the eggs of the smaller parents, breeds may deteriorate, as is so commonly seen in some localities.

During the present year land-locked salmon from Maine, in the United States, have been hatched in this country and shown in the Exhibition. It appears to be merely a variety of the common salmon, which in some places has taken on a lake life, and now does not descend to the sea, but lives and breeds in fresh water. Some examples of a land-locked salmon from Lake Wener, in Sweden, weighing as much as 15lbs., were likewise exposed for sale in the fish-market. It seems well worthy of consideration whether this variety might not be an acquisition to upper riparian proprietors, for, although smaller than its migratory relative, it is said to afford equally good sport to the angler and food for the table. It is well worthy a trial in the upper waters of the Thames. The Canadian Schoodic salmon resorts from the lakes to the streams, mainly for reproduction, but to a very considerable extent for the purpose of feeding. There are two migrations yearly from the lakes to the streams, the first, a partial one in spring, for feeding; the second, in the autumn, for reproduction.

Certain local circumstances may render it desirable to introduce from distant places new breeds of fish; thus, although the presence of salmon was wished for in the Danube, we are informed, in the expressive language of Herr von Behr, that "the Lower Danube is, during summer, as hot as hell," while the Californian streams, where they flow into the sea, are said to be not much cooler. As the Rhine salmon is not suited to the Danube, it was naturally attempted to introduce its relative, *Salmo quinnat.*

The question of hybridisation is worthy of attention, as it has been proved that, besides the various forms of fresh-water trout and the charr raised in vivaria, all are exceeded by bastard fish between the trout and charr, which, observes Director Haack, outgrow the pure breed very considerably even when raised under identical conditions; and, besides rapid growth, their delicate flavour combines the excellence of the charr with the peculiar flavour of the trout. Consequently, among salmonoids, he considers it to be the most suitable form for pond cultivation; while if hybrids are raised between the salmon and the trout, it is still doubtful to what extent sterility will occur among the progeny, and whether they would or would not take on anadromous instincts.

The smelt (*Osmerus eperlanus*) has been successfully hatched in fresh water at Howietoun during the present year, and the living young shown in this Exhibition. They may be extremely useful food for trout and charr. In the United States they have a useful invention for the hatching of smelt eggs.

In 1880 the first attempt in Scotland was instituted. The eggs were spawned into a pudding-dish and milted by the dry process; they were then placed at the bottom of a slow current of water in the open air; but all died of fungus about the fourth day. In 1881 another series of experiments were commenced. The eggs were placed in a wooden box, the bottom of which was composed of glass grilles. This box was placed inside one of the hatching-troughs, and a current of water was forced up through the glass-grilled bottom of the box which contained the eggs, keeping up constant motion. They lived for three weeks.

This year about 160 smelts, in breeding condition, were captured in the tidal waters of the Forth, and sent in fresh water to Howietoun by Mr. Napier, Inspector of Salmon Fisheries. As a rule, the females appeared to be larger than the males, but this was not invariably the case. The colour of the eggs varied from yellow to clear white, and the fish were spawned when the temperature stood at about 49 degrees, while at 45 degrees the milt became silky. The eggs were received on to a piece of window-glass, and milt was added; subsequently a little water, and by gently shaking the glass the eggs were dispersed over its surface. In about five minutes they adhered to the glass, which was then placed on end in one of the hatching-troughs. The adhesion of the eggs is due to a fine filament which is attached to the outer surface of the egg, and expands at its distal extremity into a sucker, by means of which it becomes adherent to any contiguous object. When the eggs were placed in too great proximity to one another, they, on swelling, became pressed, and their surface looked as if they were honey-combed. If two layers of eggs were present, the upper became covered with fungus—perhaps due to the length of the filament being unable to reach a spot where it could adhere. If torn off from its adhesion, death appears to result. By leaving a little clear space round the eggs pressure was prevented, and they hatched in a satisfactory proportion; this hatching occurring about the forty-second day, except in some troughs which had been kept warmer, when it occurred eight days sooner.[1]

In Maryland, in America, an attempt was made to artificially propagate the ova of this genus in 1877, but it proved unsuccessful. Since then, in 1879 and 1880, a few have been hatched on the Hackensach river (New Jersey), and preparations were made in 1882 for extensively hatching these fish by the United States Fish Commission.

The following box for smelt-hatching exists in the United States section:

RICARDO'S SMELT-HATCHING BOX (plate I, fig. 7).—A rectangular box, with a hinge-cover and perforated ends, covered with wire-cloth. The inside of the box is filled with twigs, to which the adhesive eggs of the smelt are attached.

This box is placed in the river where the current is strong, the water entering and escaping through the circular opening at the end.

Among the salmonidæ found in our lakes, in Wales, the North of England, Scotland, and Ireland, are the white-fish, or *Coregoni*. Some species are likewise present in Canada and the United States, where the ova of the *C. albus* have been artificially propagated with great success.

The eggs of some fishes, as the American white-fish (*Coregonus albus*), when dead become of a lighter specific gravity than are the live ones. The separation of the dead of these comparatively small eggs from the living was a source of great difficulty, but has now been overcome by means of self-pickers. A regulated current of water

[1] These fish subsequently died.

descends upon the ova, sufficient to allow the dead eggs to pass off with the overflow.

WILMOT'S IMPROVED GLASS INCUBATOR (plate III, fig. 18)—for the self-picking, cleansing, and hatching of eggs, of the Coregoni and Percidæ species—is a cylindrical jar made of glass (or any kind of metal) of any size or shape; a rubber-pipe, attached to a tap, regulates the supply, conveys the water into a glass tube, which rests on the bottom of the jar. The water striking the bottom glances equally round and upwards, passing through the eggs, gives them a gentle motion, and carries off all light and impure eggs and sedimentary matter through the lip or overflow, and leaves the sound eggs, from their greater specific gravity, at the bottom of the incubator. The apparatus is very perfect, and largely used in Canada and the United States.

In the United States Section exist several plans having much the same purpose in view.

CLARK'S HATCHING-JAR (OLD STYLE).—A cylindrical jar of glass, with a metal rim notched at one side, and provided with a movable wire screen, which is open while the embryo are developing, to allow the escape of dead eggs, but closed when the hatching begins, to prevent the escape of the fish. The water is introduced through an opening at the bottom, passing upward through the eggs and out at the top. Formerly extensively used for hatching eggs of the white-fish. Height, 16 inches; diameter, 6 inches.

CLARK'S HATCHING-JAR (INTERMEDIATE FORM).—A cylindrical jar of glass, with a metal rim, having a spout on one side through which the surplus water escapes. The water is introduced at the bottom, through a tin tube with a funnel-shaped opening, and passes upward through the eggs on its way to the outflow-spout. Height, 16 inches; diameter, 6 inches.

Extensively employed for hatching eggs of the white-fish at the Fish Commission hatching-station at Northville, Mich.

CLARK'S HATCHING-JAR (NEW STYLE).—A cylindrical jar of glass, with a metal rim, having a spout at one side from which the surplus water escapes. The bottom of the jar is provided with a metal cone corresponding with the funnel-shaped end of the supply tube, which is prevented from coming in contact with it by means of slight projections on its inner surface. Height, 18 inches; diameter, 6 inches.

This jar is now coming into favour for hatching eggs of the white-fish, and is extensively used at the Northville hatchery.

CHASE'S HATCHING-JAR (plate II, fig. 14).—A cylindrical jar of glass, with a metal rim notched at one side and provided with a wire screen for retaining the fish. The water is introduced through a glass tube at the bottom and passes upward through the eggs. Height, 16 inches; diameter, 6 inches.

This jar is extensively used for hatching eggs of the white-fish. When the embryos are developing, the outflow-gate remains open, and through it any dead eggs which are carried upward by the current escape, thus preventing the injurious effects which arise from fungus and dead eggs.

MCDONALD'S Y-SHAPED HATCHING-BOX.—A wooden box, with glass ends and sloping sides, for eggs. Length, 12 inches; width, 24 inches; depth, 15 inches.

The sides of the box slope toward the bottom centre until they come within an inch of each other. Below this opening is a space three or four inches deep for the introduction of water. This opening is nearly closed by means of an adjustable square wooden bar, one of the angles of which enters the centre of the opening, the sides of the bar thus being parallel with those of the box. By this means the current is divided so that the water is deflected along either side of the box toward the surface, carrying the eggs with it and causing them to pass in toward the centre and fall again to the bottom, where they are again caught by the current and carried through the same circuit. The outlet is protected by a triangular trough running across the top centre from side to side. This is placed a little below the top of the box, so that the water shall flow over its side and out through the openings. The current introduced is sufficiently strong to carry away the dead eggs into this trough, thus allowing them to escape; but is not strong enough to carry away the good eggs, which, being heavier than the dead ones, drop before reaching the trough. Great care must be taken to see that the flow of water is properly adjusted; otherwise many of the dead eggs may be retained, or the good ones may be lost.

SECTION OF V-SHAPED HATCHING-TROUGH. — A simple trough, with false sides sloping downward from the top toward the centre, leaving the space of $\frac{1}{8}$ of an inch, covered with wire cloth, between their lower edges. The upper part of the trough is surrounded by perforated tin, through which the water passes into a sluice-way and thence to the escape-pipes, which occur at short intervals.

The water enters the apartment between the vertical and sloping sides with the hydrant pressure, and is forced up through the opening and out through the strainer at the top. The eggs, being heavy, tend to sink to the bottom, where they are caught by the current and carried upward and outward toward the sides; as the current weakens, they gradually drop back toward the centre, where they are again caught and carried through the same circuit.

FISH-PONDS.

It is not surprising that pond-fish in this country are generally deemed hardly fit for the table, because, conse-

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quent upon the want of care bestowed on our ponds, the fish obtained from them have, as a rule, a muddy or an earthy flavour. Were, however, attention paid to this subject, many fish-ponds now left to be choked by mud, and rendered foul by the accumulation of decomposing leaves and decaying weeds, might be rendered clean, sweet, and capable of supplying a considerable amount of good and eatable table fish. Fish-ponds, as has been pointed out by almost every fish-culturist from ancient to present times, must not be left unattended to ; they may be allowed to stand full two or three years, but not longer, unless the proprietor delights in the contemplation of starved fish : the oftener they are dried, the better the feed for the fish will be. The best treatment for these ponds is rotating crops of vegetables and crops of fish, for which purpose at least three ponds are required, although more are undoubtedly advantageous.

The aspect of the ponds, the nature of the soil in which they are constructed, the character and amount of the water which supplies them, are all factors to be taken into account, and upon which success or failure frequently depends. Hard clays and gravels are generally unfavourable, while a marly soil is mostly to be preferred. Near the middle of the pond a deep spot should be constructed into which the fish can retreat if necessary. They should not be too deep, as shallows are necessary for the fry, which are rarely seen in deep water, which latter is colder than shallows and consequently is frequented by fewer insects, irrespective of which, cold does not favour growth in these fish. Most forms of trees in their immediate vicinity are detrimental, because leaves falling into the water, occasion the formation of a black mud and the escape of fœtid gases, which appear to be especially deleterious in winter, when ice covers the surface. Rank vegetation along the banks is often injurious, although some weeds in the water are necessary to afford shelter for ova and fish, as well as clear the water. In some ponds facilities may advantageously be afforded to cattle to come and drink, as well as stand in the water, thus augmenting the food of the fish : but the vicinity of rookeries has been deemed to be deleterious. Care should be taken that surface-water from the neighbouring land cannot obtain access, and if necessary a channel should be cut to keep it away.

There are many modes in which fish-ponds may be constructed, but an invariable rule should, if possible, be made, that means should be present by which, when desired, they may be readily run dry, and the same depth should be maintained summer and winter. Along the centre of the pond, from where the water enters to its outlet, two or three deep channels should be cut, and about the middle of the pond is a deep spot termed the kettle, two feet deeper than the pond ; while near the outlet is another spot one foot deeper than the rest of the pond. The inflow of water should never be direct from a brook, but conducted in from one side ; the sluice situated there should be sufficiently strong to render overflowing impossible, while a grating should exist to keep out strange fish. The outlet may be made of masonry or pipes, and also be guarded by a grating to retain the fish. Spawning ponds of a small size have been found in carp cultivation to answer better than larger ones. The stream of water should be able to be cut off when desired from any of the ponds ; while, if a succession of ponds exist, fish of various sizes can be kept by themselves and suitably fed and fattened for culinary purposes. If, says Roger North (1713), there be only two ponds, the first should be dried in October, by drawing the sluice, and as the water gradually subsides, the fish should be taken by degrees; but he recommends that the mud should not be removed, for fear of injuring the banks, but would rather plant a crop of osiers in the mud, or oats will grow well there. When dry, he proposed that it should be kept so all the summer, and a profit made out of the soil by ploughing or feeding. Ponds may be purified (if not very foul), and the weeds killed, by being allowed to remain dry for a few months. The following Michaelmas, or a little sooner, they should be filled again, and, when nearly full, stocked.

An interesting paper upon pond cultivation in Prussia, by Herr Eben Banditten, exists in the *Deutsche Fischerei-Zeitung*, v., No. 6, February 7th, 1882. He had a meadow ten acres in extent in a very favourable and sheltered position, which was alternately employed as a pond for rearing fish and for agricultural purposes. In August 1881, when the second crop of grass was just ready for cutting, a flood covered it to the depth of five feet. In previous years he had employed it as a spawning pond, now he decided to use it for raising and fattening carp. Knowing the quantity of food it contained, he stocked it in the spring with about five hundred carp, weighing on an average 1lb. to 1½lbs. each, four hundred ides (*Cyprinus orfus*) of different sizes, a few eels, and ducks in the proportion of one to each carp. He succeeded very well, 300 ducks, 100 geese, and 2 swans, making this pond their residence for the summer. He expected, and found his expectations fully realised, that these aquatic birds would furnish a good deal of other food for the carp. Frogs at first abounded, but the ducks cleared them off. About the beginning of October 1881, he had about 50,000 very fine young carp, 100 of them weighing about 2½ lbs.,; of ides he had only about 100. The old carp had increased in size from 100 to 150 per cent., the ides not quite so much. Frog spawn was found to be good food for ducks, and thus increased the fishes' food.

The number and sorts of fish suitable for stocking ponds depends upon many circumstances, especially as to the amount of food which is present, whether the water is from a stream or springs, and many other conditions. Boccius recommended the following proportions of fish as suitable for stocking an acre of water: 200 brood carp, 20 brood tench, 20 brood pike. North cautions the fish-culturist against over-stocking, observing that when this is done the fish deteriorate. Also that after the first year their numbers should be diminished, because the food will be less. It is well when drying a pond to examine whether the contained fish are well-fed or lean, and accordingly judge whether the water has been under-stocked or over-stocked.

One of the first accounts of the mode of hatching coarse fish, as perch, pike, roach, bream, ide, and aspius, is by C. F. Lund, in the transactions of the Academy of Science of Sweden in 1761; it is entitled 'Fiske plantering.' The principle is a box placed in shallow water near the bank of a river, where the water does not flow over: its inside is charred by fire and then lined with bushes, while its sides are perforated in order to permit free access of water (see plate I, fig. 5). Here the parent fish are confined, and when the eggs have been deposited the old fish are usually eaten by the peasants, who are not particular as to the taste or quality of their food. This process of spawning and hatching coarse fish which breed in summer has been improved upon by Mr. Oldham Chambers, who has made the sides movable, so that they, with the bushes and adherent ova, can be transported in carrying-boxes to desired localities.

RIVER AND POND FISHES.

The fish-culturist who has decided upon raising food fishes in a pond has first to investigate what indigenous or foreign forms are best suited for his purpose? In the following brief summary the salmonidæ and anadromous fish are excluded, as they form a separate subject for inquiry.

The perch (*Perca fluviatilis*) is a well-known gregarious fresh-water form which inhabits lakes, ponds, canals, and rivers, more especially frequenting deep holes or where there is a gentle current, preferring the sides to the more rapid parts of streams. Occasionally it will descend to salt water, and when found in such localities, or where it is brackish, it is highly esteemed; on the contrary, in muddy ponds it loses its flavour. It is generally held in good repute as a table fish. Being very fond of fish fry it is not an advisable form in salmon or trout waters. At its third year, and when about 6 inches in length, it commences spawning, depositing from 20,000 to 28,000 ova. It does not often exceed 3 lbs. in weight.

In the United States Section is shown an apparatus, MACDONALD EGG REEL (plate IV, fig. 22) for dealing with adhesive eggs, the mucus on which hardens under water. The eggs are taken upon cotton yarn, which is drawn up through a funnel into which the milt and eggs had been squeezed from the spawning fish. The thread covered with adhering eggs is rolled upon a wooden reel and sent in damp cloths to its destination. On arrival the cotton cord is cut into lengths of 10 or 12 inches, and suspended in glass hatching-jars.

The burbot, or eel-pout (*Lota vulgaris*), prefers clear and still rivers and lakes, at the bottom or sides of which it lurks in holes or crevices among the stones, or even skulks in rat-holes or cavities under banks. In stews it fattens well, as it will eat almost any animal substance. It has long been esteemed a great luxury; its flesh is white and delicate, but its liver is its most delicious morsel. It is found in the county of Durham; also in sluggish Yorkshire rivers, in Norfolk, in the Trent and its affluents in Nottinghamshire and Staffordshire; in the great east fen of Lincolnshire, and also in Cambridgeshire. It breeds from December to March, depositing at least 128,000 eggs. It appears to be decreasing. It is usually found up to 2 lbs. or 3 lbs. weight in this country, but occasionally larger.

The pike or jack (*Esox lucius*), is a strong, active, and voracious fish, consuming its smaller neighbours, preferring still and placid waters where weeds abound, and among which it will lurk. When emboldened by hunger nothing comes amiss, and it has been suggested that in lakes where trout are numerous and of small size it may be a good plan to introduce a few male pike to keep down the numbers, and thus proportion them more to the amount of food. The same plan has likewise been employed among coarse fish. Of its value as food opinions differ, but the river are superior to the pond ones. It has been observed that boiled, it is insipid; stewed with spices and a bottle of good old crusted port, it becomes passable; stuffed and baked, it is perhaps a trifle better; filleted, it is almost nice. In some trout rivers it appears to have entirely destroyed the native races. In carp ponds it is said to prevent the Cyprinidæ from becoming lazy by chasing them about. Breeding in March and April, it deposits from 700,000 at 28 lbs. to 292,320 eggs.

Carp (*Cyprinus carpio*).—Hardy and tenacious of life, wary in a state of nature, but readily tamed, it is most frequently found in ponds, canals, sluggish pieces of water or slow-flowing rivers. Its flavour is frequently muddy, to obviate which it is found advisable to retain it for some weeks in a stew, through which a supply of water flows. It can be conveyed long distances in well-boats, through which water is allowed to pass; and experiments made in America show that it can be transported in railway vans when only sufficient water is sent that will cover its back, and it has thus been carried for nearly four days without ill-effects. It is supposed to commence breeding at three years old, in May or June, according to the character of the season; the eggs develop quickly, the eyes becoming visible as early as the fifth or sixth day, and on the twelfth or sixteenth the young hatches. Carp of about 4 or 5 lbs. have from 400,000 to 500,000 eggs. This fish is largely cultivated for food in some countries, while in Paris, in spite of an abundant supply of marine and fresh water forms, it, with the exception of salmon and trout, is considered the most desirable form. In this country the best are from rivers, next such as come from large lakes, and the most inferior from muddy ponds. It mostly subsists on vegetable food, but also on worms and larvæ of water insects which it turns up from the mud with its head; also refuse from slaughter-houses and reservoirs. It may be considered as in season from October until April. To improve their flavour Mr. Tull castrated them, as he asserted, with excellent results. It is found up to twenty pounds' weight in this country. In employing carp as food fishes great care is very desirable in selecting the race which is going to be imported; in Germany and elsewhere, there are three varieties which are cultivated—the common carp, the mirror carp, and the leather carp. Of these three races the mirror carp is considered the superior, being the most hardy form, and bearing up best against injuries. Some fish-culturists make a speciality of raising forms possessing very few scales; sometimes these are restricted to a single row along the lateral line, or a strip along the back. Crucian carp (*Carassius vulgaris*) will cross with this form, the progeny being almost worthless for the table. The crucian and gold carp should not be permitted in the same ponds as the common carp.

Carp require a hatching-pond, which should not exceed one to one and a half feet in depth or less in parts, and having weeds in it on which the eggs are deposited. Secondly, a breeding-pond about the same depth; and thirdly, a culture or regular carp pond. Should sufficient food not be naturally present, the fish must be fed, but never in the same spot, as they become languid and lazy; the flesh of a carp that does not take exercise is rarely firm. They should have a little food at a time—early in the morning and late at night, or in very warm weather only in the evening. Pond carp, observes Hessel, are accustomed to other food than river carp. The former confine themselves to worms, larvæ and plants, while those living in streams find all sorts of animal and vegetable refuse: these latter can also stand a greater amount of food, as the current materially inclines them to take more exercise, thus increasing their appetite; while when feeding on unwholesome or spoilt food, or food left to spoil due to not being eaten, will produce disease. An old rule was to feed carp in spawning-ponds both before and during spawning, in order to prevent their hunting for food and consuming their own eggs. After spawning, the adults should be removed. Too many young fish should not be left in one pond, but in cold countries they may remain two summers.

In the United States Section are two plans for transporting carp, the first one used being termed a—

Carp Transportation Can.—This is a cylindrical tin can, encased in wood, with the top slightly contracted to prevent splashing.

Diameter, 10 inches; height, 13½ inches; capacity, 6 gallons.

This can holds ten three-inch carp. It was formerly extensively used in the transportation of this species, but it is now seldom employed, as small pails are found more convenient, less expensive, and equally satisfactory.

Carp Transportation Crate.—A wooden crate, provided with sixteen two-quart tin pails, arranged in two tiers, separated by a wooden partition.

Length, 32 inches; width, 18 inches; depth, 14 inches.

This crate has now almost wholly superseded the more cumbersome and expensive cans. In shipping cans intended for different persons in the same section and placed together in the same crate, each is provided with a tag bearing the name of the consignee. On its arrival at the proper railroad centre, the crate is opened by the employés of the express company, and the cans reshipped to the parties for whom they are intended.

The gudgeon (*Gobio fluviatilis*) is a small gregarious river fish, selecting places where the current is not strong and the bottom sandy or gravelly, seeking the shallows during the warm months, but returning to deeper water in the winter. It will succeed in some ponds, whether muddy or clear, and has been even observed to breed there, although the bottom was clayey. It breeds from April until June, depositing its eggs in shallows, where they hatch in about a month. Those from rivers are a very delicate fish, and are often termed the "river smelt." They form good food for other fishes.

The roach (*Leuciscus rutilus*) is a gregarious fresh-water fish, preferring clear and still waters, found feeding at night on the shallows, but retiring to the deeper parts during the daytime. It is in little estimation for the table, but useful as food for other fishes. It breeds in May and June.

The chub (*Leuciscus cephalus*) is found in rivers, where it frequents localities overhung by banks and trees, the eddies of weirs or bridges, about mills and in other suitable places. It is a coarse, bony fish, spawning in April and May.

The dace (*Leuciscus vulgaris*) is another gregarious river fish, not much esteemed for the table, but which forms useful food to its better class of neighbours, while its bright silvery sides render it very suitable as bait for pike. It spawns in June, and one of 28 ounces contained 480,480 eggs.

The rudd (*Leuciscus erythrophthalmus*) is a gregarious fish found in many rivers, canals, lakes and ponds. It is not much esteemed for the table, but some anglers prefer it to dace as a bait, when trolling for pike, as it is more tenacious of life. It breeds in April and May.

The minnow (*Leuciscus phoxinus*). During the summer this pretty little fish is found in large shoals near the surface, but more or less conceals itself during the cold months, while it prefers clear and rapid water. It spawns in June, and the young are hatched about the sixth day.

The tench (*Tinca vulgaris*) inhabits lakes and ponds, becoming more or less dormant during the winter months. It is very tenacious of life, and some esteem it as good food. It breeds in June, and upwards of 250,000 ova have been taken from one fish. A golden variety has been introduced in this country and extensively propagated; but as food it is inferior, while it is more readily perceived by its enemies.

The bream, or carp bream (*Abramis brama*) is a gregarious fish found in rivers, canals, lakes, and ponds, thriving best in large pieces of water, in quiet rivers, and sometimes in enormous shoals, as in the Norfolk broads or Irish lakes. It spawns in May. Although by some it is said to be good for eating, others reject it as bony, muddy, insipid, and only fit for pike and other predaceous fishes.

The white bream, silver bream, or breamflat (*Abramis blicca*), has much the same habits as the last, than which it is, if anything, considered as still more inferior, but good as food for pike.

The loach (*Nemacheilus barbatula*).—This little fish is found in rivers and brooks, when, if disturbed, it darts away or stirs up the mud for concealment. It generally hides itself under stones or other objects, and is mostly nocturnal in its habits. It breeds in March and April. It is a very good bait for trout, perch, pike, and eels.

The eel (*Anguilla vulgaris*).—The common eel, almost cosmopolitan in its distribution and a catadromous form, descends to the sea to deposit its numerous ova, while it inhabits all pieces of fresh water to which it can obtain access, thriving better in rivers having muddy bottoms than in those which are gravelly; migrating twice a year—in the autumn to the sea for breeding purposes; in the commencement of summer from the sea, the latter being almost entirely confined to small fry, termed elvers in some localities. In the winter eels conceal themselves in the mud. They are very destructive to the spawn of other fishes, consequently are not always advisable in fish-ponds. Holland supplies, at the least, half the amount of eels consumed in this country, deriving in exchange a considerable income; while we, who find our local supply insufficient, do not take steps to prohibit the sale of elvers, or young eels, which are captured in quantities and pressed into what are called elver cakes, 1408 fish going to 1lb. weight. These elvers ascend some of our rivers (as the Severn) in millions, and would prove very remunerative if reared in suitable localities, besides obviating the present necessity of eels being imported from abroad.

Foreign Fish for Acclimatisation.

Some fish culturists advocate the introduction into this country of foreign forms of fish, either from the continent of Europe or more distant climes. Such a proceeding may be beneficial or may be entirely the reverse. The first consideration should be, if the stranger is a large consumer of vegetables or flesh, and whether sufficient exists for his consumption where it is proposed to acclimatise him. Anadromous forms, as the salmon or shad for instance, as a general rule merely enter our rivers just prior to spawning time, a period when they require but little food, and consequently, until spawning is over, do not need any very large amount of sustenance. Carnivorous forms, as pike, may be useful to diminish too large a number of coarse fish in a river where they are in excess of its capabilities for supplying them with food; but when the wished-for diminution has occurred, they still continue their depredations, and may deplete the fisheries to too great an extent. Attempts were made, which were fortunately unsuccessful, to introduce the *Silurus glanis* into our rivers, a fish with an insatiable appetite, and when large, of but little value, except for the oil which can be obtained from it, and which Professor Rudolph Hessel described as having habits similar to the carp, lying on mudbanks, or feeding-places of this fish, becoming its most dangerous enemy and insatiable destroyer.

Artificial Hatching of Marine Fishes.

The principle acted upon in some freshwater fisheries of supplying undue depletion by artificial hatching of fish has likewise been attempted in the United States with respect to sea fisheries. It is carried out there by Government Commissioners, who, unwilling to regulate the modes of capture, but observing the evident impoverishment of the fisheries, plainly perceive the inutility of expecting the fishermen to stock public waters at their own expense, and where everyone might indiscriminately capture the produce. Here we go on a much simpler plan; ignore the complaints of the fishermen that the inshore fisheries are being depleted, assert they are ignorant of what they are complaining about, be incredulous of the statements of success from other countries, profess to believe that the excessive rise in the cost of fresh fish is due to some trick of the fish-selling trade, and calmly await the time when our flat-fish fisheries have followed those of our oysters, leaving untouched the question of why it is that now at least two or three times the amount of netting, number of men, and of tonnage of boats are necessary to obtain a similar amount of fish to what was taken at the commencement of this century.

The first species which the United States Fish Commissioners attempted to propagate on a large scale was an anadromous shad, *Alosa sapidissima* (a genus of which we possess species in this country), which up to 1877 had been chiefly artificially carried on in floating boxes, connected in a gang by cords, the foremost being held in its place by an anchor. It was found that during strong currents there was sufficient movement for the eggs; but when the tide was slack they rested in masses at the bottom of the boxes, and in consequence suffered greatly, being very liable to fungus, especially when the temperature was high, unless shaken up by the hand; while during storms or floods they were not infrequently upset or carried away. In 1877 Mr. Ferguson invented his PLUNGING-BUCKET (plate III, figs. 15, 16), which apparatus had a great superiority over floating boxes, especially in hatching eggs in waters where all currents were absent; also because a cooler stratum of water could be readily reached when the surface was too hot for the proper development of the eggs, a condition always present when the temperature rose above 80°. By covering the tops of the buckets with caps of wire gauze they might be sunk to the required depth where a cool stratum existed, and that without any escape of the ova. The apparatus is thus described: "It was placed upon a large scow, 50 feet long and 19 feet wide, and consists of a shafting along the centre of the scow, upon which at intervals are placed irregularly formed cams, which have a long and a short side. This is accomplished by making the outline of the cams two intersecting cycloid curves, which produces upon the lever following its circumference a quick fall and slow rise at the extreme end. A steam-engine is the motive power revolving the shafting and cams. To the ends of the levers are suspended cylinders of sheet iron, from 1½ to 2 feet in diameter, having a wire-cloth bottom, and within these cylinders the eggs are placed. The rise and fall in the water does not exceed 5 inches. A slow revolution of the shafting produces all the agitation in the water essential to the welfare of the eggs, a more rapid motion having a tendency to draw the eggs hard against the wire-cloth. The slow rise and quick fall of the cylinders also saves the eggs from this injury, as the effect is to throw the eggs high up as the bucket goes down, while, as it rises slowly up, they fall gently to the wire-cloth bottom." Each bucket will hold 20,000 shad eggs. In many localities where this artificial shad propagation has been carried on the success has been very great. In 1867 two million, and in 1869 four million, were hatched in the Connecticut river; and in 1872 the largest catches were made that have occurred since 1811. In the river Hudson, it was reported that the take of shad was the greatest that had been seen for fifteen years, and the results of its culture were beginning to be seen. In short, in many localities where this artificial propagation has been carried out, the increase of fish has been most remarkable; while new colonies of them have even been established.

WRIGHT'S SUBMERGED WAVE-ACTION HATCHING-BOX.—(Plate III, fig. 19).—A cubical box, with a hinge cover of wire-cloth, the sides being of galvanised iron; the bottom, which is of the same material, being provided with circular openings an inch in diameter, each covered with valves opening upward to admit water from beneath. In the interior of the box, an inch above the valves, is a wire-tray upon which the eggs are allowed to rest, and through which the water can readily pass. The sides of the box are prolonged downward to form an expanding rim, which serves to deflect the current upward through the eggs. The whole is suspended from a float, and held in position by means of a small weight fastened to the bottom.

Length, 10 inches; width, 10 inches; depth, 12 inches.

This box was invented for hatching eggs of the shad. It is claimed to be suitable for open streams where the current is too slight to admit of the use of other apparatus.

MACDONALD'S EGG-TRANSPORTATION CRATE.—A crate containing 18 shallow trays or wooden frames with wire-cloth bottoms, incased in canvas, and secured by frames connected by leather straps.

Length, 16 inches; height, 15 inches; width, 14 inches.

This crate is used for transporting the eggs of the shad for a distance of fifty to one hundred miles. The bottoms of the trays are covered with wet cloths, upon which the eggs are spread. Each tray holds from 10,000 to 15,000 shad eggs. When filled, they are incased in the cloth cover, securely strapped together, and shipped by boat or rail to the hatchery.

This apparatus marks the beginning of the dry transportation of shad-eggs, and has been successfully used in the work of the United States Fish Commission for the past two years.

FISH COMMISSION TRANSPORTATION CAN.—A cylindrical can of block-tin, the top of which is contracted, and provided with a cover to prevent slashing of water while in transit.

Height, 24 inches; diameter, 14 inches; capacity, 12 gallons.

This can is more extensively used than any other kind for the transportation of young shad, and proves very satisfactory. The contraction of the neck, giving only a limited free surface, prevents any violent agitation of the water.

FERGUSON'S TRANSPORTATION CAN.—A cylinder of block-tin, with movable top fitted with a rubber rim, and thumb-screws for rendering it water-tight.

24 inches high and 14 inches in diameter. Capacity, 12 gallons.

This can is provided with nipple attachments, by means of which several can be connected, so that a current of water will flow from one to another, thus giving a circulation during transit. This can carries from 15,000 to 30,000 shad.

The ova of the cod have been artificially propagated, as it was considered possible not merely to increase the supply where it already existed, but also to establish new fisheries in places where the young should be turned out. The best results are said to have been obtained at Gloucester, Mass., where those released were known to live, as many young fry were observed playing round the wharves where young cod had never been previously seen. The eggs having been taken in a pan having a little water in the bottom, and the milt was at once added, after which water was slowly mixed at intervals until the pan was full. But for successful hatching it appears necessary to give a certain change to the water, and partially keep sediment from the eggs. Various contrivances have been invented in order to ensure this result; one known as CHESTER'S SEMI-ROTATING hatcher (plate IV, fig. 24) is thus described:—This consists of a tin cylinder, 18 inches in diameter, and 24 inches deep; with four rectangular openings, each 2½ inches wide, extending from near the bottom to within 5 inches of the top. These and the bottom of the cylinder are covered with wire-cloth, to prevent the eggs from escaping, or the dirt from entering. On the outside of the cylinder, along one side of either opening, are placed strips or pockets of tin, at an angle with the side, and extending partially over the openings, so that the adjacent pockets face in opposite directions. As the cylinder rotates on its axis, the water is forced in at the two opposite openings and out at the others. Beneath the wire-cloth bottom are four more strips of tin, radiating from the centre, and placed at such an angle that the rotation of the cylinder presses the water against them and up through the bottom. The whole is placed in a trough nearly filled with constantly-changing water, and sunk to such a depth that the water nearly fills it. The cylinder turns on a pivot, the power being supplied from the engine by means of shafting, to a horizontal arm firmly fixed to its axis, and is kept constantly turning back and forth through an arc of 90°, thus keeping the water changing, and giving the eggs a tendency towards the top centre. With this process fairly good results have been obtained. The time required for the development of the eggs varied greatly, being considerably affected by the temperature of the surrounding water. Of those of the cod taken on November 13th the first hatched in thirteen days, while some of those secured on December 17th required fifty-one days.

It was found that spawning fish could be collected off the American coast with little difficulty, and brought to the harbour alive in a common welled smack, and then transferred to the hatchery, where, if necessary, they can remain to ripen, and thus hundreds of millions of eggs can be secured in a single season. The young hatch well, and appear hardy ; and, as observed from the ovaries of 25 good-sized cod-fishes, if all the eggs were hatched, would furnish more fish in number than are captured in one year by the combined fleets of cod fishermen from all the different fishing ports in the United States during the most prosperous season.

WAVE HATCHING-BOX. (Plate II, fig. 13.)—A rectangular box, with a wire-cloth bottom and openings covered with the same material on the sides. Just below these, on the outside of the box, are wooden strips which serve as floats for holding the box in the proper position in the water.

Length, 32 inches; width, 17 inches; depth, 16 inches; float, 3 inches wide.

This box is employed in open streams for utilising currents caused by the action of the waves. The box, when placed in the water, sinks to such a depth that the floats which extend around its exterior rests upon its surface. The upper portions of these floats make a slight angle with the surface, so that each wave as it comes in contact with the float runs up a slight incline, and after reaching the highest point, passes down into the box, thus giving a constant circulation, and the best possible motion to floating eggs. The original form of box was supported by hollow air-tight tin cylinders, as shown in plate II, fig. 10.

BRACKETT'S HATCHING-BOX. (Plate I, fig. 4.)—A rectangular box of wood, the front end of which slopes inward at an angle of 45° for the purpose of deflecting the current. The bottom is covered with wire-cloth, and the water is forced through it by means of a tide-strip attached to its further edge.

Length, 22 inches; width, 20 inches; depth, 12 inches.

BRYAM'S FISH-HATCHING BOX (plate II, figs. 11 & 12) may be employed in shallows, or in stormy and agitated waters. It has its riding or breasting end inclined and supported upon the surface of the water by floats, at right angles to the length of the box.

PARKER'S ROTATING HATCHER.—A windlass connected with a system of cog-wheels, which communicate motion to the hatching-cylinder by means of an endless chain. The cylinder is made of perforated tin and wire-cloth, to admit of a free circulation of water. On the inside, suspended from the axis, is a small basket or trough which contains the eggs. Diameter of hatching-cylinder, 10 inches; width, 4 inches.

The motion is communicated to the windlass, and thence through the clock-work to the hatching-cylinder, by means of a weight which is suspended from the end of the windlass rope. The weight is raised by means of a crank attached to the windlass, and the distance through which it falls is considerably shortened by the use of compound pulleys.

AUTOMATIC TRANSPORTATION CAN.—A cylindrical can of copper, with contracting neck to prevent slushing, and a movable cover, the centre of which contains a brass plate with tubular openings, through which the water enters and escapes. Height, 18 inches; diameter, 14 inches.

To the inner end of the outflow-pipe is attached a wire frame, covered with cloth, which serves as a strainer to prevent the escape of the fish. The outer end of the other tube communicates with a reservoir of water by means of rubber tubing. When several cans are fed by the same reservoir they are placed side by side, and so connected that the water passes readily from one to the other.

The eggs of pollack (*Gadus pollachius*) have been likewise artificially treated in the United States; although they float similarly to those of the cod, they are smaller, and appear to develop more rapidly, hatching at most in five or six days with water of the ordinary temperature. A 23½ lb. fish had over 4,000,000 eggs; and a 13 lb., 2,500,000.

Haddock's eggs were hatched in 8 or 9 days in a floating box.

Herring's eggs adhere to any substance they are first brought into contact with. Consequently they should at once be placed in the situation it is proposed they shall remain until hatched. Up to now the young placed in artificial hatcheries have been found to die after the absorption of the yolk sac.

In the Exhibition is an apparatus for hatching DEEP SEA FLOATING EGGS (plate IV, figs. 23 & 29), invented by Mr. Oldham Chambers upon the same principle as the "Thorough" Vase for rearing trout fry, with this exception, that the supply pipes are perpendicular and perforated not only at an angle of 45 degrees, but with an upward tendency, thus assisting the ova to float during the period of incubation.

This apparatus is intended for hatching the eggs of the cod.

Mr. Oldham Chambers also exhibits an apparatus for hatching DEEP SEA ADHESIVE EGGS (plate IV, fig. 27), such as the herring, consisting of an oblong box about 5 feet in length, 2 feet in width, and 1 foot in depth, in which are placed screens covered with muslin, upon which the ova are deposited, and the sea-water passes through the box.

MARINE VIVARIA.

Among subjects well worthy the attention of fish-culturists are the formation of vivaria for the reception of marine fishes, so that a constant supply for the market would be available, even at such periods when gales preclude the sea-fishermen from carrying on their occupation. These vivaria may be either entirely supplied with salt water by tidal influence, or they may be lakes wherein the lower portion consists of salt or brackish water and the upper of fresh, being even fed by a stream. In order to be a pecuniary success the necessary food should be obtain-able in the vicinity at a cheap cost, whether such be shell-fish, fish, meat offal, or manufactured substances. Likewise, if an insufficient local demand for fish is present, the means of inexpensive and easy carriage to a suitable market should exist. Several such vivaria have been formed on a small scale around the British Isles, at various times by different individuals.

Parnell drew attention to a salt-water vivarium for fish near North Queensferry, where a number of marine forms were kept in a pond about 200 feet long and five fathoms deep, and into which the tide ebbed and flowed twice daily. All the fish appeared to thrive well, especially the cod, which were found to be firmer in the flesh and thicker across the shoulders than those obtained in the Firth of Forth. Yarrell also alluded to similarly formed vivaria as existent in the Orkneys and in Fife. At Port Logan, in Wigtonshire, an excavation existed in the rock about fifty feet in diameter, while at low tides about eight feet of water remained in the basin and an additional six feet at high tides. Here cod thrive and are always available for the table. In these vivaria it is necessary to regularly feed the fish.

The Romans were accustomed to keep fish for the table in large vivaria, some of which were supplied with salt, others with fresh water; the former, however, were so expensive as to be only within the means of the wealthy. As time went on, these stews appear to have been frequently kept by their owners as a source of profit, and various modifications from time to time were introduced, during the course of which it seems to have been ascertained that many marine forms could be accustomed to a fresh-water state of existence.

This phenomenon of marine fishes changing their condition of life, so that they become either temporary or permanently occupants of fresh water, has for centuries attracted the attention of the fish-culturist, but owing to local circumstances it has, perhaps, been more remarked upon in tropical than in temperate climes. But even in this country we see the anadromous salmon, shad, flounder, and other fishes ascending our rivers for breeding purposes, and in fresh water the eggs of some are hatched, and the young salmon resides in streams until sufficiently old to adopt its parent's mode of life. This brings us to consider whether if marine forms enter fresh water, and their return to the sea is cut off, such an accident is necessarily fatal to their existence. In the brackish water of the Coum river, in Madras, half-beaks (*Hemiramphi*), mullets (*Mugilidæ*), and other marine fishes are captured months after the annual monsoon communication with the sea has been closed. Such changes are gradually effected, and do not appear to lead to any structural modifications in the animals affected. In short, some marine fishes may enter pieces of water which, losing their saline character, become brackish or even fresh, and such changes do not necessarily occasion their death, for they may thrive in such situations.

During the last few years particular attention has been directed to a similar phenomenon in northern Europe, but on a far wider scale. Certain sea fishes, as the four-horned bull-head (*Cottus quadricornis*), a marine sucker (*Liparis barbatus*), and a variety of the common herring, have been found in the northern portion of the Baltic, where that sea is least saline, while they appear to be entirely absent from its southern extremity, where their presence would naturally be expected, had they obtained an entrance from the German Ocean. The existence of these fishes in a comparatively leaner and smaller condition in the Baltic than is seen in their Arctic relatives, has been explained by supposing that they are the remnants of a fauna which formerly extended into the Glacial Ocean. During the later portion of the great ice age most of Finland and the middle of Sweden were submerged, while the Baltic, which was a Gulf of the Glacial Ocean, was closed at its southern extremity. As the Scandinavian continent has become elevated, the Baltic has been cut off from the Arctic Ocean by the northern portions of Norway and Finland, while to the south it has opened a communication with the German Ocean. Consequently its fishes are the descendants of its former glacial marine fauna, and not products of immigration through the Cattegat. These fishes still remain in the northern portion of the Baltic, as if inherited instinct told them that such was the direction in which their ancestors resided. And now the water is almost and at times quite drinkable, and these sea species have come to be residents in almost or quite fresh water.

The foregoing instances show how marine fishes may either voluntarily enter into and reside in fresh waters, as well as how they may be gradually acclimatised to such, provided the change is effected by degrees. Also that not only will some forms thrive, but they may even breed under these new conditions. It has often been observed that strictly marine predaceous fishes will follow anadromous forms from the sea long distances up rivers. I have captured the cock-up (*Lates calcarifer*) as far inland as Pegu, in British Burma; and when investigating the fishes of the Mahanuddi river in Orissa in 1867, I found a species of saw-fish (*Pristis Perrotteti*), up to four feet in length, and at least forty miles from its mouth, in perfectly sweet water, and beyond tidal influence. I likewise obtained others in the river at Pegu. The extension of this species has also been remarked elsewhere, for, in 1857, M. de La Gironnière found it inhabiting the fresh waters of the Laguna de Baij, Luzon, and so did Dr. Meyer in 1872. This last naturalist, having procured a series of examples, compared them with marine specimens from the bay of Manila, when an accurate examination showed no differences; the changed conditions of life had exercised no appreciable alteration in any of their external characters. In short, these fishes having entered rivers for predatory purposes, may voluntarily remain, or be involuntarily detained there, and consequently take up a permanent abode in this new locality, continuing their species in their new home without necessarily returning to the salt water.

The Earl of Ducie, in 1881, observed upon having spent two months in the Norwegian fjords in his steam yacht, that in Midgulen lake, 61° 43′ N. Lat. and 5° 53′ E. Long., he found pollack (*Gadus pollachius*) living in the fresh water. This lake is about five hundred yards from the sea, with which it is connected by a river averaging about twenty yards in width by three feet in depth. In another fjord, which contained fresh water, he took a cod, a coal-fish (*Gadus virens*), and a pollack, all at the inland end of the lake, the last fish being actually in a snow-water stream. The sea fish had complete possession of the lake, which, as in other instances, was entirely fresh.

In 1831 Mr. Arnold, of Guernsey, communicated to the Zoological Society of London some experiments which he had personally carried out in a five-acre lake of varying depth, having a muddy, gravelly, or rocky bottom, and which was principally filled with fresh water. Here for nine months in the year cattle came to drink, but in summer the water was too salt, due to a supply from the sea being received through a tunnel. Bass (*Labrax lupus*), grey mullets (*Mugilidæ*), turbot (*Rhombus maximus*), brill

(*R. lævis*), plaice (*Pleuronectes platessa*), soles (*Solea vulgaris*), and smelt (*Osmerus eperlanus*), were introduced and throve, while the mullet, it was remarked, bred as freely as if they resided in the sea, and Sir J. Gibson-Maitland has hatched numbers of this latter fish in his fisheries. Semper mentions that the grey mullets and the bass have been bred successfully for the market in the fresh-water lake of Acqua, near Padua. In 1881, being at Devonport, I was shown a most beautiful piece of water into which a small stream flowed from the adjacent high-lands, while, at its lower end, a tunnel communicated with the backwater, and through which saline water entered at high tides. A long weir prevented entrance of fish into or their exit from this lake, and here were many grey mullet and bass living and thriving.

In 1825 a communication was read before the Wernerian Society from Mr. Meynell, of Yarm in Yorkshire, recording how he had succeeded in retaining smelt or sparling in a fresh-water pond which did not communicate with the sea, and how they not only throve but bred for successive seasons. The sole will live and breed in fresh water; and on some having been retained in fresh, and others, of like weight, in saline water, the first at the end of a year were found to have increased at twice the rapidity of those which were kept in salt water. The flounder (*Pleuronectes flesus*) is so much esteemed by the Frieslanders that they naturalise it in fish-ponds. Mr. Bland, of Derriquim Castle, Kenmare Bay, had a vivarium constructed in an inlet guarded by reefs of rocks in Sneem harbour by means of a strong barrier of stones placed across the entrance, but through which every tide flowed and ebbed, leaving a sufficiency of water inside for the fish. Here mullets, whitings, bream (*Pagellus*) soles and plaice succeeded best; haddock likewise did well; but gurnards became pale in colour. Whitings were so tame as to feed out of the hand, and all the various forms assembled at feeding time on the appearance of the tray: they were particularly partial to potatoes.

Fish Passes.

Fish passes, commonly termed fish ladders, are constructions erected in rivers for the purpose of enabling fish to surmount or pass natural or artificial obstructions, which are either an hindrance to their attaining their spawning beds or impede their descent to the sea, and which are destitute of free gaps through which they might pass. For, as was most truly observed by the Royal Commissioners in 1860, "every fact elicited during our inquiry bears witness to the conclusion that an open river is the best for all, and that a recurrence to the ancient and clearly pronounced policy of this country, by the removal of obstructions from the water, is the sure and only road to the restoration of the fisheries." Passes, however efficient they may be, are not complete cures to the injuries inflicted by obstructions; for at these places, except in high floods, the gravid salmon will loiter when ascending the stream towards their spawning beds, and the kelt, while descending, will similarly hesitate some time, prior to trusting to this novel and suspicious mode of procedure, consequently protection should be afforded at these localities.

Fish passes, which may be constructed of wood, stone, concrete, or iron, can be subdivided into (1) such as assist the fish by means of ladder-steps, or a series of pools, to pass over the obstacle; or (2) by means of a succession of locks to pass through the obstruction.

About the year 1830, Mr. Smith, of Deanston, invented a salmon ladder, the principle of which he explained to a Select

Committee of the Houses of Commons in 1836. The dimensions of this ladder were as follows: Height of weir, 10 feet; width of ladder at top, 11 feet; length of ladder, 240 feet; ope of ladder, 11 feet by 1 foot; width at foot, 24 feet; breakwater, high, 1 foot; side walls, high, 1½ foot; incline, 1 in 24 feet.

There are not a few sanctioned passes in this country which the fish still persistently refuse to make use of, due in some instances to the steep gradient on which they have been constructed. Good authorities have considered that as a rule the incline should not be more than 1 in 8 feet for an effective salmon ladder.

The passes which have been proposed for assisting fish to ascend through the body of an obstruction are few in number, and scarcely in favour at present, but possibly they have a better future in store for them.

The first proposition of this description which I can find is as follows: In a report made to the Madras Government (1868) from Surgeon Major F. Day respecting fisheries and the weirs across Indian rivers, and proposing employing their under-sluices and vents as fish passes, plans and descriptions were printed and circulated in January 1871. It was suggested employing the vents of the under-sluices as passes, by turning them into a species of lock. Modifications for the purpose of preventing too great a dash of water into these locks were shown to be necessary, while it was stated, that one having been constructed on the scale of an inch to a foot when in England, and having been properly fixed in a stream, some gold carp were tried, and three passed through. A model of the first invention, constructed with the kind assistance of Mr. Mostyn Owen, was placed in the Buckland Museum in 1869.

The Cail "lock-swimming salmon pass" was first described before the British Association in the autumn of 1872, in which year it was designed, the inventor claiming that by its means fish can be taken up falls in every river, however high. The principle, as shown in Mr. Cail's first drawing, planned to overcome a 12 foot dam is by forming a series of locks having a rise of 18 inches each, which, with two extra for floods and freshlets, equals 15 feet level with the highest flood line. Although these locks may be constructed as small as 5 feet square, Mr. Cail prefers them larger, and 3 feet deep. The bottom lock is the largest, while the pass should be designed as to its size, form, and direction of the chambers to suit the nature and form of the ground, while the entrance should be as near to where the fish congregate as possible.

On a similiar principle an upright stair is designed for places where the river banks are not suitable for continuing locks horizontally, but where the water is closed by steep rocky sides at the fall, and where a space can be got in a corner to build a 12 feet square pass, having the lock made either square or by constructing the divisions diagonally across to make the locks triangular. Should the rise of the lock be 16 or 18 inches, it affords abundance of height to carry the locks over each other to any height; and it can be turned on to the bank by a trough, when required, and taken round beyond the obstruction, whether natural or artificial, to the high water. He observes that in these locks "the only current of any consequence is confined to a short space at each opening (or inlet), and is there moderate, with a head of 18 inches, and only extending for a few inches on each side of the opening, all the other parts of each lock being nearly still or quiescent."

Diseases of Fish.

Fish are subject to epidemic, endemic, and fungoid diseases, as well as to many other causes or conditions which have a deleterious effect upon their health. These abnormal destructive influences may be (1) consequent upon a poisoned condition of the water; (2) atmospheric conditions and accidental causes; (3) diseases by which they are affected, including those of the ova stage and infancy; (4) fishermen's and poachers' energies, including the injuries occasioned by vermin.

Beginning with how fish are poisoned by the condition of the water in which they reside, the following primary subdivision of the subject may be adopted. This poisoning may be virulent and *direct*, due to its immediate effects upon fish life, or else it may be mechanical, as in cases where the presence of mud chokes the gills, and occasions suffocation. Or it may be *indirect* by causing the destruction of the living food which exists in the water, or by occasioning or assisting an unhealthy condition of the fish which reside therein; this latter, however, will more appropriately find a place while discussing diseases and their cause.

Commencing with the fresh waters directly destructive to fish life, due to their noxious condition, we find many gradations of impurities. Thus, in May 1865, large quantities of fish were found dead in the Roden, near Wem, in Shropshire, due to an old *gas tank* having been drained into a sewer which emptied itself into the river. The fish were dead for miles, the bottom of the river being literally strewed with them, not a single one being seen alive. In the Teign great destruction of the finny tribe was perceived, due, it was believed, to the presence of *mine-water;* and the county analyst found that sulphuric acid and sulphate of iron largely abounded in the stream. A minnow (*Leuciscus phoxinus*) and a rudd (*L. erythrophthalmus*) were placed in about a pint of water taken from the river near where the stream joins it coming from the Wheal Exmouth Mine. On immersion, they became very agitated, swimming here and there with great rapidity, and springing out of the water. Then their eyes appeared to become distended, they swam on the surface, and in about ten minutes the poor little minnow sank to the bottom and lay on its side. The rudd was likewise affected, and death terminated their sufferings within the hour. Some others were immersed for the brief space of three minutes in water taken from the Teign, and then removed to some clear good water, but they never rallied, and three hours subsequently were found to be dead. *Chloride of lime* is largely employed by poachers in order to poison fish, and scarcely a month passes but that a notice may be read in the police reports of some one having been punished for this offence. But this proceeding may be legalised, provided it is done in a wholesale manner ; thus we are informed that the proprietors of the great paper-mills on the Cray river have obtained a special Act of Parliament, freeing them from any penalties which might be incurred from pouring the self-same substance into the stream. The noxious character of the refuse of paper-mills, dye-works, and bleaching-grounds, are unfortunately but too well known, and mostly permitted to continue poisoning rivers, to the partial, and in some places, total annihilation of the fish, as well as affecting the health of human beings or cattle which may incautiously partake of the apparently limpid stream. But this poisoning, though sufficient to kill some forms, may not do so to all, dependent upon the amount and virulence of what is discharged: young fish are first affected; then members of the salmon or trout family; next carp; and least of all the common gudgeon, which will live in very polluted liquor, so it is generally produced in Court by the counsel for the defence of pollutions, swimming about in some of the suspected water, and shown as a proof to the judge and jury how unfounded a charge has been raised.

Artificial root manure, which is formed of bones dissolved in sulphuric acid, has been observed to injure fisheries. From three to five cwt. an acre are necessary, and should this be employed in a field sloping down to a river, and a severe thunderstorm set in just after it has been spread, the surface rain-water which runs off to the river becomes impregnated with it, and that to the certain injury of the fish, and probably the destruction of much of their food. Sheep-dipping has likewise the same effect the *dip* being poisonous to fish. In East Prussia, in 1879, a brewer having about 300 tons of beer unfit for consumption allowed the mass to run off into a pond, with the result of poisoning the contained fish.

I have in India observed rivers flooded at the first burst of the monsoon, and stagnant waters have been washed into them, destroying every living fish, evidently due to some poisonous substance which they contained. I have also seen the flooded Bowany river charged with mud, and many sorts of fish lying dead on its banks, and floating down the current. Natives will likewise throw a dam across a sluggish stream, then by stirring up the mud the fishes will become choked, which causes them to come to the surface to breathe. In Ireland I have seen much the same effect produced from a somewhat similar cause: the season was hot, the water low, some cattle went into a pool formed by a small stream in order to drink, while moving about they so mudded the water that two trout came to the surface nearly suffocated. The grayling, formerly abundant in the Aire, in Yorkshire, were all destroyed in 1824 by the bursting of a peat bog, which became discharged into the river.

The instances which I have adduced demonstrate how noxious and poisonous ingredients finding their way into ponds and sluggish rivers may be immediately destructive to fish life, although not so rapidly to some forms as to others; while the Teign experiment goes to prove that poisons may be imbibed in sufficient quantities to take away life, although the fish has been but a few minutes in the polluted river water, and subsequently transferred to such as is perfectly pure. Floods and waters having large quantities of mud in solution, would seem, in some cases at least, to occasion death by choking the fishes' delicate gills, and thus preventing respiration from being carried on.

It seems probable that steam-boats on rivers do a considerable amount of injury to fisheries; not solely by discharging their noxious residue into the stream, but by constantly keeping up a wash they disturb the banks and the spawn, injuring or even killing the fry, by leaving them in hundreds to perish on the banks on to which they have been washed. Due partly to the great increase of population, and a disinclination to interfere with the employers of labour, some of our rivers, especially near their mouths, may be likened to enormous drains, with the result as seen in the Thames of destroying entire species of fish, as the salmon, which cannot now be said to exist there in a state of nature. For to such an extent are noxious substances discharged into our watercourses, that even in some which are moderately rapid, the poison possesses sufficient virulence to cause immediate death to any fish which come within the influence of its agency. Occasional floods clear out the waterway in some rivers, while the mouths of drainage pipes are commonly near the banks, and thus the salmon has a chance of ascending, provided it keeps to the centre of the stream. But the fry mostly keep more to the shallows, and along the margins, and consequently when they are descending to tidal waters they have to pass through the most impure portions of the stream, which, if it does not destroy many, must render them in such a sickly condition as to fall an easy prey to the predacious forms of fishes and fish-eating animals, which lurk about the estuaries of rivers. The results of Hoffmeister's experiments in Germany upon the effects of sewer-matter upon fish tend to show the noxious character of chlorine, and of manufacturing refuse in which sulphur exists. When water was mixed with these substances, the fish placed in it turned on their sides and displayed signs of approaching death, but some recover if removed to fresh water, others do not. Resistance to impurities increases with the size of the fish, and their sensibility to free acid and alkalies is small, but quicksilver and salt of copper are rapidly injurious to them. Salts of iron and alumina act in various ways, according to the character of the fishes operated upon, carp possessing ten times the resisting power of trout. Small quantities of chloride of calcium were found to have no injurious effect upon trout, even after several hours' trial. The higher the temperature the greater the noxious effects of substances of a poisonous nature; consequently fishes can exist during winter months in impure water longer than they are able to do in summer.

Sawdust in rivers, from the time of Pontoppidan until the present, has been deemed deleterious to salmon fisheries. It is said to subside in rivers, filling the place where fish eggs ought to develop with impure and injurious matter, occasioning a fatal fungus.

Passing on from fresh to saline waters we find that both the direct and indirect causes of destruction present in ponds, canals, and rivers, may likewise be in operation in the sea, the water of which may be so noxious as to at once destroy the residents, certain forms succumbing more rapidly than others. Also the food upon which the fish subsist may be diminished, due to some extraneous cause, rendering the locality totally or partially unable to support the shoals which generally arrive at certain seasons, in order to obtain food or seek a locality which they may deem desirable for the continuation of their species. Poisonings of the sea-water for hundreds of miles in extent are known to occur off the coast of India, but such phenomenon have not been observed in our seas of late years; but in a Parliamentary report into the state of the Salmon Fisheries, in 1825, it is stated that 30 years previously, so great was the mortality among certain fish, that ships sailed through many leagues of the North Sea where the surface was covered with dead haddock.

I will now pass on to the second subject of causes of destruction, or such as are due to atmospheric conditions and accidental influences. A low temperature has frequently been observed to be disastrous to some of the finny tribes, sand smelts (*Atherina*), surprised by a sudden frost in the shallow waters of a harbour, have been killed in numbers. Congers are very sensitive to cold, at which times they become what is commonly known as "blown," and float on the surface nearly or quite dead. Near Cork, in 1841, many died due to frost, and others were easily captured, although the water was from 40 to 60 feet deep, and brackish; while there are many recorded instances of eels and other fish succumbing due to excessive cold. On the other hand, some forms will recover after they have been apparently frozen; thus, Mr. Wright observed, in 1866, that during a very severe frost, a few winters ago, some gudgeons, which had been kept in a fish-can filled with water, became completely frozen into literally a mass of ice; believing them to be dead, they were flung on to a manure heap, and slightly covered by straw. A few hours subsequently they were found to be alive and brisk. Thirty-five gold-fish were in a pond at Dumfries, which was 3 feet deep; this was frozen into one solid mass, subsequently the fish were thawed out, and twenty-five entirely recovered. Livingston Stone remarked having repeatedly witnessed the resuscitation of frozen trout, pickerel, and perch, on thawing them out in fresh running water, even after they had been carried for miles, but that it is only under certain circumstances that they will revive. If caught on a cloudy day, when it is freezing hard, provided they are not hurt by the hook, and they freeze immediately upon being thrown on the ice, they will revive on being thawed out. But if allowed to toss about in the sun, on a clear day, and probably not frozen for an hour or two after they are caught, they will not recover. Sir John Franklin, in his first overland journey to the Polar Seas, states that the fish froze as they were taken out of the nets, and in a short time became a solid mass of ice, and by a blow or two of the hatchet were easily split open, when the intestines were removed in one lump. If in this frozen state they were thawed before the fire they recover their animation. A carp was observed to recover after it had been apparently frozen thirty six hours. Experiments have shown that no animal completely frozen is susceptible of revivification, as freezing disorganises the blood; but animals may be surrounded by ice without being frozen themselves, unless the temperature is very low. During the winter of 1880–81 a great destruction of salmon ova occurred in Highland rivers and streams, through the displacement of spawning beds by masses of ice, which the severe frosts accumulated, and numbers of salmon were found dead imbedded in it.

Electrical disturbances may be the accidental cause of the death of fish in tropical countries ; hail and thunderstorms united will sometimes depopulate rivers. In 1879 the occupants of a small fish-pond in the Duchy of Nassau were destroyed by a flash of lightning, on the following morning all being observed dead on the surface, and presenting the appearance of having been half boiled. On July 7th, 1865, a flash of lightning struck a house in Hamburg, from which at about 200 feet distance, in a shady spot in the garden, and in the open air, was a large fresh-water aquarium, containing forty-three fish, consisting of tench, carp, dace, roach, gold-fish, eels, and two species of loach, &c. At the moment the flash of lightning occurred, every one of these fish became suspended perpendicularly downwards in the water, with their tails at the surface, feebly and vainly attempting to swim towards the bottom of the tank, with all their fins strangely attenuated, as transparent as fine tissue-paper, and densely covered on both sides with myriads of fine air-bubbles, while their heads and bodies were not so covered. In less than half an hour forty-one were dead, strongly curved, almost in the form of semi-circles and already fast decomposing ; two gradually recovered upon being placed in running water. Direct heat on water may be very destructive to fish-life, not only among the young but also to adults. During the dry weather in the Orkneys, in 1882, the water in Loch

Harray, on the West Mainland, was reduced in volume, and rendered tepid by a succession of hot days. The trout assembled in shoals at the mouths of the burns, and were slaughtered in thousands by netting. Of course the coolest places were at spots where streams emptied themselves into the Loch. While there are few who have observed young fish being reared in ponds, but have not been made unpleasantly aware of the fact, that if the temperature rises above a certain point the fish die.

Gales are also occasionally destructive to fish, as on April 13th, 1874, when a violent one broke over Scilly, and large fish as conger, hake, ling, &c., were tossed about in their watery homes, and at last flung by hundreds on the rocks. Some were denuded of scales, others had their heads stove in, while even those which live at rocky bottoms fared no better than their neighbours. A high tide may prove mechanically destructive in a river; thus in October 1881, between Kew and Mortlake, a great quantity of small roach were left on shore by a receding tide; as many as three and four thousand were returned alive to the river. In Norfolk, it has been remarked, that should the salt water overflow localities generally filled by fresh water, the first fish to suffer are the pike, bream, and roach. Tench are nearly exempted, due to their remaining in the broads, to which sea water seldom extends, but, should it do so, they perish before the bream. Perch will bear a strong admixture, and eels seem to resist saline influence altogether.

PLATE I.

1. A. S. Collins' Fish Spawning Screen.
2. " " " , full view.
3. " " " , top.
4. Brackett's Hatching-box.
5. Lund's Hatching-box.
6. Slack's Hatching-Grill box.
7. Ricardo's Hatching-box for adhesive eggs.

PLATE·I

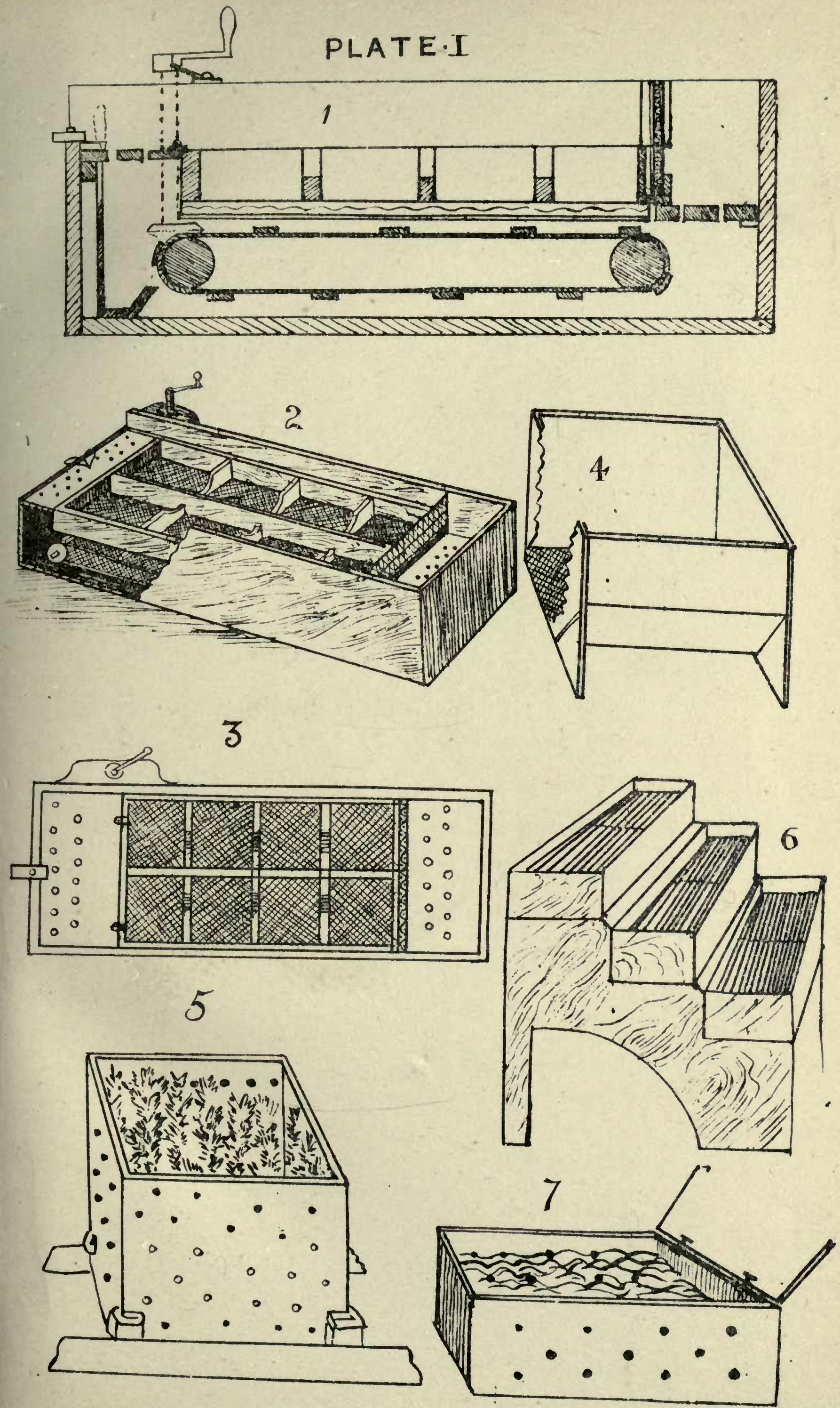

PLATE II.

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8. Sir Jas. Maitland, Bart., Howietoun Fisheries Hatching Grill.
9. Section of Grill, showing method of fixing glass tubes.
10. Hatching-box with air-tight tin tubes for support.
11. Bryan's Fish Hatching-box.
12. „ „ „ , top, showing outriggers, or supports.
13. Wave Hatching-box.
14. Chase's Hatching-jar.

PLATE II

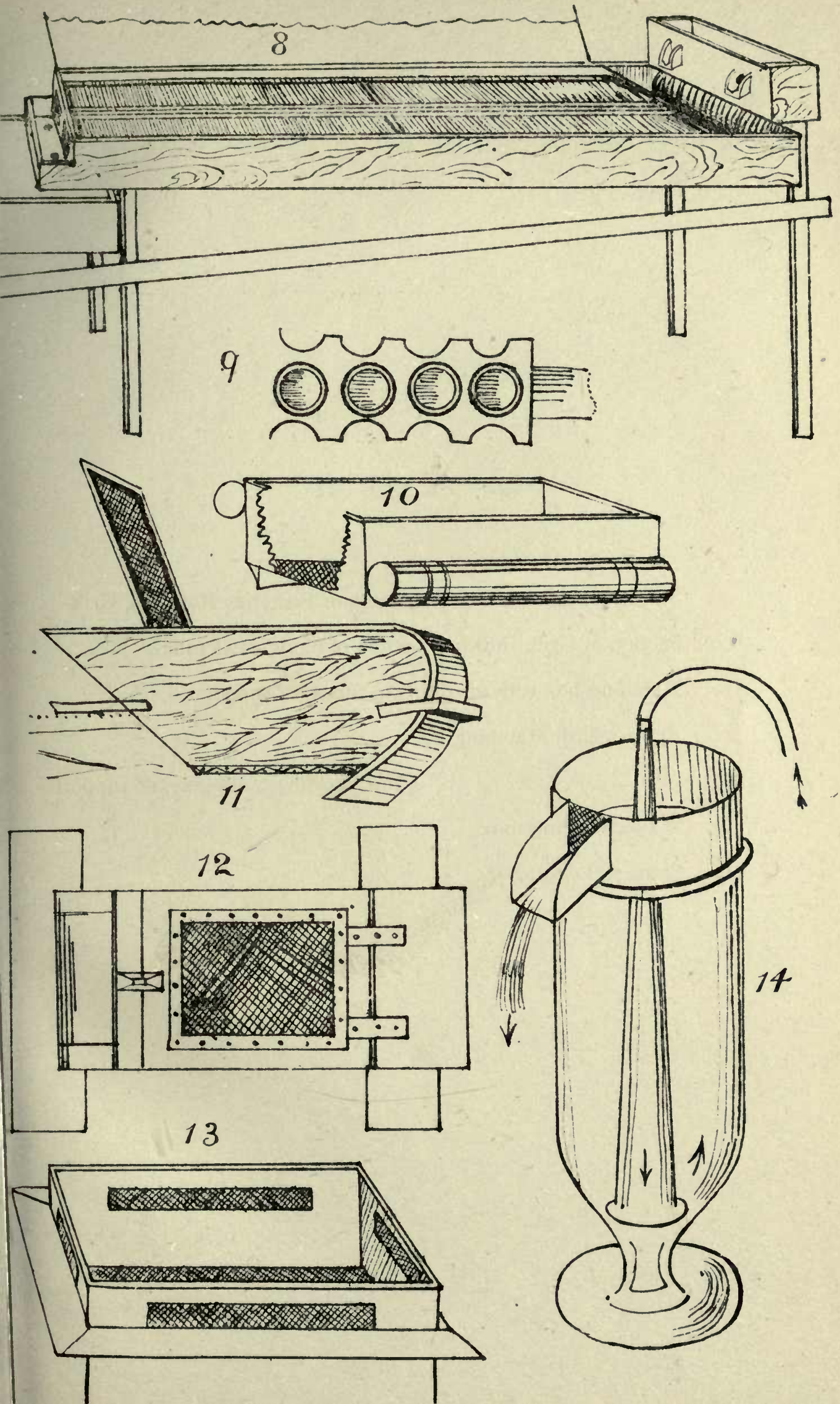

PLATE III.

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15. Ferguson's Plunging Buckets.

16. „ „ „ , section.

17. „ „ „ , machinery causing the slow rise and rapid fall of the buckets.

18. Wilmot's Hatching-jar.

19. Wright's submerged Hatching-box.

20. Ferguson's Hatching-jar.

20*a*. Fish Collecting Tank.

PLATE III.

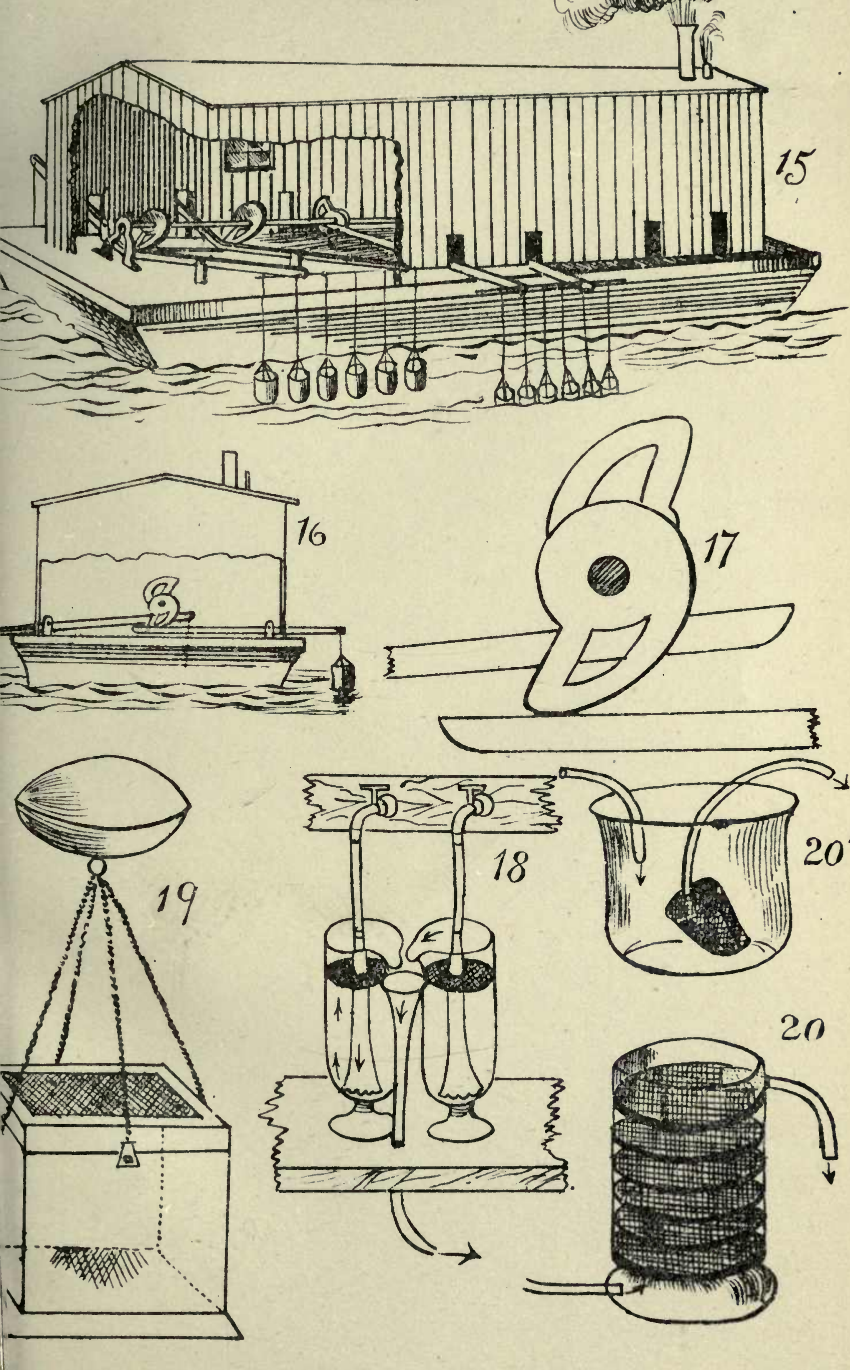

PLATE IV.

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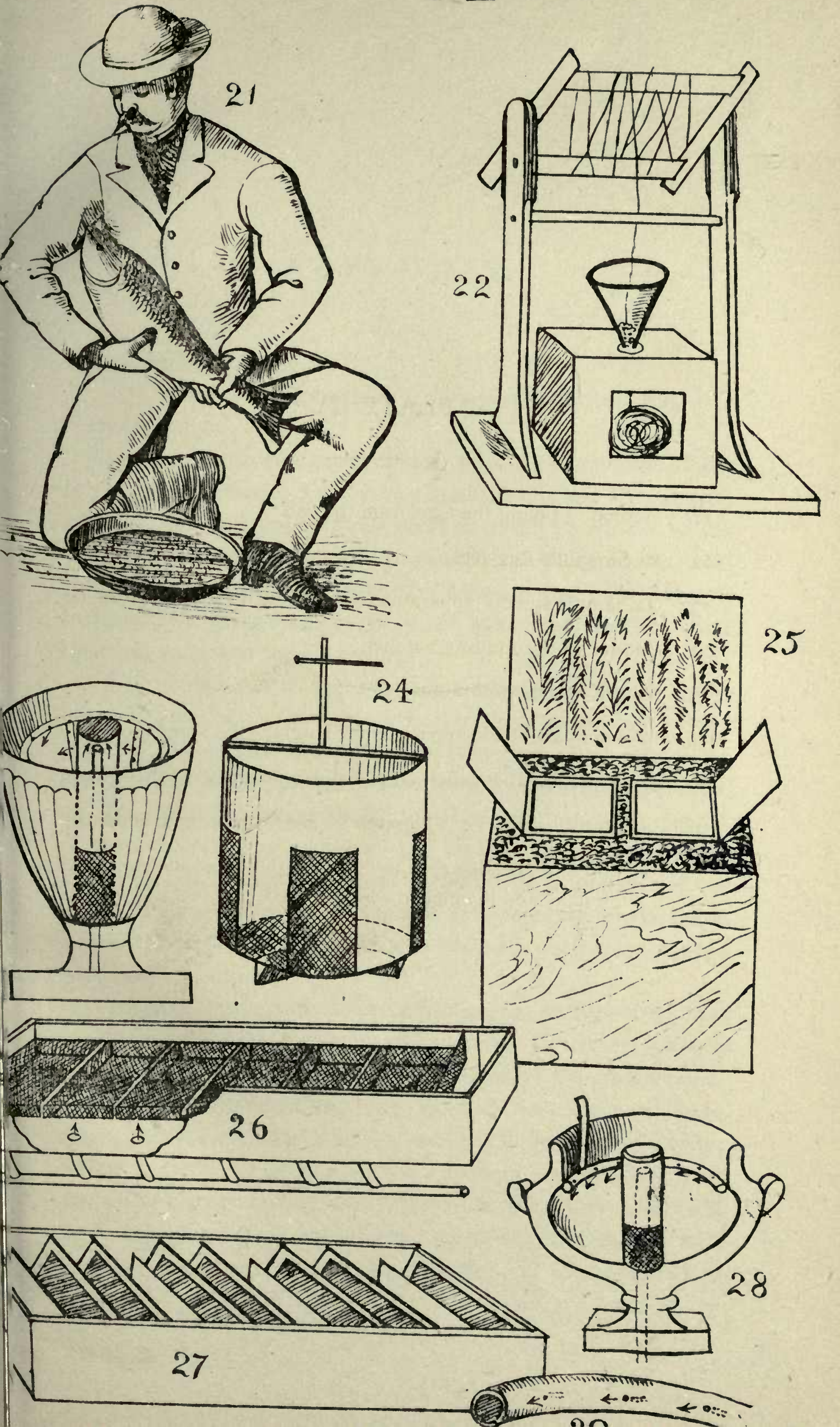
21. Method of taking the eggs from the fish.
22. Macdonald's Egg-reel.
23. Oldham Chambers' apparatus for hatching deep-sea floating eggs.
24. Chester's semi-rotating hatcher.
25. Atkins' transportation box.
26. Oldham Chambers' apparatus for hatching salmonidæ ova.
27. Oldham Chambers' method of hatching deep-sea adhesive eggs.
28. Oldham Chambers' "Thorough" Vase for rearing salmonidæ.
29. Section of the leaden pipe in "Thorough" Vase showing holes in the pipe, and manner in which the water is forced through the holes.

PLATE·IV



APPENDIX.

To the SECRETARY

Of the INTERNATIONAL FISHERIES EXHIBITION.

DEAR SIR,

"In compliance with the invitation from the Committee of the International Fisheries Exhibition contained in Class VI., Div. 61, I venture to send you a short account of an expedition to the Continent, undertaken in 1852, for the purpose of introducing into England several species of freshwater fishes, at that time unknown to it, viz., the golden tench, the pond loach, the scaleless carp, the royal carp, and the sly silurus.

"The golden tench (*Cyprinus tinca auratus*) of M. E. Bloch, but I believe only a variety of the common tench, yet a very beautiful variety and one easily maintained, was first introduced into England in the spring of 1852, from a place called Baredow, 25 miles from Breslau in Silesia, together with two other species of carp, the scaleless carp and the royal or *spiegel* carp, which latter fish is, I believe, a cross between the scaleless and the common carp. These were brought from the property of Baron Cloch who had more than 2000 acres of land, alternately cropped with corn and fish.

"To the same expedition two other species of fish were added in Berlin, viz., the pond loach, and the sly silurus (*Silurus glanis*), together with many more specimens of the golden tench.

"Through the friendship and valuable assistance of Baron Cloch and of Herr Max Rüdiger, and the kindness of the station master at Berlin, of Herr Shultz at Hamburg, and of the English captain of the 'Hamburg' and 'Hull' steamers, all went well with these fishes until they neared the English shore, when they were met by a thick fog. The captain alleging that he might be kept three days at sea, said with reluctance that he dared not supply any more water. Ice was plentifully used and the water kept aërated with a large long brass syringe with numerous fine holes. At length the fog lifted, and the captain seeing his way, graciously granted the fishes more water, and steamed into Hull.

"Meanwhile, the water was entirely renewed ready for the express train. The custom-house officers, either from excessive zeal in the performance of their duty, or from curiosity, insisted that the water should he turned out from two carboys and from two large tubs, that they might satisfy themselves there was nothing in them contraband! This cruel and unnecessary demand was resisted, and in the end with success, owing to the testimony of the passengers, and their indignant remonstrance, coupled with the fact that the largest tub containing three fine specimens of *Silurus glanis*, which had early died on the way, had been given to the mate of the steamer for his kind assistance.

"This tub was ordered to be new, but the cooper had used some staves from an old *wine* cask, and these fish being total abstainers resented the insult and died. But time had been wasted, the express train had been lost, and of consequence all previous arrangements for England were at an end.

"The fishes were knocked about from Hull to Peterborough in a goods train. The late Rev. John Fountaine happening to be on the platform when the train arrived there, two carboys were given him, one containing some pond loach, the other *three* golden tench; these he took with him and placed their contents in two separate ponds belonging to his brother, the late Andrew Fountaine of Narford Hall in Norfolk. The rest of the golden tench, the scaleless carp, and the royal carp were placed in a pond of three acres, a few miles from Norwich. The house and shooting on the estate were let to a gentleman with the exceptions of the above pond and the fish it contained, which were especially reserved to the landlord. However, the son of the tenant caught numbers of these fish, and a pike was put into the pond; so that years afterwards, when the pond was laid dry, the pike having been seen and shot, one single golden tench alone remained which was taken to Brooke. Two years after the *three* golden tench had been put into Mr. Fountaine's pond, one of them, a fine female full of ova, died. Great expectations rested on two individual fish, and hope suggested that they were a pair. Two years afterwards the pond was full of little golden tench.

"Years later, Colonel Joseph Hudson wished that some of these fish should be sent to London for the dinner of the Acclimatisation Society. They were sent, but only on the express conditions that they should *not* be eaten, but should be placed on the dinner table alive and in an aquarium, and afterwards put in a suitable pond to breed. Mr. Cook, the late Mr. Fountaine's gamekeeper, a truly honest man, delivered them in carboys at the Shoreditch Station into the charge of a man sent by the late Mr. Frank Buckland, who took them to the dinner. Some ot them were afterwards sent to Mr. Hickford Burr of Aldermaston Park, near Reading, where they bred.

"Mr. Fountaine also gave some to the Duke of Marlborough, who ordered that all instructions sent with them should be strictly carried out. But this was not done; and although the fish did splendidly at Blenheim for many months, when the frost broke up they were all found dead. No deep hole had been made in the pond in which they might hibernate. Mr. Fountaine also gave, about fourteen years ago, seven golden tench to the present Lord Walsingham, who placed them in a fine piece of water, fresh cleaned out and in every way admirably adapted for them. Some fine specimens were kindly sent by his lordship to the Fisheries Exhibition at Norwich. Large numbers of the progeny of the original seven have been also sent to the International Fisheries Exhibition by Lord Walsingham.

"Baron Cloch informed me that he had a few fish, a cross between the golden tench and the common carp. He clearly did not wish to give me any of them, and I had no desire to introduce a mongrel fish, feeling that the breed of fishes should be kept as pure as possible.

"The rest of the sly silurus were carried to Morton in Norfolk, and placed in a pond near the river Wensum. Two years the pond was dragged, and the fish found there. After a time, the grating which confined them was broken, and they got away into the river. Years afterwards one was seen by a labourer, who said he knew it was one of my fish by its worms, meaning the two long barbules which it has on its upper jaw and which reach nearly to the dorsal fin.

"The Danish Minister in Berlin took an interest in this expedition and kindly gave me a letter to be shown to any of his Government officials, ordering them not to delay the expedition, but to forward it to the utmost of their power.

"In 1853, application was made to the Custom House authorities in London for somewhat similar assistance, but it was refused, and no more expeditions were undertaken. This was regretted, as from the accumulated experience of many expeditions, multitudes of different species of fishes might, and would by this time have been acclimatised in England.

"Believe me, dear sir,

"Very faithfully yours.

"GEORGE DUCKETT BERNEY."

MORTON HALL, NORFOLK.
28th April, 1883.

ZOOLOGY AND FOOD FISHES

BY

GEORGE BOND HOWES

DEMONSTRATOR OF BIOLOGY

NORMAL SCHOOL OF SCIENCE, AND ROYAL SCHOOL OF MINES

SOUTH KENSINGTON

CONTENTS.

ZOOLOGY AND FOOD FISHES.

It may be safely said that there is no greater source of popular error than that arising out of the mere want of knowing the exact relations of a being to its surroundings. This is largely due to the fact, that the generality of mankind, absorbed in the cares of daily life, passes by unheeded things overlooked because always present.

As all human knowledge has been acquired by the exercise of ordinary powers of observation, no apology is needed here for their application to a familiar fish.

In one of the tanks of this exhibition there will be found the common Trout; admired by all for its beauty and delicacy, well known to the angler for its agility, and to the fisher by certain external features, it still bears for us all under the present circumstances a lesson of even greater importance. All science is cosmopolitan, and systematic working is demanded of its followers and advocates, in order that it may fulfil its purpose in the advancement of knowledge; to this end our little Trout is known to every Zoologist by the name of *Salmo fario*, that having been bestowed upon it by Linnæus, the father of our present system of nomenclature. While admiring the grace and elegance of the living animal, it may perhaps occur to some of us that it is just what we should imagine a fish ought to be—a thing with a pointed head and a long tail. True, but is this all? First, let it be noted that the body consists of three subdivisions—a head, a trunk, and a tail;

the latter is used as a propelling organ, and there is a total absence of anything like a neck. The object of this is at once apparent, as any irregularity in the surface of such an animal would be a serious obstacle to ease of progression. The mechanical propelling action is kept up by the tail, which is produced into a notched fin—the caudal fin—but it will be seen that the more delicate movements are regulated by the other fins, of which in this animal there are seven. A little in front of the middle of the body there is placed, on the back, the large anterior dorsal fin, and midway between it and the tip of the tail there is a small posterior dorsal fin; on the lower or ventral side of the body there occurs, in nearly the same position, a single anal fin, so called because it lies immediately behind the vent. If a line were drawn along the middle of the back for its whole length, it would coincide in position with these dorsal and ventral fins; they are therefore said to be median, as distinguished from the remaining four which are lateral and paired: this line would also subdivide the animal into two halves, each of which would be like the other, and such a creature is said to be bilaterally symmetrical. The paired fins then obviously correspond, in relation, to our own limbs, and they in fact represent them; the anterior or pectoral fins are placed, as they would be with us had we no neck, close behind the head; while the posterior or ventral fins are in position rather more than midway between the pectoral and anal ones. The body is seen to be clad for the greater part in small scales, which, however, do not cover the head and fins; it is of a whitish colour beneath, becoming greyish laterally, and getting darker as the back is reached; the head and body, in part, are spotted with black, and generally there occur also some yellowish or reddish spots upon the sides. As the Trout, in common with even man himself, has a habit of modifying its colour under change of circumstances, variation in this respect is not surprising.

Running along the side of the body is a streak, called by Zoologists the lateral line; it is a highly modified structure of the nature of an organ of sensation, and in all probability plays a more important part in the economy of the animal than is at present imagined. On examining the head, the large eyes are clearly visible, and midway between them and the tip of the snout there is seen on either side an aperture, which upon close inspection is found to be divided into two by an oblique fold of skin; this is the external nostril leading into the nasal chamber. There are no true eyelids present, but the skin is produced into a couple of transparent folds, which lie in front of and behind the eye respectively.

The only remaining parts in the living animal to be noted within the scope of these pages, are those concerning its respiration. The fish, in common with all living things, plant or animal, must have air, and as this is held in solution in the water, much as we should hold water in a sponge, the fish gets it by swallowing and squeezing, so to speak, the surrounding medium.

Immediately behind the mouth, on either side, is seen a movable flap—the operculum; its movements will be seen to follow immediately upon those of the mouth, and as under cover of it there lie the red gills, it is also called the gill cover. There exists a series of slits in the side of the neck between the gills, placing the cavity of the mouth in communication with the gill cavity, and so with the exterior; this being so, the animal on opening its mouth admits the water, the mouth is then closed, and the current of water, unable to find exit elsewhere, is forced out over and between the gills, the movements of the gill cover being partly due to the force of this outsetting current, and partly to a muscular effort. In order that the water may not pass down the throat, and so on into the stomach, the back of the former is closed; but more than this, for if carefully watched, it will be seen that the fish does not completely close its mouth, and that at every respiratory movement there appears between the jaws an apparent film, clear and almost transparent; this, which has been called the "veil or cross-membrane" among fishes, really consists of a couple of delicate folds of the lining of the mouth, so arranged that the water, in the very attempt to rush out in front, forces them into action to defeat its own purpose.*

These observations are about all that an inexperienced onlooker can turn to any scientific account, without the aid of anatomical knowledge; but a deal may be done by making good use of the power of observation in the ordinary course of life, and sufficient can be made out of the organization of a fish or other animal by merely pulling it about, if not in the exercise of the gastronomic function itself, to illustrate the leading facts of its structure.

Upon handling a fresh and uninjured Trout, the first noticeable thing is that whereas the body is soft and clothed in muscle or flesh, the head and its adjacent parts are hard and encased in a bony skull; the fins, too, are supported inside by a series of horny filaments or rays, and if put on the stretch, the scaleless skin which covers them will be seen to form a kind of web, while these fin-rays themselves fray out as they approach the edge of the fin. In front of and giving attachment to each of the paired fins can be felt a bony mass; that of the anterior is very large, and it—the shoulder girdle—runs up towards the skull, and forwards under the gills; the posterior one, on the contrary, is very

* This can be well seen in the Pike.

small, and runs parallel with its fellow, constituting the hip-girdle. The two correspond to our own shoulder blade and hip bone respectively. These several bones, together with the vertebral column, make up an internal or endo-skeleton, as distinguished from the scales which, forming an armour on the surface, constitute an external or exo-skeleton. Each of the scales, if raised, will be seen to both overlap and to be overlapped by its fellows, and while a delicate film of skin will be found connecting them together, a forcible pull is needed to displace one, which, like the drawing of a tooth, proves a close connection to exist between it and the underlying tissues. These latter, in a large fish, would show signs of rupture at that point to which the scale had been attached.

If the mouth is forced open, it will be seen that the two jaws are beset with a series of sharp teeth, which are distributed over the whole gape, extending as far back as the middle of the eye, while in addition there occur, on the roof of the mouth and on the tongue, certain sets of similar teeth, all of which are recurved and so arranged that when once the prey is seized, its struggles only serve to hold it the firmer. The folds of the veil or cross membrane already alluded to, can be seen to consist each of a backwardly directed flap of the lining membrane of the mouth, lying behind the teeth borne by the jaws, and so arranged that the water, in attempting to flow out whence it came, must of necessity force them in front of it, until meeting they stop its passage. If the gill cover be raised, there will be seen four complete gills, each supported on a bony base called the gill arch, while behind the last one there can be felt a small but similar arch, which bears no gill; like the rest, however, it has on its upper edge a series of horny filaments, the so-called gill-rakers, which are beset with minute teeth. Closely applied to the inner side of the gill-cover is a small gill-like structure; this is, as it appears to be, a reduced gill, known as the opercular gill or pseudobranchia. That which is called the "belly" of the fish, is in reality a large cavity—the body cavity—which, as can be readily seen, lodges all the visceral organs; its walls are made up of flesh, which is continued into the great muscles of the tail. Conspicuous among these internal organs is the large swim-bladder or air-bladder as it is at times called; it lies along the back, just under the spine, and is that which we familiarly call the "silvery streak" of the Herring. Immediately below this lies the alimentary canal, with its related structures; chief among these are the yellowish liver, with its bile-duct and gall-bladder, and certain finger-like organs, known as the pyloric appendages. It can easily be seen that this alimentary canal is a tube having thick muscular walls, and lined by a soft moist mucous membrane; at the point where these said processes are attached, there is a sudden change in its characters; the walls, which become thicker as you pass from the mouth, suddenly get thinner, and so a constriction or valve is formed; the portion between the mouth and this valve constitutes the œsophagus and stomach, and all between this and the vent is the proper intestine, which, it will be seen, does not pass straight out of the body at once, but is bent up before doing so. Attached to the hinder end of the stomach is the dark red spleen, and if on eviscerating a fish such as this a little care is taken to slit up the intestine, no difficulty will be found in ascertaining the nature of its contents. In the stomach we find more or less undigested food, perhaps but recently swallowed—some small worms it may be in this case, or what not; in the bent part of the intestine will most certainly be seen a whitish, pulpy looking mass, which, as we follow it back, becomes greenish, getting darker as the vent is approached, and in all probability will contain certain small pieces of solid matter, such as chips of twigs, small stones, or other similar structures. The alimentary canal then is but a long bent tube running through the body, beginning in the mouth and ending in the vent. If its contents are washed out, there can be seen in the Trout, in rather more than the last half of the straight portion, a series of circular folds, which project into its interior; they vary somewhat in shape, and really correspond in position to certain blood vessels in the intestinal wall. Such an arrangement as this is called an intestinal valve. If the swim-bladder is opened, its thin walls can be seen to enclose a large undivided cavity, filled with air, and in its front end is a large aperture, which opens by a short duct into the gullet. Suspended below this air sac are two whitish-yellow organs, which vary in size with the season of the year, being, in the Trout, largest about autumn; one is often larger than the other, and when ripe they constitute the roe; the "hard roe," consisting of a number of small "grains" as fishermen term them, is really the female reproductive organ, each grain being a small egg, and the "soft roe" is the male organ of generation.

Close under the spine, and running along the whole length of the body, are two dark-brownish organs—the kidneys; they are placed side by side, and lying along the face of each is a transparent tube—the kidney-duct or ureter; these two ducts unite and open behind the vent by a pore. In the female, immediately in front of and on either side of the vent is a small slit, which, as it places the body cavity in communication with the exterior, is called the abdominal pore; when ripe the roe is passed out or shed through its agency.

It must be noticed that when we remove the flesh, unless the animal has been first boiled, some force is needed to pull it away from the backbone; here lies the root of a most important matter, for while it is obvious that the bony skeleton protects certain important organs, it at the same time forms a support for the body, and also offers a surface of attachment for the flesh or muscles, by which the ordinary movements of the animal are maintained.

Ample opportunity is afforded us in almost every day of our lives, of observing that this backbone consists of a number of similar bodies which get smaller as the tail is reached, and that each of them is a bony nodule from which go off certain processes to either enclose or support important structures. The ends of each disc are excavated, so that between any two there is in life a space which encloses a gelatinous mass; as each of these bodies is called a vertebra, the whole series form what we know as the vertebral column.

As regards the head, the eyes have already been noted, and the nostril will be found to lead into a small sac—this is the organ of smell or olfactory organ. Our fish then can smell, and it is as certain that it can see, but at first sight we are at a loss to account for its marvellous powers of hearing. There can be felt through the skin close behind the eye a hard bony case, and if this is sliced, something is sure to be seen of a delicate but complex organ, enclosed within it; this is the auditory organ, and the well-known "ear stones," to which such wonders have been accredited medicinally, are contained within it. There are no visible "ears," such as those which characterize but so rarely adorn ourselves; but they only form part of the apparatus, and the truth is, that the fish has infinitely larger ears hidden inside its head than even we possess, but it has no trumpet-like arrangement with which to convey the sound directly to them like ourselves. How far this is true of all fishes we shall see in the sequel.

Inside the head a white pulpy mass can be found. It is small, and lies just behind the eyes and between the ears; it is that seat of cunning and deception called the brain; a complex structure it is true, and suffice it to say, that it does not fill the whole cavity in which it is lodged, and that if traced back it can be seen to be continued into a long white cord—the spinal marrow—or spinal cord, which runs along the back to the tail, and is protected as we have seen by the bones of the spine. Going off from some part of it can be seen certain delicate white cords or nerves, which are connected with all the organs of the body, and no difficulty can be found in making out at least the large one which enters the eye from behind. We thus see that the head bears the brain and organs of the higher senses which are closely connected with it, and it may be noted that these occur in the same order in the lowly fish as in the lordly man.

Summing up all this, we find that the body is made up of so many sets of organs, or systems as we call them; there are the skeletal, the muscular, the alimentary, the nervous, and so on, each of which has its own special function. If, however, any organ so far described, or any part of the body is examined, it will be seen to be more or less completely permeated by blood vessels, as the red colour of the sanguinary fluid shows; and in the living fish this can be most admirably seen in the gills, and at the bases of some of the fins. Immediately in front of the liver, and beneath the gills, there lies the heart, and all the various blood vessels are directly connected with each other and with it. This "wellspring of life" is for ever pumping on the vital fluid, which in its course passes from it through the gills, thence to every corner of the system, and back again to its portals. Sometimes palpitating, sometimes fluctuating, but never ceasing, this active organ sets us a noble example, with, at a low estimate, two and a half thousand-millions of pulsations during the life of a man of three score years and ten; performing work each day exceeding that required to raise 120 tons to a height of one foot.

Dismissing now the structure of the fish, let us consider the mutual relationships of the various systems detailed above. We all know that both a fish and a man must eat to live, although it often happens that one or other of them may reverse the process; we know that if starved we must perish, and so it is quite clear that this feeding propensity lies at the very root of the matter. Any one who has watched the natural movements of a fish or other animal, must be aware that throughout life a deal of waste matter is passed out of the body in one form or other, and it must have occurred to such an one, that it is to make good this waste that we eat.

It is characteristic of all living things, animal or vegetable, no matter of what they are composed—and this is often of much that is distasteful—that they consist in the main of carbon, hydrogen, oxygen, and nitrogen, which by their union form what are called proteinaceous substances. If, then, this process of waste is constantly going on, it must of necessity be the result of a breaking up of these, just as certainly as the loss of substance in ordinary wear and tear is due to a breaking up of that which is concerned. In the case of living things, in order to make this good, recourse must be had to the four constituents aforementioned, and it is one of the misfortunes of the life of an animal, that whereas the plant can manufacture its protein out of the soil, the animal, having no power of doing this, must get it ready made; and to this end it is that all that it eats was originally part of some other living thing.

Allusion has already been made to the contents of the alimentary canal of the Trout; but upon reflection, it is quite clear that in addition to the purely nutritive material, there must be taken into the system, by so voracious an animal, much that is not wanted; for instance, although the fish requires certain fatty and mineral substances in addition to the purely nutritive ones, it, on eating say a minnow, neither wants nor retains all its bones and hard parts, any more than would a man. Once in the system these must be got rid of, and while no man ever dreams of swallowing fish-bones or tea-leaves, it may not perhaps have occurred to many of us, that in discarding these and similar objects, we are doing by instinct, just that which nature is constantly doing for us unconsciously. As swallowed, the food-material is insoluble, and before it can be taken up into the system it must be broken up and rendered fit for use. The walls of the stomach have buried up in them certain glands, by the agency of which, together with that of the pancreas, when present, and the liver, this is effected, and a digestive process goes on. That milky-looking emulsion, found in the first part of the intestine of the Trout or any other animal, is food material thus acted upon, and as the intestinal walls contract it is forced through them much as you can squeeze mercury through a wash-leather. It is then taken up by the blood as it flows on, and is thus conveyed to the parts of the body as so much nutritive material; it is now as fully part of the animal as is its blood, and an assimilative stage is reached. The innutritious portions, not being taken up, because not dissolved, are now passed on, and together constitute the solid excreta, the characteristic colour of which is due to the admixture of the colouring matter of the bile. An excretive function is thus established; but it is only one form of such, for in its course through the body, the blood is for ever giving up the aforesaid nutritive material, and receiving in exchange waste products—products of decomposition—which are again drawn off from it, and finally cast out of the body as useless; their retention would in fact prove fatal. The kidneys are the leading organs which perform this duty, while that form of excretion going on in the gills is known as respiration or breathing.

As distinguished from these excretory processes, those going on in the liver and other glands, where the bile or a similar fluid is formed to be again used in the system, are known as secretions. These functions are all absolutely essential to the welfare of the individual; stoppage of them would cause death, and they are therefore said to be vital; there are certain others, however, hardly less important, chief among which is that of motion; moreover, if the living animal be watched, it will be seen that it also has the power of altering its course, and of doing numerous other things, which we cannot ascribe to any but an intelligent or at least a highly sensitive power—a power of control over its actions, in which even the highest animals are at times deficient.

One essential remains. The Trout, at all times timid and retiring, frequently rests by day under shelter of some shady spot, and its activity increases towards night; towards autumn, however, it seeks its fellows, activity is generally very great, and the conjoined efforts of the two sexes come into play for the furtherance of the species; the roe is shed, and a reproductive phase is reached. The creatures now live on, again to repeat these several processes, or, their course being ended, they pass away in what we call death. Looked at thus, the whole organism is but a machine, in which, from a material point of view, a constantly recurring cycle of changes is for ever going on, assimilation and waste perpetually at work. A balance in favour of assimilation results in the accumulation of nutritive material, and growth follows; while a balance in favour of waste leads on to failure on the part of one or more organs, and the body, no longer capable of concerted action, dies. This "natural death" or wasting is, however, not to be confounded with that which is the more common cause of death—destruction—which is really artificial, and due to the presence of a foreign element having no existence in the healthy system.*

We are now in a position to form a clear notion as to what a fish is, and of its relations to its surroundings. That which is true of it is equally true of all living beings, from man himself down to the smallest organism which our microscopes can reveal. Life is the sum of these several activities, and the reason for introducing any mention of them here is simply and solely because it is for the products of certain of them that we capture our fish.† For the maintenance of this "life," and the gratification of its manifold desires, our complicated trading systems exist.

Leaving now this physiological line of thought, it will be noted that our Trout is one of 9,000 or 10,000 species of animals, each of which agrees with its fellows in having a bony vertebral column, a bony gill cover, and in certain characteristic features of the bony skull, the gills, and other

* No better case can be here cited than that of the Salmon-disease.

† Certain special functions and their significance, will be dealt with in due course.

organs. For these reasons they are all classed together, and called the *Teleostei*, or bony-fishes. As we proceed further, we find that of these some 3,000 have an air-bladder which opens into the alimentary canal, and we therefore group them together and call them the *Physostomi*. Certain of these again exhibit characters in common; they differ very much in size, colour, and habit; some ascend the rivers merely to spawn, others live in deep water, while others never leave the river or lake in which they abound. Their internal anatomy differs somewhat, and while they agree on most points, there is a great diversity on others, as, for example, the number and size of the pyloric appendages. Still, they all have scaleless heads, the small second dorsal fin, and other characters in common; and while they are not the only fishes in existence which show one or other of these, it is still very convenient to associate them under one order, which, with the Salmon as its head or type, we call the *Salmonoidei*; it includes the allies of that animal, all the Trouts, the Truffs, Blue Polls, Chars, Polans, the Smelt, Grayling, and others. It will be observed that this result is the outcome of the comparison of a series of forms; certain features predominate, and we therefore speak of them as characteristic of the group; but as, in comparing any two forms, differences are to be found, our standard, although convenient, is artificial. Still, in accordance as any form differs from it, it is said to be modified; if, as in the case of the grey and the common Trout, the difference is slight, the one or other is said to be slightly modified; but if great, we say that it is highly modified. This branch of science is known as *Morphology*, and it is the expression of likeness and unlikeness; as will be seen, its teachings are in some respects purely tentative, and liable to be replaced as knowledge advances. They are none the less useful for working purposes however, and we will now apply them to certain characteristic forms of food fishes.

By such methods we create our species, genera, and so on, study of each of which shows to us evidence of an ever-present tendency to change, an ever-constant wrestling for power or precedence in the struggle for existence. Inability to cope with adversity leads on to extermination ; competency to do so results in survival, under changed circumstances—"the survival of the fittest."

The *Physostomi* include such valuable food fishes as the Herrings, Carps, Eels, the Pike, and their allies ; whatever variations may exist among them, they all have in common the open air-bladder, and excepting instances where the first dorsal or pectoral fins may be spinous, all the fin rays are soft and branching like those of the Trout already referred to.

Taking first the Herring tribe or *Clupeidæ*, which includes the Pilchards, Sardines, Sprats, Shad, Anchovies, Whitebait and others, we have to deal with shore-loving gregarious forms, whose bodies are covered with large scales, which on examination are seen to be smooth-edged, or cycloid as they are called, as distinguished from those which, having comb-like edges, are called ctenoid ; the head in these animals is scaleless or naked, and along the ventral side of the body the scales often assume the form of serrated bony plates. Unlike the members of the Salmon tribe they have but one dorsal fin, and as in them, the pelvic or ventral fins which lie vertically below this are said to be abdominal, while the pectoral fins are in their normal position. The notched tail is very short, the vent and single anal fin being placed far back. The eyes are large, and guarded by two folds of skin, as in the Salmons ; these are not true eyelids in the sense of those of the higher animals, although like them they are protective organs. So far as external characters go, therefore, they differ from the Salmons mainly in the absence of the second dorsal fin. When the mouth is examined, a marked difference is seen, for its supportlng bones are highly movable, and united together by a flexible integument, so arranged that on opening the mouth there is formed a sort of funnel. Their food consists of minute animals and small fish, and, like nearly all fishes, they swallow their prey whole; their teeth are reduced to a minimum, being either very small, or, as in the Shad and Anchovy, practically absent. The animal swallows its prey in great quantities, swimming on to it so to speak open-mouthed; as of necessity it must take in much that is not wanted, the gill-rakers are enormously enlarged and form a straining apparatus, through which, on closure of the mouth, the water and any useless material are drained off. All have pyloric appendages and gill-structures like the Salmons; the air-bladder, however, is strangely modified, for it opens behind the vent externally, and its duct communicates, not with the gullet as in the Trout, but with the stomach; no great skill is needed to see that this "silver streak" runs up into the head, and it there gets in among the bones of the skull, abutting against the parts of the ear in a very curious fashion.

Turning now to the Carp tribe or *Cyprinoids*, among which are found the Roach, Dace, Bream, Minnow, Rudd, and their allies, we come to a group of highly modified freshwater fishes. Externally they are much like the herrings, except that the body is generally more oval in shape. In the well-known Gold-fish and some others the dorsal fin is elongated, generally, however, the ventral fins lie just beneath its anterior end. Very often, that region of the body in front of these is shortened in proportion as the body is rounded. In some of the Breams, the body-cavity and vent are carried forwards, and with them the ventral fins, so that the anal fin, lengthened in proportion, comes to lie beneath the dorsal. Most of them have toothless jaws, and, with the exception of certain African Loaches, a large horny tooth at the back of the throat. Here are fishes wholly or mainly vegetable feeders, they have no jaw teeth, but as a crushing power is of service to them, the last pair of gill-arches—which do not, however, bear gills themselves—send in teeth, to meet which the skull sends down a ledge of bone into the roof of the mouth, which bears the large horny mass alluded to above. They have no pyloric appendages, but upon opening a Carp or Roach, one cannot fail to be struck with the large air-bladder ; it is subdivided into two chambers, the front one of which communicates with the alimentary canal by a long duct, and also with the ear, not, however, by sending up a process into the skull as in the Herring, but through the agency of certain small bones which become so modified as to form, between it and the ear, a chain of buffers.

The air-sac in most fishes is hydrostatic in function, that is, the animal has it in its power, either by the control of certain muscles or otherwise, to partially fill or empty it of the contained air or gas ; it thereby acts as a float or a balloon, altering the fish's specific gravity. It is no uncommon thing for this organ to rupture and burst, when, on being taken from the water, the animal is relieved from pressure. Although this hydrostatic function is that of the air-bladder originally, it is not its only one. Its tension in the Carps is most striking ; so fully distended is it that it will answer visibly to the touch of a hair, and as it is in close contact with the body wall and viscera, it is but fair to assume that it also serves to convey to the ear, by means of the structures just described, impulses originating in the motion of bodies in the water; the Carps and their allies all live in ponds, lakes, or shallow rivers, and the air-bladder, not needed for hydrostatic purposes, is here put to a new use. This change is correlated with life in shallow water, as the only other fishes which show it are either freshwater forms, or if they enter the sea are merely "coasters." One of such is the gigantic Sheat-Fish, a *Siluroid* which abounds in the Danube. Many fishes produce an audible sound on removal from and often in the water, and certain of these Siluroids have been called the "Fiddler Fishes" from the characters of the sound they produce; while many forms, either by the flapping of the gill cover, by the sudden expulsion of air from the air-bladder, or by certain other methods, produce these and similar sounds. It is only among the Siluroids that we find a special apparatus set apart for this purpose, and it may be that the accessory auditory apparatus is specially adapted in connection therewith.

The fact that in some of them the body wall thins where the air-bladder comes in contact with it, favours the supposition that it is related to the ear, as is the drum of that organ in the higher animals.

Any such apparatus would be advantageous, if only it could detect the presence of the voracious Pike. The characters of this freshwater demon are familiar to most people, and however man might regret it, its disappearance would be hailed by many valued fluviatile fishes. It is represented by the genus *Esox* alone, the massive well-set frame of which needs no comment here; we find the second dorsal fin again present, but this time in the absence of a first, while its long body bears the familiar abdominal ventral fins. In the head there are seen great changes;

the capacity of its mouth is well known, the nostril, instead of being at the extreme end of the snout, is placed a little in front of the eye, and it is clear, therefore, that the "running to jaw" which it exhibits is due, as in many other fishes, to an elongation of the pre-nasal portion of the head. Teeth of the most formidable kind are here everywhere present; jaws, tongue, gill-arches, and every available support, are alike pressed into the service; the terrible weapons have hinged and movable bases of attachment, and are so arranged that while they favour the entry of its prey, any attempt at escape is impossible, for they then fly up like so many harpoon blades, and hold it the firmer. Although certain of its teeth are fixed, this voracious animal in strictness hooks itself on to its prey, as indeed do many fishes; and considering this, the fact that it is at times choked in the attempt to devour a fish bigger than itself, or an animal beyond the capacity of its jaws, is easily explained, as is also the total absence of gill-rakers.* In that the pyloric appendages may be present or absent in species of a genus, their absence in the Pike is not surprising.

The only remaining Physostomous fishes which can be noted here are the Eels. Fishes with elongated Eel-like bodies occur in most of the great groups, but the Eels properly so called are the *Murænoids* of Zoology. The long-bodied, scaleless Conger, and its small scale-clad freshwater ally are familiar to all; but it may be noted that in

* Two specimens showing this will be found in the Western Galleries. The fishes were killed in attempting to swallow a duck and an eel respectively, and it will be seen that in the latter case the eel, by virtue of its shape, would most probably have escaped, had not the pike, in its greed, closed its jaws and thus brought its fixed teeth into play.

the latter the small scales are completely buried up in the thick skin. The vent is placed well back, the tail exceeding the body in length by but a little, the pectoral fins are small, while the ventral ones are wholly absent. The post-ocular region of the head is here elongated, and there is a large mouth, which in some Eels of the Tropical seas is carried back for an immense distance; teeth are present, and the upper jaw bones are partly united to the skull. The fins and gill cover are alike soft, and their supporting bones, though present, are reduced to a minimum. The gills are normal, and the gill covers unite with the body walls, so as to leave a small passage on either side, immediately in front of the pectoral fin. In some Eels this is carried further, and the two pores run together and form a single aperture on the under side of the head; and probably these and other modifications have to do with their sustaining powers on land. They are of a restless, wandering disposition; that which best characterizes them, however, is the continuity between the anal, caudal, and dorsal fins.

This same condition is seen in the young of other forms, the separate dorsal and anal fins being, in the adults, derived as the result of a breaking up of the at-first continuous fin. The Eel never breaks it up at all, and is in this respect a big baby, for which reason it is said to retain an early or embryonic condition. The retention of infantile characters, however, is no new thing in even the study of mankind. If carefully watched, there will be seen near the end of the tail a pulsating area—the so-called caudal heart; it is really an enlarged portion of the great lymphatic vessel of that region, which, owing to its size, gives rise to a visible pulse. The backbone of the eels usually consists of between 200 and 300 vertebræ, and stands at one extreme of the Teleostean series, at the opposite end of which are the

Coffer fishes, which never have more than 15; the Eels, however, are surpassed by some of the lower fishes in this respect. They have no pyloric appendages, and an abdominal pore is present. Perhaps into no subject affecting the fish-interests has more error ever crept than into the "Eel-question." The ancients, even Aristotle and Pliny were literally "at sea" here; spontaneous generation and hermaphroditism have alike been resorted to, in order to explain away the apparent anomalies concerning the propagation of this group; even to-day, the popular notion that they are mud-begotten finds favour. Early in the 17th century, an Italian physician, examining only the larger specimens from brackish water, first found the female roe; and although it was as well known then as now, that the old Eels went down to the sea while only young fry returned, neither he nor anyone had up to that time examined the smaller individuals, believing them to be young ones. But upon doing so some nine years ago, an Austrian naturalist succeeded in finding in them the corresponding male organ, like that of the female, necessarily immature at the time of observation. After strange oscillations between fact and fiction, the question stands thus: the ripening fish leave for the sea in the autumn, and after an absence of five or six weeks they spawn—in some cases on known mud banks; in the spring the young ones begin to come up the rivers, with an experience of some eight or ten weeks of marine life, to enter upon a fluviatile existence. The parents, however, do not appear, and the only supposition is that, like the Lampreys, they spawn and then die. First among the difficulties of actually demonstrating the ripened male organ, is that of capturing an Eel in the deep and open sea.

Compared with what is seen in the Salmons, this migration of the Eels is instructive. Among the former, we have animals, living in the sea, but finding it favourable to the welfare of the race to ascend the rivers to spawn ; this they do in a variable degree, but the Smelt, which usually ascends to freshwater from August to April or May, has been kept captive and healthy for years in inland ponds. The Eels present a case the exact reverse of this ; having already accustomed themselves to life in fresh water, they find it profitable, not to say absolutely necessary, to return to the sea to spawn.

Leaving now the bony fishes with an open air-bladder we come to the consideration of those in which, unless altogether absent, its connection with the alimentary canal is lost. These forms are known as the *Physoclisti.* Bearing in mind the fact that the connection did at one time exist, the distinction looses all value except as regards the adult fish ; it is, however, an exceedingly convenient one. These fishes fall under two great groups, sharply marked off from each other by the characters of their fins, which, within certain limits, are either soft or spinous.

Foremost among the soft-finned group or the *Anacanthini,* comes the Cod tribe or *Gadidæ,* which includes the Cod, Whiting, Haddock, Pollack, Coal fish, Hake, Ling, and their allies. The Ling is somewhat Eel-like in shape, while the Eel pout or Burbot, the only freshwater representative of the family, resembles the Eels in its habits. The true Cods are essentially northern forms, occurring at variable and sometimes at great depths ; they approach our shores during the winter to spawn, when they fall an easy prey, and are captured in immense numbers ; while throughout the whole year, they, in common with the smaller members of the family, are fished for on account of their great culinary value. They all have a heavy scale-clad body, with a large head, immovably fixed to the spinal column. Their fins, when compared with the Eel's or with those of the embryo, are exceedingly instructive. The dorsal fin is generally broken up into two or even three parts, and the anal fin into two ; but even where this is the case, the intervals between them, if present, are very slight, while the caudal fin, rarely notched, is generally rounded posteriorly. In some, the dorsal and anal fins are each represented by a single long fin, while in others there is practically present the continuous fin of the Eel. The tail is enormous and very powerful, and the body-cavity is proportionally small, the vent being carried very far forwards ; generally it—as in most Teleostei—and the anal fin lie vertically below the second dorsal fin ; rarely, however, it may be somewhat farther back, or, as in the Whitings, still farther forward. The pelvic fins are carried forwards with the shortened body-cavity, and, as they appear to lie in front of the pectorals, are said to be jugular. Nature, however, knows no such inversion as this, and on examination we find that the pelvic girdle is so small, that it comes to be lodged completely under cover of the immense shoulder-girdle, but still as surely behind it as in even our own case. With one exception, the fins of all the Anacanthini are supported by soft rays ; horny in texture, they fray out in a fan-shaped arrangement, each branch of which consists of a series of transversely-jointed filaments, each tapering off to a point. Very variable is the barb, present for example in the Cods and absent in the Whitings ; teeth are well developed, and there is a very large tongue present, which, like that of all fishes, is not gustatory in function. The customary four pairs of gills are present, while, as in many other Teleostei, the pseudo-branchia, instead of being gill-like, forms a rounded so called " glandular " mass. Pyloric appendages are always present, and in the Whiting there are one hundred and twenty of these, opening by but four apertures, and not singly as in the Trout. The air-bladder is, in the deep sea forms especially, marvellously strong and thick-walled ; on either side it sends off a process, which is coiled up alongside the skull but does not run into it as in the Herring ; in its interior there is present a large so-called gland, in reality a vascular network, through the agency of which a gaseous interchange goes on. The results of analyses of these gases are very remarkable, and their meaning is at present little understood. A large liver and a coiled intestine are present, while the roe, as in very many other forms, consists of two sac-like masses, which, uniting, form a duct which opens behind the vent by a small pore, and behind this again the kidney duct opens. There are no abdominal pores, such as are found in the Salmons and Eels.

Next in order comes the extraordinary group of Flat Fishes, the side swimmers or *Pleuronectidæ,* as they are named. Among them there exist such important food adjuncts as the Soles, Dabs, Brill, Flounders, Turbots, Plaice, and their allies. The indigenous British forms are all highly modified, and among those which at times reach our coasts, the large Halibut * approaches most nearly the typical fish type. Rarely scaleless, no member of this family lives at a great depth, and some are said to adapt themselves readily to fluviatile existence. They are all carnivorous, and live at the bottom, where they "flop" along in a highly characteristic fashion ; the tail moves horizontally, but still in the same plane as in other fishes, as regards the body. Obviously we have to deal with a highly-modified family, living on the sand, where they lie and so to speak suck in small forms of life ; unable to carry the flattened body in a

* Good specimens of this can be seen in the Canadian section.

vertical position, they dispense with the air-bladder, and thereby increase their specific gravity, and to this same end all the cavities are reduced to a minimum, the vent being carried as far forwards as it can get; the tail thereby becoming greatly enlarged, gives the animal as much solidity as is possible. Everyone knows that these creatures have their two eyes upturned, so that the body comes to lie on what is called its blind side; this, in common with the proper under or ventral side of most animals, is usually white, while the upper or exposed side is coloured. The real meaning of animal colouration is, at present, unsolved; it has been ascribed as due to surface energy and other causes, but whatever may be its origin, it certainly is protective in function. The variable colours of these Flat Fishes, like those of many other animals, either slow of movement or accustomed to periods of inactivity, are but so many disguises, under which they assume the characters of their surroundings; and while this may alter with changing circumstances, some of them go further, and develop certain tubercles on their bodies, which take on appearances of surrounding objects. Known as "protective mimicry," this arrangement obviously ensures the safety of the individual, if only by throwing any predaceous passer-by off the scent; it is to this same end that the Oar-fish, the Fishing Frog, the Sea-Blennies, and a host of other forms, have their bodies frayed, coloured, or ornamented.

In all, the ventral fins are jugular, and very often laterally compressed, so as to appear like a portion of the large anal fin; the pectoral fins are normal, in the Soles becoming very small, and in the variegated Sole that of the blind side, no longer of use, practically disappears. Teeth, in some wanting, may occur on both sides of a nearly symmetrical mouth, as in the Turbots, or on one side only of a more distorted mouth, as in the Plaice, and when present they are either very small or reduced to mere crushing organs; in both cases the nasal organs participate in the want of symmetry. The dorsal and anal fins form each an undivided tract, and the limb-girdles are approximated, and so arranged as to facilitate ease of motion of the great tail. Strange as are the modifications here set forth, the young fry have all the characters of ordinary fishes; they are free swimmers with symmetrical bodies, white beneath and coloured above and at the sides; as they become flattened, however, the eye of the blind side is carried round, distortion of the skull and other attendant changes take place, the pigment becomes restricted to one side only, and the adult and often completely discoidal condition is reached. These changes may affect either the right or the left side in different forms, as can be seen on comparing a Flounder and a Turbot; they occur before the dorsal fin has grown over the head, so that the eye is merely rotated on its axis. In one solitary case, however, the fin grows first, and the eye, loath to vanish altogether, forces its way through the head, thus realizing the apparent anomaly seen in the adult. Even the visceral organs do not escape distortion. If a Turbot, a Plaice, and a Sole, be examined in order, it will be found that in proportion as the body cavity is decreased in size—the vent being carried forwards—it sends into the tail a paired backwardly-directed process; the viscera which grow into these pouches completely fill them, and so space is economised. In the Plaice, the roe alone grows into these, and they are short; but in the Sole, where they extend back for two thirds the length of the body, that of the right side carries the intestines, that of the left a portion of the kidney, while both lodge the roe in addition. It is worthy of note that other heavy-tailed fishes, for example the Weaver, may do this, but less conspicuously.

The second great group of Physoclistous fishes constitutes a collection of some 4000, mostly marine forms, which vary enormously as to external features. Some are scaleless, in others the head and even the fins are scale-clad, and very often skin, scales, or fins, may be highly modified. In most the ventral fins are placed well forward, and in one or more of the fins the bony rays are produced into great spines, and no one who has watched the defence of its nest by a Stickleback, will need to be reminded that these are offensive as well as defensive in function. These fishes are therefore called the spined-fins or *Acanthopterygia*, and such indispensable food-forms as the Mackerels, Mullets, Perches, Gurnards, and their allies, are those which appeal to all fish eaters; while the Wrasses, Blennies, and Sticklebacks, find a host of admirers everywhere.

First then in importance come the Mackerels, or *Scomberoidei*, and their allies, usually of small size, though in the case of the hot-blooded Tunny * they may reach a length of ten feet.

The Mackerels are gregarious, restless surface-swimmers; their long bodies covered with small scales are everywhere familiar; the tail is so deeply notched that its two halves are capable of independent action, and all the fins are so articulated as to give ease of motion, the whole body being framed for rapidity of progression. The two eyelids found among fishes are here well marked, and the naked head is produced into an obvious pre-nasal growth. The fins are very curious; the pelvic members lie far forwards under the pectorals, and their position here shows that they are not necessarily associated with that of the vent, which is very

* A good example of this fish will be found in the Canadian section.

far back. The dorsal fins are very instructive ; the anterior one is placed far forwards ; between it and the second there is a break, and here again the second dorsal is over the first anal fin, while behind these there occur, both above and below, a series of five so-called "false fins" or "finlets." In the Stickleback, on the contrary, these finlets are in front of instead of behind the second dorsal fin ; and since in the Tunny the first dorsal is prolonged back to meet the second, the finlets occurring behind the latter, it is clear that all these and the caudal fin severally answer to the continuous fin of the Eels and of the embryo. This condition is realised in the viviparous Blenny of Scotland, and while among these Blennies, Perch, and Bass, we find approximations towards the Anacanth Type, we find in some Perch, Bream, Bass and others, that the dorsal fin remains uncleft. Among the Ruffs it is spinous for nearly its whole length. We thus see that among this group of fishes, there occur all grades of modification, both as to structure and continuity of the median fins. In the Sticklebacks, moreover, the ventral fins are reduced to the well-known "belly spine," while among them, as in the prolific Scad and others, certain of the body scales may also become spinous. If the Mackerel's mouth be examined, small teeth will be found, and those of the gill-arches lock back like the Pike's teeth ; as in the Soles and certain other fishes, we here meet with the strange phenomenon of a coloured mouth cavity ; shining and iridescent, a snare that may entice the Herring fry, and other small fishes upon which they feed, literally into the jaws of death. A very efficient straining apparatus exists, in the presence of a double series of rakers along the outermost gill-arch. The air-bladder, usually present, is in some of the tribe absent ; and the energy exhausted in giving the immense rapidity to their movements is accompanied, as in all similar cases, by a rapid oxidation and consequent increase in body temperature.

Certainly no less valued as food fishes are the Mullets. The Red and Grey Mullets of commerce are in no way related; and, taking first the Red or Sur Mullet—prized alike in their time by both Roman and Briton—this little fish, covered in its large, thin scales, is familiar for its two barbules and its rich colour, which, as fishers well know, intensifies with death. The mechanism by which this phenomenon is brought about is much like that giving rise to the "blush" of the Cuttle-fish; there are present (in this and certain other fishes), within the skin, small sacs filled with pigment, which under certain stimuli are brought into play; each sac is caused to expand, and the diffusion of the contained colouring matter gives rise to the characteristic tint. As to the barbules, inasmuch as when not in use or when the animal is threatened with danger they can be completely tucked away under the jaw apparatus, they are obviously of great importance to the animal's well being; these and similar structures are very variable, both in number and relation, among fishes, but from the above-named and other considerations they would appear to be sensory in function.

The Grey Mullets inhabit brackish water, and, unlike the Red Mullet, the head is scale-clad, the ventral fins are lodged well back, and, as rarely happens among bony fishes, the lateral line is absent. These Grey Mullets and others play among fishes the part of "the man with the muck rake:" active enough except when feeding, they at such times "gulp" in the mud on which they rest, hoping for the best. For this purpose there stretches between the bones of the upper jaw a flexible membrane, and the mouth is produced into a protrusible apparatus. The pre-nasal region of the head is excavated in order to receive this when at rest. Teeth are excessively small or absent, but those portions of the gill-arches which lie in the roof of the mouth are so modified as to form a straining apparatus, and the animal, taking in mud and all, by its agency sorts the "tares from the wheat," the latter being retained and the former ejected, but not until a final straining off has taken place through the very efficient gill-raker apparatus. In addition to the multitude of small organisms living at the bottom, the ever-recurring deaths at the surface bring about a constant subsidence of decomposing organic matter; and while such a fish as the Mullet does not, therefore, get a bad meal in the end, this process of decay is a factor in the food of fishes the importance of which is much underestimated. The alimentary canal of the Grey Mullet is modified accordingly, and as a deal of vegetable matter must be consumed, we find, as is often the case among vegetable-feeders, that the intestine is long and coiled; the stomach is powerful and gizzard-like, and pyloric appendages are present. An exceedingly curious and inexplicable feature is seen in this and many other fishes in the presence of a black pigment, giving the lining membrane of the body-cavity a sooty appearance; that membrane is usually somewhat pigmented among fishes, but in few animals is this extreme reached.

Among the Wrasses, a protrusible upper jaw (no uncommon thing among fishes) coexists with highly modified teeth, but in these "lip fishes" the apparatus is not suctorial.

The Perch tribe have already been noted incidentally. They are all highly modified forms, as is seen in the presence of scales on the median fins of some species; they include the Perches, Bass, and their allies. The true Perches, although essentially fluviatile, have marine representatives, and this, in the case of these highly modified forms, is interesting, seeing that there is every reason to believe that all freshwater fishes have been derived from marine ancestors. Their teeth are generally simple, and the ventral fins are placed far forward. It is to us perhaps no matter for surprise to find that even among fishes, the offensive faculty is here getting the mastery over the head, for the bones of the gill cover, taking the hint from the fins, are here produced into sharp and formidable spines. This armature of the head leads up to the condition which we find in the Gurnards, among food fishes. These animals, in some cases capable of rising to the surface, are essentially bottom forms, and rarely occur at great depths. No better instance can be found, as illustrating the working of nature in a highly specialized form of life; here are fishes, by the very nature of their surroundings, liable to all kinds of hardships, and it is extremely interesting to see how nature, unable to shake off inherited characters, so modifies "the things that be" as to ensure the safety of the race. It is quite clear that the broad armed head so far exceeds the body in diameter, that the latter is, so to speak, under cover of it as under a defensive shield—an obvious advantage to an animal which, though not a good swimmer, still moves about on a rugged sea-bed in anything but an apathetic manner. The teeth are small, and the bones of the skull are run into a compact mass, which is produced beyond the jaws into further buffer-like protections; the skull, limb-girdles, and gill covers, alike develop powerful spines, and less marked ones occur on the body.

The curious "feelers" of the ordinary Gurnards, about which so much mystery seems to hang, are really but three pairs of dismembered elements of the pectoral fins; they have all the characters of them, and are supported by jointed fin rays. They are no doubt sensory in function, and while they may serve as a probing apparatus they can be used as organs of locomotion; this gives the creature power to move backwardly like a Lobster, and injury to the dorsal fins, which might occur in thus moving among projecting masses on a rugged bottom, is prevented, by these lying when at rest in a groove, under cover on either side of a row of serrated bony plates. This is but an exaggeration of that which occurs in many other fishes. Now comes the question of the under side of the body; and here again, nature, having nothing else to fall back upon, calls into play the hip-girdle; this, meeting its fellow in the middle line, forms a great expanded plate, which, it can be seen at once, strengthens the flattened body-wall below. The bony investment of the whole body, met with in the little Armed Gurnard, prepares us for what we find among other groups, such as the curious tropical Coffer-fishes, and, to come nearer home, the familiar Pipe-fish and Sea-horse.

One other family of edible Acanths demands notice; that of the Lump-suckers. Heavy unsightly animals, having bony tubercles imbedded in their thick skin, they derive their name from the fact that, in common with many other forms, the ventral fins by their modification give rise to a great sucker; and if any one doubts the tenacity of this organ, let him try and remove the brute when once it has anchored itself, and he will come away at least a wiser man. Their skeleton is often very deficient in earthy matter, as indeed may be that of some Eels.

Some being clad in bone, others, as the Sea Bream and Wolf fish, which occasionally reach our markets, having enormous and powerful teeth; nearly all the members of this great group are formidable denizens of the water.

So much for fish structure; and now comes the question of utility. No one who has ever been an invalid can fail to recognise the importance of a fish-diet ; and the reason for which most Teleostean fishes are captured is, that their flesh, on being eaten, when well boiled puts no such strain upon the digestive organs as do the more solid foods. This is, to no small extent, due to the fact that the fatty material, which requires little or no digestion and can be at once assimilated, is in them diffused more evenly throughout the tissues than in those animals from which we derive our more solid meats. The accumulation of fat, however, is often so great, that only the least fatty fishes can be eaten with comfort, and thus it is that Cod, Whiting and others are so much in demand. The amount of actual nitrogenous food in fishes is enormous ; and they also yield a good supply of earthy matter, without which we should come badly off. Beyond this all is a question of taste, the value of the fish being due to some special flavour, which may arise from a variety of causes. In all animals, fat is either derived from the tissues of others devoured, or is elaborated within the system itself. Fishes, but not they alone, store up in the liver an enormous supply of this ; and to that power, in species of the Cod tribe, we stand indebted for our far-famed cod-liver-oil, while fish fats are also used in the manufacture of train oils. The Eels, apart from their edible value, furnish us, in the case of the Conger, with a constituent of the "mock turtle" soups, and in "Eel-fairs" time the little fry are literally "fried" into cakes.

Passing now to the Sturgeons, the only representatives in Europe of a once great order of fishes, we find that, like the Gurnards, they live at the bottom of the sea or river they inhabit, and here again we find the head encased in a bony armour, while, as also in some of the bottom-living Teleostei, there are sets of bony plates, disposed in rows along the body; the skin elsewhere is not naked, but lodges minute asperities, and the sides of the tail are completely invested in a close-set series of bony elements. Carried to an extreme in other genera, this exo-skeleton forms in them a dense armour, which, from the characters of its superficial enamel-like layer, is called Ganoin, and these fishes are therefore known as the *Ganoids*. Of them there are but seven genera living, one of which has a naked body, while in others this armour may either assume the form of plates, so modified as to "play" over each other when the body is in motion, or as in one American genus—Amia—of large cycloid scales, in which, as in most other respects, this animal resembles a typical Teleostean. The ventral fins—absent in one highly modified African form—in the Sturgeons, and in all the members of this group, are abdominal, and lie far back like those of the Salmons.* This also is true of all fishes below the Teleostei, those being the only animals in which the pelvic fins become displaced. As to median fins, the Sturgeons have but a single dorsal and anal fin respectively, placed nearly over each other; the vent is far back, and obviously these two fins answer to those similarly placed in the Salmons. Amia, among living Ganoids, has a long continuous dorsal fin, while in the "Bichir" of the Nile—*Polypterus*—this is continuous with the tail fin, and broken up into a series of "finlets" much like those of the Mackerel; unlike them, however, each is provided in front with a very powerful spine, so arranged as to protect the animal when in motion, and the finlet itself when at rest. One North American genus, like both the Sturgeon and Pike, has a single dorsal fin placed far back, and as its jaws are prolonged and dentigerous it is called the Bony Pike. While both it and the Sturgeon have such modified fins in the adult, in them both when young all the median fins are continuous like the Eel's. The tail fin

* These fins are often variously modified, or even united into one, in some fishes.

of the Sturgeon is deeply notched, and consists of two lobes, one of which is much the longer, and, as can be clearly seen, this—dorsal lobe—carries the axis of the tail end of the body; it is in reality the modified and originally straight tail of the embryo, which, as the lower lobe—or the ventral lobe as it is called—appeared, was displaced by it, so that the tail, thus becoming unsymmetrical, is said to be "heterocercal." The usually symmetrical or even rounded tail of the Teleostei does not at first sight appear to have much in common with such a form as this, but if stripped of its flesh, an exaggeration of the same arrangement will be found, except that the further enlargement of the ventral lobe has given rise to an apparent symmetry. This is known as the "homocercal" tail. On the other hand, certain Ganoids retain the perfectly symmetrical tail fin of the larva, as do certain lower fishes which we shall consider later on. The Sturgeons, devoid of the formidable teeth which many members of the group possess, bring us again face to face with scavengers; and so the modifications of the jaw apparatus are in some respects like those already seen in the little Grey Mullet—that is, the bony mouth supports, having a flexible membrane stretched between them, are free of the skull, and so modified that under contraction of certain muscles they can be protruded. On the top of the head, midway between each eye and the gills, is seen an aperture—the "spiracle," which leads by a tube into the cavity of the mouth; in some Ganoids, as in the Teleostei, this is absent, but by virtue of its presence there are here two passages of communication with the exterior, and the timid Sturgeon, taking advantage of this, not only "gulps" in its food as does the Mullet, but, actually burying its proboscis, sucks it in, using this second channel for purposes of respiration. While swimming it takes in the water by its mouth, like an ordinary fish. The Sturgeons, in common with a long-snouted ally—*Polyodon*—found in North America and China, have no teeth in their jaws, and it is a highly instructive fact that the young of both possess them; in the Sturgeon they are fully developed like those of a Shark, but only to be thrown off as age advances, when, obviously not needed, they give place to the minute dentigerous organs which clothe the gill arches of the adult. All the living Ganoids have an open air-bladder, the pseudobranchia of the Teleostei may or may not be present, while in the Sturgeon it forms a true gill; pyloric appendages may coexist with a true pancreas, and the lining membrane of the intestine, like that of the Salmons, is folded, not, however, into a series of annulations, but into a spiral, for which reason the intestine is said to contain a "spiral valve." This structure always lodges blood vessels, and is really but an increased area for absorption. It also exists in the Sharks and Rays, and among the variety of forms it assumes in them we find a type much like that of the Salmons again present; there cannot be the least doubt therefore that all are identical. The Sturgeon has abdominal pores, which open at the sides of and not behind the vent, as in the Trout; as in the Teleostei so in the Ganoids they may be absent, and the kidney and generative ducts may each open independently. The gill cover of the Sturgeon does not completely cover the gills. On boiling the Sturgeon we find that the bony skeleton is superficial and but skin deep so to speak, and that the skull, unlike that of an ordinary fish, is but a mass of gristle or cartilage, while in place of the bony vertebral column, there is a rod of somewhat similar material. This is a highly important fact, for all animals when young have such a skeleton as this, and as they age, it becomes replaced by the bony one so familiar to us all; and those gelatinous masses, already referred to as lying between the vertebræ of the Trout, are the last remains of it in the adult. The Sturgeon is in this respect another of those big babies already mentioned. This axial rod, which occupies the place of the bony vertebræ of other fishes, is known as the notochord, and with its sheath is still eaten in some parts of Russia. In some Ganoids, as in the Teleostei, this is largely replaced by the bony vertebræ, but very often in the latter, as in the former, the end of it remains gristly. The Sturgeons and their allies form a group of some 20 species, found in the rivers of Europe, Asia and North America, they are essentially Northern forms; some are exclusively fluviatile, while all spawn in fresh water.

The roe of the Sturgeons furnishes when prepared, our caviare, and each "grain" of that delicacy would be competent, under certain conditions, to produce a Sturgeon. Neither prince nor peasant in this land needs to be reminded of their edible value; in the Baltic provinces and North America they are regularly eaten, either cooked or pickled, and the Sterlet is a time-honoured Russian delicacy. From the thick-walled air-bladder of the Sturgeon, and in India from two Teleosts, our isinglass or "fish glue" is obtained, and it does duty now as well as ever it did upon a Greek or Roman plaister. All along, we have seen that there is hardly a single Ganoid character that is wanting among the Teleostei, and, did space permit, it would be easy to show that this great group, with its thousands of living species, has been derived from the Ganoids, of which but 30 species exist. There are living forms which prove this, and as we go back in time we find the case reversed as to numbers, showing the Ganoids to have had the ascendency at one period in the world's history; among the fossil forms, we also find every gradation in skeletal anatomy between the opposite extremes of the two types.

In both Teleostei and Ganoids the gills project freely into the gill cavity; in the next lowest group they retain their embryonic pouch-like nature, each opening independently; and as the gills are lamellate or plate-like, these fishes are called the *Elasmobranchii*. There are some 300 living species, which include the Sharks and Dog-fishes, or *Squalidæ*, and the Rays or *Batoidei*, with their allies. No air-bladder is ever present, and the intestinal valve has been already alluded to. The exo-skeleton, when present, is modelled upon a somewhat different plan from that of the higher fishes; teeth occur in the jaws alone, and there are certain other characteristic features in their visceral anatomy; suffice it to say that the mouth in all is lodged on the under side of the head, while in the region of the vent there is an immense single aperture, the opening of a large chamber which receives the alimentary, kidney, and generative ducts; it is therefore a common outlet, and the classical term "cloaca" is applied to it. On either side of this there is usually present an abdominal pore; and these fish generally deposit their eggs in a leathery purse, in which the young are protected during development; two Sharks, however, bring them forth alive.

The sagacious, active, voracious *Squalidæ*, as variable in habit as in size, are marine forms, although some few ascend the Amazon, Tigris, and Ganges rivers. The smaller familiar Dog-fishes are generally shore forms, while the larger Sharks, sometimes reaching a length of 30 or 40 feet, are among the most formidable of all living beings; often they are wanderers, and may follow a ship for weeks in open ocean. On the other hand, some, having small teeth, are in a sense harmless. The body is generally elongated, and the tail, in all a powerful propeller, may be shortened; the pelvic fins are always abdominal, and the pectorals are placed as usual. The median fins vary very much, but neither dorsal nor anal fins exceed two in number, although the caudal fin may be continued round the tail for some distance above or below. The tail, often quite straight and symmetrical, may be bent up as in the Sturgeon, bearing an unequally-lobed fin, which, in the Swingle-tail and the great harmless Thresher,* attains an extraordinary development. The anterior dorsal fin may lie even behind the ventrals as in the common Dog-fishes, or may be above the pectorals; the posterior dorsal fin, when present, is usually pretty near the anal. When, as often happens, the median fins are represented by but a caudal and two dorsals, the latter are usually similarly related to the paired fins; the body—in some of a dull colour, in others variously marked or tinted—is in all covered by small dentiform scales, constituting the shagreen of commerce. (The Sun-fish among Teleostei has a similar investment.) The teeth, though often different in the two jaws, are of a similar nature to this shagreen; like the scales which form it, they vary very much in shape and size, in some cases sharp and cutting, in others broad and crushing, in others combining these two extremes, while that which is sometimes described as their "shape," is really due to alteration in wear. It is well known that the lining membrane of the mouth of all animals is formed by an ingrowth of the skin which covers the body, and as everyone knows the two things are continuous at our own lips. This being so, it follows that that skin carries in with it the power of producing

* Representatives of these, and of the Basking and Greenland and other Sharks rarely seen in this country, will be found in the Canadian section, and elsewhere.

scales, and these mouth-scales we call "teeth"; in some Sharks, the transition from the body scales to the teeth can be easily followed as we approach the mouth. The gill slits—in some very small, in others exceedingly large—are always placed at the sides of the head, immediately in front of the pectoral fins; usually there are five of them on either side, but in some Sharks of the Tropical seas there are six or seven. The eyes are large and lateral, and in some guarded by a membrane, which, as in frogs, reptiles, and birds, can be drawn over the eye at will. Behind each eye in most Sharks, there is present a valvular spiracle, which in life keeps up a rythmical respiratory-movement, and like the Sturgeon's, leads into the mouth-cavity; that cavity itself is enormous in all, chiefly on account of the great width of the gape; and the actual aperture of the mouth—in some far forwards, in others back even behind the eyes—has its actual position determined by the elongation of the head, into which the jaws never enter as in the Pikes. Hardly a picturesque thing at any time, the interior of the mouth in one Dog-fish, which, however, rarely reaches our shores, is black, for which reason the Italians call it the "Hell's mouth." In most Elasmobranchii, it will be seen that the nasal aperture, which is also on the under side of the head, leads into a sac, and that a fold of skin is so arranged as to incompletely shut it off from, and at the same time to put it into communication by an underlying groove with the mouth. Here once more we are facing a big baby, for, in even our own case, there is a period in our existence in which the nose is similarly arranged; that which is here a groove, becomes in us a canal by the complete closing over of this fold.

Among the Elasmobranchii we find some of the most remarkable modifications of the fish-body, as for example the Hammer-headed Shark and others, but certain forms, known as the Monk-fishes or more familiarly the Angel-fishes, as, like those mysterious beings, they are possessed of wings, are of especial interest. Their "wings," as any one can see on comparing a Shark, are really the pectoral fins, which are rotated towards the head; behind them are smaller wing-like pelvic fins, while the tail is very stout and fleshy, as in the true Sharks. We have, in fact, the transition stage between the Sharks and Rays here realised. All Rays when young are long-bodied Shark-like animals; as they grow, however, these great pectoral fins enlarge, and in the Angel-fish and some few Rays they get no further, while in the majority of these latter they still grow on, and, uniting with the head and body, form the disc-shaped adult. The Batoidei are mostly marine, but some are exclusively fluviatile; they rarely occur at great depths, and while the more Shark-like forms are free swimmers, the majority of them, like their flat brethren—the Pleuronectidæ—live at or near the bottom, where they usually feed on small animals. Bearing in mind what we saw in the flat fishes, it is not at all surprising to find the surface of the body variously coloured or ornamented for protective and other purposes; while even the spines may, in addition to the defensive function, also serve this purpose. It is no uncommon thing, especially in the smooth forms, to find the under surface of the body coloured, and not white as is usually the case; often the great spines, with which many are armed, may also occur on the under surface, and these modifications, in all probability, have to do with their mode of feeding, for many of them instead of hunting down their prey, swim down on to it, and, by arching their great fins, cover it in as under a cloak, much as a bat will sometimes cover in an insect before devouring it. The head and under surface of the body here, and less conspicuously in the Sharks, show numerous small pores; in relation to these, there can often be seen more or less tortuous canals lying immediately beneath the skin; they converge towards the head, where they receive an enormous nerve supply, and are undoubted organs of sensation, of the nature of the organ of the lateral line already referred to. Commonly and erroneously they are called mucous canals; the formation of the slimy mucous, however, is wholly concerned with changes going on in the skin, and these canals have nothing whatever to do with it. The flattening of a sole or that of a skate are obviously two distinct things; the former—a compression—affects the tail in the main, and the paired fins remain small; while the latter—a depression—affects the paired fins, and in proportion as it is increased, the tail, no longer of use as a propeller, is modified. Unwilling to part with this appendage, it is for these reasons that in some it becomes a long filament, the use of which is unknown; in the Sting-Rays it bears a most formidable spine, while in even the common Skates it lodges on either side a "pseudo-electrical" organ, so called because it differs in position and structure from the truly electrical apparatus of the Torpedoes; this latter lies between the head and the expanded pectoral fin in front.

An electrical apparatus is also found among the Teleostei. A Sheat-fish (*Malapterurus*), from the freshwaters of Tropical Africa, and the so-called Electrical-Eel, of Brazil, both possess it. In the former of these two cases the animal reaches a length of some four feet, and the electrical organ is distributed over the whole surface of the body; in the latter, which is about six feet in length, it is restricted, not as in the Torpedoes to one area, but to two, occurring upon either side at the back of the tail and along the anal fin. These organs are capable of producing a powerful shock, are abundantly supplied by nerves, and are as fully under control of the animal as are its muscles.

In neither Angel-fishes nor Rays are there anal fins in the adult; the dorsals—which may be one or two in number or absent—are never placed in front of the ventrals, often, as in the common forms seen in our markets, lying at the extreme end of the tail. As the result of the changes undergone, the eyes and spiracles remain on top of the head, while the originally lateral gill-slits are carried round, and together with the nasal sacs and mouth lie on the under surface; inasmuch as the pectoral fins have been rotated forwards, the gill-slits lie, as of necessity they must, internal to them. The snout is often prolonged into a beak or rostrum, and in the Sword-fish this bears the well-known lancet-like blades, which, in common with the spines of the Thornbacks, or shagreen of the Sharks and indeed of some Rays, are but so many modified scales. On examination these are all seen to consist of dense more or less tooth-like organs, known as placoid scales, and each has, like the teeth from our own gums, a bony base. Shagreen is chiefly used for handles of swords, knives, and similar instruments where considerable "purchase" is required. This power is due to the fact that these small tooth-like scales inflict so many minute scratches upon us at the time of using, really grafting themselves into our skin. Many Sharks have the power of erecting these organs in self defence, while others, as for example the common Picked-Dog of our coasts, have enormously enlarged spines at the bases of certain fins, with which they, by taking an actual aim, can inflict a most deadly blow. If further demonstration of this is needed, let a man stroke a common Dog-fish the right way and he is smooth as satin, but let him try and reverse the process, and he will return a wiser but a wounded man. The fact that in an ordinary scratch no bleeding follows proves to us that there is a layer of our skin in which blood vessels do not occur; and if the scale of a large-scaled Teleostean is carefully examined, it, in common with its fellows, will be found to be covered over by this non-vascular epidermis as it is called, which is here pigmented. So it is with the young Skate. More than this, however, it can be proved by removing one, that they just as certainly overlie the deep vascular layer; bleeding then takes place, because injury has been done, and the vascular plug over which they lie, and from which they are exclusively formed, is the so-called pulp, to the shape of which both the tooth and the scale conform. One difference, however, does exist, for while we have but two sets of teeth, the more fortunate Sharks and Rays have the power of replacing them from behind as fast as they are worn away in front.

Among Elasmobranchs, and especially the Skates where the spiracle is large, no difficulty is found in seeing that it lodges a pseudo-branchia; this is obviously not the same thing as that of the Teleostei, for, as in the Sturgeon, a fully-formed half-gill takes the place of that organ, while behind there are in addition at least four complete gills. The Elasmobranch skeleton presents us with a marvellous diversity of modifications; in some there is a partly or wholly complete bony vertebral column, in others, we find a simple notochord as in the Sturgeon, and while in that animal all the outlying structures are bony, in some Sharks the notochord alone is replaced by bony discs, and the outlying parts are cartilaginous. Other modifications, too detailed for notice here, occur, but the skull and the skeleton of the fins retain in all the embryonic condition, the cartilage of which they consist, though it may be encrusted in bone, being never replaced by bone. The skull forms a complete box, which lodges the brain and expands in front of the eye into two olfactory chambers, and behind it into two auditory chambers, which lodge those sense organs respectively. Further detail concerning these is needless here.

Sharks are used for soups in China and Japan, while in our own land the Smooth-Hound, Tope and Picked-Dog, are eaten on emergency, but not as a rule ; in Cornwall, a soup is said to be made of the Rough-Hound, and while at one time the Monk-fish and Rays used to be cooked in abundance for food, the latter and especially the Skate are still somewhat in vogue. The Monk-fish and Dog-fishes of our coasts furnish a type of shagreen much used for polishing hard surfaces, and oil is extracted from the liver of the Larger spotted Dog-fish.

Standing quite away from the ordinary Elasmobranchs, is the genus *Chimæra ;* in that its flesh is at times eaten, and that it furnishes oil, said to be used medicinally, it may be mentioned here. There are but four species known, and as it makes raids upon the Herrings, it is called the "Herring King." Rare on our own shores, it abounds in the Polar seas ; its body is naked and curiously shaped, ending in a long filiform tail ; all the fins are large, especially the pectorals and the first dorsal which lie above them. This fin is armed with a powerful spine, and the male animal has a curiously toothed appendage immediately above and between the eyes ; the anal and caudal fins are confluent. Among its many interesting peculiarities, it may be here noted that its young bear certain placoid scales, which they soon lose ; in the adult, that portion of the lateral line organ which lies on the side of the head, is, like that of the young of other forms, an open groove enlarged at intervals ; if closed between these enlargements we should have the typical condition. The mouth is guarded by six cutting teeth—four above and two below—which are never replaced. A spiral valve exists in the intestine, and there is no spiracle present; the gills are closed in under an operculum, having all the relations of that of the higher forms, but containing no bones. There is a nearly simple notochord ; and other modifications, beyond the scope of these pages, exist, which show it to be a form standing alone among living fishes.

The Lampreys form another isolated group. Highly modified Eel-like creatures, with their fins forming a median fringe, which encircles the tail and may be broken up dorsally, they show no trace of paired fins, for just as is the case with most snakes they have lost them, and are, for these and other reasons, said to be degenerate forms. They are mostly free-swimming, and occur in abundance in both hemispheres. The large and much-prized marine Lamprey (*Petromyzon marinus*) ascends our rivers—chiefly the Severn—in the spring to spawn ; and the river Lampreys, or Lamperns of fishers, are used both for food and bait. In all these animals the proper jaws of other forms are suppressed, and there is developed in front of the true mouth an immense accessory sucking apparatus, fringed with small tentacles in some, and bearing horny teeth, which latter, in that they are formed outside the lining membrane of the mouth, differ from those of other fishes. As the result of the development of this sucking mouth, the nasal sac, which is here single, and which lies in the young animal on the under side of the head as in Sharks, is carried up to the dorsal side. The tongue is long, always tipped with teeth, and rasp-like, and is so arranged, that the animal, attaching itself by its lips, withdraws this, and, producing thus a vacuum, holds on in the fashion of the schoolboy's sucker. They may be seen to anchor themselves thus to stones or floating objects ;

and while the Lamperns feed upon small fish and other forms, which they take in as best they can, the sea Lamprey is said to attach itself in this way to either dead or living fishes, chiefly of the Cod tribe. This done, it is said to rasp out a morsel of its host's flesh and depart. The Hags or Myxinoids, however, instead of doing this, usually enter by some natural aperture, and actually force their way inside the body, for which reason they are called the "borers." Often they do not leave it again until nothing but bones remain, which their horny teeth cannot touch; they are therefore true parasites, and here, as always under such circumstances, the individual, dead to all self-respect, becomes a mere degenerate hanger-on. Their presence is the more obnoxious, in that their skin contains stinging organs like those of the Jelly-fishes. In order to fulfil these functions, it is clear that the gills must become modified, and this necessity leads up to a strange series of changes. Firstly, the gills are always pouch-like, for which reason these animals are collectively called the *Marsipobranchii.* In the Lampreys there are present seven pairs, which open at the sides of the head externally, and internally they lead into a special chamber, which lies beneath the œsophagus and can be shut off from the mouth by a couple of flaps or valves; if watched, there can be seen a rythmical pulsation going on, the water setting both in and out by the gill apertures. Here, once more, we find a means of separation of the respiratory from the alimentary functions. In most of, but not in all, the Hags, the gill-sacs open externally by a single pore placed far back on either side, and internally into the pharynx itself; here then arises a difficulty, and they get out of it by breathing through the nose. For this reason the nasal organ opens into the cavity of the mouth in them, but not in the

Lampreys. The vent is placed far back, and the alimentary canal is a straight tube; behind this there is a papilla, placing the generative and kidney ducts in communication with the exterior. The eyes are small, and in the Hags buried up beneath the skin and useless. The eggs, when laid, are often buried in the sand after the fashion of the Salmon's, and the young pass through a series of larval stages, which extend over a long period; as this is so, the metamorphosing larvæ were once thought to be a distinct species and were called *Ammocœtes.* The skeleton is wholly cartilaginous, an immense notochord being present; this cartilage contains a deal of fat, and, contrary to the general rule, is said to yield no chondrin on boiling.

The only remaining group, viz., that of the Mud-fishes, is one of the most interesting among all living animals. They are poor swimmers, and though found in brackish water are restricted to the rivers of Queensland, tropical Africa, and the Amazon. The three so widely distributed living genera, are the last survivors of a once great race. The "Barramunda" of Queensland,* and the African *Protopterus*, are both common food fishes in those countries, while the South American genus *Lepidosiren*, is but little known. The body in all is elongated and covered with cycloid scales, and what median fins do exist are confluent; the organs of the lateral line are present, and the ventral fins are abdominal and far back. The paired fins, unlike those of nearly all living fishes, are paddle-like, and each consists of an axis, fringed on either or on one side alone, while in the African genus the axis alone remains. They have teeth, an intestinal valve, abdominal pores, and true gills, in common with other

* Specimens of this animal—*Ceratodus*—can be seen in the New South Wales Collection, and a well-prepared skeleton of it and other fishes in the West Galleries.

fishes; but they stand alone in being able to use the open air-bladder as a lung; in accordance with this, the blood vessels which supply it, contrary to what is found in all other fishes whatever, are either partly or entirely connected with the heart itself. These animals, by virtue of this arrangement, can breathe by lungs and gills, either together or independently, and are therefore called the *Dipnoi.* They thus not only have the power of living on land, which in fact they do in search of food; but the African genus, in time of drought, constructs a mud-hut in which, leaving air-holes, it lies in a torpid condition, until liberated on return of the rainy season.* For these reasons the name of Mud-fish is given it, and the specimens which reach our aquaria are sometimes transported mud-hut and all, and liberated upon arrival. These, and a host of other modifications beyond us here, show that we are dealing with an animal obviously a fish and yet not a fish, inasmuch as interference with gill respiration, which would be fatal to an ordinary fish, is in it to an extent optional. We are, in fact, on a borderland between two great groups, and in the whole realm of nature forms similarly connecting any two apparently well-defined groups are to be found; we thus get "harmony in discord" and continuity in all.

While no other fishes have a lung so fully functional as this, many are capable of living for a time out of the water, and others cannot live without coming to the surface to breathe. The failure to live an exclusively terrestrial life, among them as even to go lower in the scale, among some Crabs, is not for the want of trying. We have most of us heard in our young days of the climbing Perch of India; this little fish utilizes its spines in ascending the Palm-trees,

* The ordinary Carp, Eels and Tench are said to bury themselves in the mud during the cold months, a habit, however, not to be confounded with that of the Mud-fishes.

and as to its respiration, it developes from its gill-arches, as indeed do some Herrings and others more or less completely, a structure known as the labyrinthiform organ; this lies in a pouch above the gills, its walls are folded and refolded after the fashion of a sponge, and the water held in its meshes serves to keep the gills moist while on dry land. That it also performs a respiratory function in the water is clear, as this Perch, in common with others having a similar apparatus, is drowned if prevented from coming to the surface. If the gills of an ordinary fish are bandaged up certain death ensues, but if these forms are so treated they live on, so long as allowed to rise to the surface. Among the Siluroids, some Indian forms attempt a similar thing, by sending back, as in the genus *Saccobranchus*,* a long pouch in among the muscles of the body; here, it will be remembered, the air-bladder is used for purposes of hearing. A South American genus, *Callicthys*, passing the air through its alimentary canal, has an intestinal respiration; in some of these still other strange modifications in the same direction occur, in the presence of which even the gills themselves may be reduced. Some of the Ganoids on the other hand, rising to the surface, make use of the air-bladder as a lung, but in no known fishes, except among the Dipnoi, is prolonged life upon dry land possible.

This leads up to the *Amphibia*, of which the only commonly edible form is the Frog. Its appearance is too familiar to need description here, and no one who has merely seen its skewered hind legs, as offered for sale on the Continent, would recognise in them the ventral fins of a fish to which they correspond. The Frog, like the fish, has no neck, and while the caudate Tadpole is a free swimmer, the adult is tailless; the skin is scaleless, but some of the lower

* This fish and the climbing Perch are both represented in the Indian section.

amphibia are, like the fish, scale-clad. The internal organs are at first sight unfish-like ; but the truth is that in it and right on up to man himself, there is much more that is "fishy" than people are wont to imagine. Under ordinary circumstances, the Frog may live either in or out of the water, and for this reason it and all its allies—our Newts, Efts, Toads, &c.—are called the amphibia ; it must, however, come to the surface to breathe, and this it does in a very characteristic fashion. Unlike us it has no ribs, so that costal respiration is impossible, and experiment shows that it cannot breathe with its mouth open ; what it does, therefore, is to depress the floor of the mouth—it first being closed—whereupon the air is sucked in through the nostrils ; these are then closed, the floor is raised and air is forced into the lungs, which, by their own elasticity in the main, again expel it as the nostrils are opened. Thus it is that we find, in place of the movements of our chest, corresponding movements of the floor of the mouth. The Frog is carnivorous, but the teeth, which exist in the upper jaw alone, are prehensile ; no lateral motion of the jaws or biting is possible, and the tongue is also capable of being protruded and used as an organ of prehension. Eyes, with well-marked eyelids, are present, as also are the ears, which here, as in the fish, show no signs of external appendages ; contrary to what is seen in the fish, however, the drum of the ear is visible behind the eye. The vent is placed at the extreme end of the body, and on either side of it there can be seen as in the Eel's tail, a rythmical pulsation, due to the presence of a pulsatile lymph-heart.

The bearing of the Frog upon the fish, however, is best seen in the Tadpole ; that, as everyone knows, is a long-tailed, free-swimming animal, it has gills and a sucking mouth with horny teeth, and at one period, gill-covers exactly like those of a fish, and like those of the Herring King not supported by bone. It is an animal for which you can find no name but that of a fish. Later on lungs are formed from the gullet as is the fish's air-bladder, the gill-covers close over; gills, tail, and horny teeth disappear—the "moult" is passed—and the animal now becomes a Frog. Inasmuch as it passes through a true fish-condition, it is said to have a complete metamorphosis; but there are many allied forms, which never get beyond the gill-bearing stage. In this building will be found one of them, the Axolotl, an inhabitant of the lake which surrounds the city of Mexico. If this animal is deprived of access to the water, that is, subjected to the equivalent of a series of droughts, its gills disappear, and as it for ever afterwards breathes by lungs, it completes that which the Mud-fish had begun. Its eggs, especially when laid on dry ground, often give rise directly to gill-less forms; in either case the lungs alone remain as the organs of respiration, and the creature becomes terrestrial. Other changes, not the least important among which affect the colour, go on, and we have a "species" produced before our eyes; more than this, however, for there is here realised the transition from the branchiate to the abranchiate forms, and the air sac, now a lung, remains such, right on up to man himself; and from this point onwards, just as we saw fish trying to become terrestrial, so we shall find terrestrial forms which, dissatisfied with their surroundings, tired of the new love, go back to the old one and try to become fish.

First among the higher animals possessed of this ambition come the Turtles, which as we all know are true reptiles; like other reptiles and birds their eggs are enclosed in a hard shell.

The members of this group of the *Chelonia* as they are called, like the Lobsters, Crabs, and many other animals, carry their "house" on their backs. This great exo-skeleton is but an exaggeration of what we have already seen in the fish, and by its agency they often defy destruction, except by the capacious jaws of the Crocodiles and certain fishes; in retaliation for this, some Chelonians make a favourite repast upon the eggs of those great monsters. Among them we find adaptations to almost every mode of life; there are land and water Tortoises, but the marine forms alone constitute what are called Turtles. Of these there are but three living genera; they occur chiefly in the Pacific and Atlantic oceans, and furnish that *sine quâ non* of the city dignitary, and our no less valuable tortoise-shell. In India, one soft or Mud-Tortoise is eaten.

The general build of their body is well known, and at first sight it may seem strange that such heavy brutes should lead an aquatic life; some water Tortoises, it is true, are little less heavy than land ones—they have inherited the "house" and cannot shake it off, so they reduce it, and in the Mud-Tortoises it is quite soft. In the Turtles it is less bony than in the solid land forms, and as the capacity of their enormous lungs must diminish their specific gravity, it is not surprising to find them living on the surface of deep water, where their favourite food abounds. On land they are far less active than their terrestrial brethren, and this, because the limbs are modified for swimming purposes; the clawed-toes of land forms are here bound together to form paddles, and as this is most marked in the fore limbs, from each of these all the claws but one disappear. They come periodically on land to deposit their eggs, and as the injunction to crawl on the belly extends to them, man, taking advantage of their weakness, gets the ascendency. All Tortoises have a long neck, upon the flexibility of which the power of capturing their prey depends; in some it is naked, but the Turtles have head, neck, and limbs, all covered with horny scales. The "house" is so fashioned in all, as to leave the head and neck, limbs and tail free; in some these can be partly or in others wholly retracted, and being the only freely movable organs, the bony structures which support other parts become firmly united with the shell. As this includes the ribs, these animals, having no proper chest, breathe like Frogs—they swallow the air much as we do a pill. The lips may be fleshy, but the mouth is generally guarded by two powerful horny beaks; and in the case of the Turtle, from which we derive our tortoiseshell, as the upper jaw is recurved like that of a bird, it is called the Hawk's-bill Turtle.

In its edible *confrère* the jaws are notched and jagged, much like the beak of a snail. They have eyes and eyelids, a tympanum beneath the skin, and are in every respect reptilian. The Turtle which yields our soups is an enormous brute, sometimes reaching a length of 6 to 8 feet, and weighing nearly eight hundredweight; from its colour it is called the Green Turtle (*Chelone viridis or midas*). While its house is somewhat flattened and smooth, that of the Hawk's-bill Turtle is beautifully sculptured, and the plates which in the former merely fit together, in the latter are scale-like and overlap, which for this reason is also called the Scaly Turtle (*Chelone squamata or imbricata*). Unlike its great relative, it rarely exceeds two feet in length, and although of no edible value an allied species is eaten abroad. That which characterises it therefore, economically as artistically, is its thickened scaly investment.*

No difficulty is experienced in removing the thin though similar plates from an ordinary Tortoise, at death. If examined thus, it will be seen that these horny plates are

* Examples are shown in the Western Galleries and elsewhere.

neither covered in under an epidermis like young scales and teeth, nor do they correspond in relation and number to the bones of the underlying "house." Proven thus to be totally different structures to either, they are, as from these facts they must be, actual modifications of the epidermis itself. Tortoiseshell then is an epidermal thickening, which, like all similar structures, owes its presence to activities going on in the skin—we are dealing now with that which the fish has not.

On the back of the Hawk's-bill Tortoise there are thirteen of these large plates, with an edging of small ones. While on the limbs, neck and tail the latter alone occur, it can be seen upon removal, that of those on the back the five median ones overlie ten bony elements, while the four lateral ones have beneath them on either side eight expanded bony masses. These are true bony scales, formed like those of a fish beneath the epidermis, and for purposes of distinction are called "scutes." Owing to the nature of the changes undergone in the production of a firm rigid body, the underlying backbone and ribs have completely united with this so-called carapace. On the ventral side these scutes keep clear of the endo-skeleton, and give rise to a defence, as unlike as it could be to that which in dress but better in warfare, is called a plastron.

Crocodiles and Alligators do, and Lizards will, take to the water, and there thus remain among reptiles but the snakes for consideration. The use, medicinally, of viper soups, broths and what not, practised by our forefathers, still survives even in Surrey, and let the unfortunate "Sea-serpent" turn out to be what it may, the fact remains—that Sea-snakes do exist. The common snakes can do everything but fly; they climb, run, or swim, with marvellous radidity. In America there exist non-poisonous, and in south Asia poisonous, freshwater snakes. The Sea-snakes occur in the Indian and Pacific oceans, and may reach a length of ten to twelve feet; many of them, unlike the Tortoises, have adapted themselves exclusively to the new life, and being poisonous are among the most deadly inhabitants of the deep.

Among birds, Ducks and Swans, not to say Gulls, Waders, Pelicans, Sea Eagles, and still less the Darters, Spoonbills and others, are more or less familiar to most people, as being capable of leading a partly aquatic life or of at least feeding upon fish. All these, including the Grebes and Divers, are bird-like; their plumage has the ordinary characters; their wings, except that in some they are small, are clad in the customary long feathers, and the hind limbs are free of the body. The neck, beak, or legs, may be specially modified, but except for a webbing of the foot there is nothing fish-like in them; some of them can both dive and swim beneath the surface, but when we come to the Penguins we find an adaptation to a temporarily submerged condition, reaching its maximum among living birds.

To this end something of the nature of a fin is established, the bones of the fore limb are closely applied together, and flattened in such a manner that—all power of independent movement being lost among them—the limb moves as a whole. In order that the least possible resistance may be offered to the animal's progress, the feathers of the body are small, of uniform pattern, and scale-like; and while something approaching this is seen among other marine birds, it is only in the Penguins that the fore limb—no longer bearing the familiar wing feathers—is converted into a paddle. The hind limbs, modified in some respects, when compared with those of most living birds, are bound down to the body, as in the Seals, only the foot being free; this being so, the body itself is carried erect on land, giving the bird a strange and highly characteristic appearance. The young Penguin is among the most curious of nature's productions; it has shaken off its inherited power of flight, but the modifications of its limbs render it a most ungainly looking animal, as it "waddles" about until fully competent to trust itself to the depths of the Southern Ocean.

The only group now remaining for consideration is the Mammalian. Mammals are so called, because they possess organs which enable them to suckle their young which are brought forth alive, and in them, unlike all other animals, the body cavity is divided into a thorax which contains the heart and lungs alone, and an abdomen which lodges the rest of the viscera. They all have hairs at one or other period of their existence, which, like the scales of the reptile, are exclusively epidermal in origin; not infrequently they may have scutes also. The skeleton, the organs of circulation and respiration, all have special characters by which they can be recognised from those of other animals; in common with birds, mammals are said to be warm-blooded, as distinguished from so-called cold-blooded reptiles and fishes.

Our Hippopotami, Rats, Voles, Bears, Dogs and Beavers all take to the water, but no mammals lower in the scale than the Otters, are equally at home on land or in water. These creatures, with their webbed feet and broad flattened tail, are, in the case of the large Sea-Otter of the North Pacific, hunted almost to extinction for their fur. Beyond this, suffice it to say that that animal approaches the Seals in appearance and habit, and that its skull and teeth have all the characters of those of a typical carnivorous mammal. We must most of us know, that if a warm-blooded land mammal would live in water, it must at least keep in the heat; and this first difficulty is overcome by the Otter, for it has beneath its skin a layer of fat—a blubber—which effects the purpose. We ourselves possess this to a less marked degree, and one is curious to know to what extent the success of great swimmers may not be due to a similar condition.

Next come the Seals and the Walrus. They carry matters a step further, for now we find that the body is becoming more fish-like; obstructions are being cleared, and in all but some Seals the ear goes. Those which retain it are called the Otaridæ or Eared-Seals. The nasal organs are very large, and in some visibly sacculated; the animals have perfect control over their valvular nostrils, and all now becomes a question of fins. Here an important difference steps in. In all, the fore and hind limbs are each bound up in the webbed skin, for which reason the group is called the *Pinnipedia;* the hind limbs are in part similarly bound down to the tail, but, while the ordinary Seals use their feet, the Sea-Lions use both their limbs as propellers. The Sea-Lion and Walrus begin by elongating the thumb, so that it becomes the longest finger of the five, the others all getting shorter in succession; by this means a fin rather than a paddle is formed, and the hind legs are retained for walking purposes. This being so, the animals can support the body on all fours on land, and they progress by this means in a highly characteristic manner, walking on the entire palm of the hand and sole of the foot, both of which members are carried at right angles to the body. The Sea-Lion, having a long neck, grooms itself after the fashion of a dog, and can scratch its head with its hind limb,* while the thick-skinned Walrus can look behind it as readily as can a man.

The ordinary Seals, however, have the hind limbs thrown

* One of a series of artistically-grouped examples is preserved in this attitude in the Canadian section.

back, in which position they are bound down to the tail, the enlarged feet alone being free; these they use as a propeller. The fore limbs remain small, and are carried close to the body. By these, as in the fish, the more delicate movements are regulated. As they thus have no power of raising the body on land, they are among the most helpless of all animals when "beached," but among the most active when once in the water. The nails in all are small, and in some there are extra supports formed for the expanded flippers. The teeth in most Seals are of the true carnivorous type; the familiar large canines, and the sharp-cutting cheek-teeth like those of a dog, are proofs of the real relationships of these forms. In some, as for example the great Bladder-nosed Seal, the teeth show marked signs of reduction in size, and they are in most so disposed that those of the two jaws interlock, after the fashion of a fish's teeth. By virtue of this arrangement, the teeth come in some to be nearly uniform in size throughout; all are small, and between them there are great gaps to receive the teeth of the other jaw. All these animals, including the Walrus, shed their milk teeth. The Walrus is characterised by its well-known "tusks," which are but immense eye-teeth or canines; they are present in both male and female, and the other teeth are reduced in proportion as these are enlarged. This highly intelligent brute presses its tusks into service for purposes of locomotion on the ice, as well as for both offence and defence, its only masters being the Polar Bear and man; their main function, however, is that of digging out the small-shelled animals from the shores on which it lives. Walrus fishing is now practically a thing of the past, and the only parts of the animal now used outside the Arctic circle are the tusks, which are still in vogue by ivory workers

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and dentists. It is confined to the North Pacific and North Atlantic seas, but its remains are found fossilized as near home as Suffolk. The Finlanders used to make a regal tribute of it.

From all that we have seen, it is clear that heat must be kept up, just as nutritive material must be supplied, alike for the maintenance of our bodies; and regarded from this point of view our sealskins, and other similar animal products used for clothing, are but so many "foods" indispensable to our existence. The inhabitants of the Arctic circle once used the Walrus, as the Esquimaux still use the Seals, to supply every imaginable want. They eat even its liver and blubber; their clothes, boats, tents, weapons, and even the "coffins" for their dead are derived from it; while, having no cotton factories, they sew with its sinews. Nearly all Seals, wherever they are plentiful, are used for food; we nevertheless threaten both to deprive the Islanders of their food and the world of its Seals, by our systematic, not to say brutal and inhuman raids upon the young, in our greed for finery.

The skin, which in the Walrus is thick and leathery, sparsely hair-clad, and often scored with battle-marks, is in the Seals thickly covered in the short close-set seal-fur; the actual characters of this vary much with age, in some it is variously coloured, in others almost white.* The body of most mammals is clothed in "hair" and "fur," just as a bird's is clothed in "feathers" and "down." In the Seals and Walrus, as in our more familiar domesticated mammals, certain of these hairs are enormously enlarged to form the so-called "whiskers," which, as everyone fully knows, are not completely formed until some time after birth. The customary distinction between "hair" and "fur" Seals,

* Examples can be seen in the Newfoundland Collection.

therefore, inasmuch as it is often entirely a question of age, is an unnatural one; the true hair Seals are but those in which the longer "hairs" predominate, the soft "under fur" being reduced, just as in pigeons, among familiar birds, the "down" is reduced. The Eared-Seals furnish both hair and fur-kinds. Both they and the common Seals are found in N. and S. latitudes of the two hemispheres.

The body, in some Earless-Seals hairy even to the soles of the feet, is in all clothed in the afore-mentioned fur and hair, and the market value of the dressed skin is proportionate to the care with which the long hairs are removed. This is done by a very simple process, underlying which there is a most instructive lesson. The hair, like a bird's feather and a tortoise's scale, is a modification of the epidermis, but unlike the scale, its base sinks down into the skin for purposes of attachment, and forms a so-called root; as this sinking is proportionate to the length and size of the hair, it follows that the "hairs" of the Seal must lie deeper than its fur. The skin upon removal is pared to such a level as shall destroy the attachments of the hairs, they are then plucked, and the under fur, uninjured, alone remains.

When we come to the Porpoises, Dolphins, and Whales, with their allies, the first noticeable thing is that, like the Eels, they have lost their hind limbs. Only in the Whalebone-Whales is there ever a trace of them, while all others have a remnant of the hip-girdle alone left. This is accompanied by a much closer approximation to the fish type than is seen in the Seals; the tail, short in the Seals, is here very long and bears a fin which, unlike that of the ordinary fish, is transversely set. The head is, in all, run into the body so to speak—there is no longer a true neck—and here again there is realised a true fish-like condition;

in many, the vertebræ of that region all unite into one solid mass, which may itself unite with the vertebræ behind; the articulations of the skull with the backbone are, as compared with those of a typical mammal, highly modified. The fore limbs are now quite destitute of nails, and converted into complete fins; they correspond with our own arms and hands, and while in the Seals, as in ourselves and some of this tribe also, the joints of the fingers never exceed three in number, in others, their number may be increased with the elongation of this "fin." On the back there is often present a somewhat large dorsal fin, which like the tail fin is not supported by bone. The members of this group vary in length from four to about eighty feet, and they are found in all the great seas. Some are of a gregarious, roaming disposition, others follow up fish-shoals, while many feed on small animals. The "Killer-Whale" * will attack anything, from a Whale downwards, and some members of the group await the return of the Salmon at the river's-mouth. Fluviatile representatives occur in South America and in the Ganges. The head may be small and rounded as in our common Porpoise, or as in the Sperm-Whales (*Physeters*) may reach a length half that of the body; the body itself is clad in a thick hairless skin.

Highly modified as are these animals, they nevertheless cannot shake off their identity, for while the adult of one genus alone—the Inia of the Amazon—has hair about its "beak," the young of all have at least traces of the familiar whiskers of the mammal. The eye, never so large and intelligent as that of the Seals, may be almost as small in comparison as the Mole's, and it never has a nictitating membrane. The external ear has gone, but the Porpoise and some two or three others, when young, have this

* *Orca.* A skeleton of this animal is exhibited in the Swedish collection.

appendage developed, like that of the Seals, but on a smaller scale; in the case of the adult Porpoise individuals have been also known to exhibit a trace of it. We saw in the Sturgeon, that the separation of the respiratory from the feeding process was a matter of convenience; in all permanently aquatic mammals it obviously becomes a necessity, as we all know what opening a mammal's mouth under water means. To this end, the larynx is here, as indeed it is in some land mammals, fastened into the nasal passage, and thus kept clear of the mouth. The nasal organs do not generally open at once on to the exterior as in ourselves, but into a large accessory chamber, which again opens by a single valvular "blow-hole." In the Baleen-Whales, the so-called blow-hole is double, and, as there is in them no accessory chamber, the couple of long tubes which put the nasal organ into communication with the exterior, are really the nostrils, much elongated, Seal-like but not saccular. The mode of respiration itself, is, in these animals, exactly that of other mammals; ribs, diaphragm, and so on, all exist, and the notion that water is ejected in "spouting" is an entirely-erroneous one, for, as the animal begins to breathe before quite reaching the surface, the water above it is displaced by the outsetting current of air. The viscera and brain in these animals are entirely mammalian, and the only thing to be noted here, is that the stomach is very complex, as is that of many land mammals. Contrary to the general rule among these, no act of rumination accompanies this. The Whales cannot get back to the "gilled" state, but their blood system is nevertheless curiously modified.

The flesh of many of these forms was formerly eaten even in this country, and still is elsewhere; the tongue being a special dainty. The milk is at times used. The skin of the Porpoise, and chiefly of the White-fish (*Beluga*),* is still used for shoes, laces, and machine-bands. The visceral organs are used by the Northern Islanders for a variety of purposes, ranging from soups to cords, curtains, and even windows. The sinews, like those of the Seals, are pressed into service for threads.

The blow-hole and nostrils vary very much in position, and in any case the shape of the no less variable forehead, is the converse of that of the underlying skull; just as the bony ridge over our own eye—that pet seat of the perceptive faculties—is of the underlying brain. In any case, there is in this region an enormous accumulation of fat, but the mere thickening of the skin of the head is no new feature, as many fishes, and especially the Sun-fish, possess this to the utmost degree. In the Sperm-Whales, there is in this region a great chamber known as the "case" filled not merely with fat, but oil, from which our spermaceti is obtained. Oils are also extracted from the blubber which invests the body, and which serves in life, as already noted, to regulate the bodily heat, and also as a protection. Fat accumulates beneath the skin for these reasons, but in our land forms, our butchers' shops show us that it does not do so to a very marked degree, until all the available space within the body is utilised.

The ambergris of perfumery is obtained from the excreta of the Sperm-Whales, and is probably derived by them from the Cuttle-fish, upon which they feed.

When we come to the teeth, we have to face a marvellous series of phenomena, every bit as much food for the mind, as the organs themselves are food for our markets.

The whalebone of the Whalebone-Whales—the Baleen

* Stuffed examples of this, conspicuous by the absence of a dorsal fin, are visible in the Canadian section.

or right Whales of fishers—not to say the great tusks of that veritable Unicorn, the Narwhal, are familiar to most people. These *Cetacea* are subdivided by naturalists into toothed (Denticete), and whaleboned (Mysticete) forms. We saw that the Seals found it necessary to modify their teeth, and in all living Cetacea they are small and of one uniform pattern—they never have more than one fang, and the teeth of the two jaws interlock like those of a fish. Most forms which retain their teeth, find it necessary to increase their number; and while few mammals except these ever have more than forty-eight teeth in all, we find among them nearly double that number, in one case nearly two hundred being present. Others, as the Sperm-Whales, have no teeth in the upper jaw, and often but few—in one case* but two—in the lower; still others, as one Grampus and the White-fish, early lose their teeth. When we come to the Baleen-Whales, we find that the enormous mouth, out of all proportion to everything else, is lined by the whalebone or baleen. In the higher animals, we have seen that the epidermis has become active in the production of hair, while beneath this, the dermis still retains its power—inherited from the fish—of forming teeth—mouth scales. On the body the hairs have replaced the body scales, and bearing in mind that in all this same skin forms the lining membrane of the mouth, what is more natural than that it should also carry in with it the power of forming hair? this it does, and this hair, which hangs down from the roof of the mouth, we call whalebone. This is not all, for though in the fœtus of these animals teeth are formed, they do not cut the gum; they disappear

* That of Sowerby's Whale. An instructive series of specimens including this, a Grampus, and other Cetacea, are displayed to the best advantage in the Swedish Collection.

and are said to be absorbed, that is, they are dissolved, and their constituents, whirled away in the current of the blood, are voided elsewhere. The modification and partial suppression of the teeth seen in other forms, have in these become total, and hair has now replaced the mouth scales. Here then, just as in the case of the Frog and Tadpole, we have in the life history of the individual, a complete recapitulation of the changes undergone during its evolution in time—its so called phylogeny. The like is true of all living things; but rarely are the steps so clear as here, where truly "he may run that readeth it." Similar structures to whalebone are nowhere wanting, the quills of the Porcupine, the horny part of horns, and even our own nails, are every day examples. The tongue of the Whales, unlike our own, is incapable of motion, and fixed to the floor of the mouth. On feeding, the animal swims open-mouthed on to its prey, the mouth is closed, and on raising its floor the water is drained off through this great "whalebone" strainer, leaving the enclosed thousands of lowly Jonahs to be swallowed at will. Going to the other extreme, the male Narwhal retains only one enormous canine tooth, which generally grows out on the left side to a length about half that of the body. Germs of the two canines exist in the young, and in the female both are absorbed. The two very rarely cut the gum in the male.* The Greenlanders still use this tooth as a weapon, and we for ornament and in turnery. Mankind, always ready to ascribe a magic power to that which he does not understand, has at times applied this organ to a medicinal purpose; as to its use by the living animal, the most reasonable suggestion ever offered is, that by its agency ice-holes are kept clear for purposes of respiration.

* An example of this is shown in the Canadian Section.

There now remain but the Mermaids and their allies—the group of the *Sirenia*—for consideration; setting aside the question of their fabled charms, their flesh, a royal dish among the Malays, is said to be good eating. In Queensland Dugong bacon is still to be obtained.* Their bones are very dense and ivory-like, their skins are very tough, and from these, canes, sticks, and whip-thongs, are severally made. Their subcutaneous fat yields a substitute for our cod-liver-oil.

There are but two genera living, and a third—the Great Northern Sea-Cow—has been extinguished within the last century and a half.† These two are, the Dugong of the shores of the Indian Ocean, and the Manatee of East S. America and West Africa. Their bodies, which conform somewhat to the fish type, rarely exceed 12 feet and never 20 feet in length; like the Cetacea, they have lost their obstructive external ears. While they, too, have replaced the hind limbs by a horizontal tail-fin, remnants of the pelvic girdle remain. The absence of the dorsal fin, the short neck, and the sparsely hair-clad skin, all show that they are not so highly modified as are the Whales; the same is true of their fore-limbs, which, although modified to form paddles, are never elongated; the modifications of the limb are in fact the opposite of those seen in the Cetacea. In the Dugong, where they are most marked, the nails, present in the Manatee, have vanished, and the bony parts of the limb tend to run together. The larynx is not prolonged into the nose as in the Cetacea, and a number of interesting internal modifications occur.

* Stuffed examples of the two sexes of this creature are conspicuous among the New S. Wales exhibits.

† In the Swedish Collection, among the trophies of the *Vega* voyage, there will be found a beautiful skeleton of this animal.

The Grey Whale has been similarly exterminated in the Lagoons of California.

When the muzzle is examined, we find that both lips are very large and prehensile.

The teeth are strangely-modified; no canines ever appear, and the incisors are always lost, with the exception of two in the upper jaw, which become the large tusks of the male Dugong; being incisors they correspond to the tusks of the Elephant and not to those of the Walrus. The cheek teeth, too, are highly modified; 5 on each side in the Dugong, there may be 10 in the Manatee, above and below. Unlike those of the Cetacea, however, they are not small and sharp, but broad, crushing organs, such as we find in the herbivorous mammals. Such in fact are these Sirenia, for they live on seaweeds and certain plant life.

It is probably known to most people, that our sheep and oxen, and many other vegetable-feeders, instead of having incisor teeth in the upper jaw, have a callous pad, against which the lower incisors bite. The skin, which both lines the mouth and covers the body, forms this pad, just as it forms hoofs for their feet; and in the Sirenia, each jaw, curiously modified, bears in front a large horny gum pad, in place of teeth. This is not all, for inside each cheek there is present a patch of true hair, modified to form neither horn nor whalebone; the roof of the mouth is also produced into a series of ridges, such as can be seen in that of a sheep in any butcher's shop; these are often horny among mammals; prolong them, and break them up, and something would result for which no name but whalebone could be found. In these Sirenia, then, there coexist, in the same mouth, teeth inherited from the fish, side by side with those later products in time—horn and hair.

THE UNAPPRECIATED FISHER FOLK

THEIR ROUND OF LIFE AND LABOUR

BY

JAMES G. BERTRAM

AUTHOR OF 'THE HARVEST OF THE SEA'

NEWHAVEN FISHWIVES.

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THE UNAPPRECIATED FISHER FOLK.

THEIR ROUND OF LIFE AND LABOUR.

INTRODUCTORY NOTE.

IT was expected of Sir Walter Scott, when the author of 'Waverley' was in his prime, and his novels and poems were undoubtedly *the* books of the period, that he would some day devote his attention to the toilers of the sea, and weave the round of fisher life, with its perils and privations, its brief joys and prolonged griefs, into one of those romantic narratives of which he had become the master spirit.

It is certain the great novelist meditated at one time a work of that kind, and that he employed himself on several occasions in gathering such information as would give reality to its details, as also in making those studies of character in which he so much delighted. The friends of Sir Walter Scott have now mostly all gone over to the majority; and there can be only very few alive to-day who have held converse with the "Lord of Abbotsford." Probably Doctor William Chambers was about the last of the men who knew Sir Walter, and could have spoken from personal knowledge of that great man's aspirations, but now the good doctor himself, after a life of much usefulness, is sleeping his last sleep. It was the doctor's brother, however, Robert Chambers, who told the writer that Sir Walter had intended at one time to write a story of fisher life and adventure, and that he had even gone so far as to mention his project to Constable, his publisher.

It is our loss that the author of the 'Waverley Novels' did not include in that grand series of books, a narrative of the toils and troubles of those who try to find their daily bread in the treacherous waters of the ravening deep—other than *The Antiquary*. No pen can be thought of that would have touched the subject with greater felicity. During the brief residence of Sir Walter at the fishing village of Auchmithie, on the Forfarshire coast, he had many opportunities of studying the daily round of fisher life. Twenty years ago there were persons in Auchmithie who remembered the illustrious visitor, and who took note of his anxiety to make himself acquainted with the eccentric people who formed the little community, in which for a short time he had taken up his abode, and some of whom were reproduced in the pages of *The Antiquary*. In the rude fishing village of Auchmithie in the time of Sir Walter, the fisher folk were unchanged from the days of a far back period, and even at this day they are still much as they were then—a peculiar people. The superstitions and curious manners and customs that had been handed down from generation to generation still prevailed—the observances connected with the births, deaths, and marriages of the people were insisted upon, and in all respects the fisher life of Auchmithie was typical, and represented in a broad sense the daily life of the hereditary fishermen and fisherwomen of Scotland. It is certainly in Scotland (and in Cornwall as well) that the life and labour of this hardy and industrious class of persons can be studied to the greatest advantage, and in some places even yet their daily round of existence rolls on much as it did a century ago. In Scotland, the patriarchal system of work is still largely maintained; in many Scottish fishing villages the family fishing boat is as much an institution as a family walnut-tree is in France. In a number of the English fishing ports the order of business is somewhat different from what we see in Scotland; there is less of sentiment and comparatively little of the superstitious element, but at Holy Island, Cullercoats and some other places the fisher class are much the same as we find them in Scotland or Cornwall. In Scotland, the fisher communities seldom receive any accession of new blood, and fathers and sons go on succeeding each other for many generations. The fisher folk intermarry in their communities, and so preserve those traditions of labour and the observance of those social customs which have become stereotyped among the people who go down to the sea in fishing ships.

It is interesting to know, moreover, that in nearly all fishing villages, whether they are in Scotland or in France, in Spain or in Holland, the life of the fisher people, as of course it can scarcely help being, is of the same complexion; a life mostly of hard work, much danger, and scanty remuneration. Yes, the fisher folk of France are the very brothers and sisters of those of Scotland, their manners and customs, their modes of life, and all that pertains to their dangerous occupation on the waters, being nearly identical. The various communities seem to have set themselves down in convenient places for following their avocation. There are villages and little towns upon the shores of the sea that nature seems to have destined for the abodes of fishermen; there is usually a natural harbour—"a bieldy cove," in which the little fleet of fishing boats finds, during all seasons, a happy refuge from fierce winds and battling waves.

It may not, perhaps, be generally known to those who are not in possession of special sources of information, that in all fishing communities, the woman is head of the house, and nowhere, in all fisherland, at home or abroad, is this more the case than on the Firth of Forth. The Newhaven fishwife has become a celebrity, and she is indebted to King George the Fourth for much of her fame. That monarch during his memorable visit to Edinburgh, in the year 1822, said to Sir Walter Scott, that some of the Newhaven women were the handsomest he had ever seen; and her present Gracious Majesty has been likewise pleased to admire them. Indeed, since the Queen's first visit to Edinburgh, the Newhaven fishwife, with her picturesque peculiarities and the dulcet notes with which she charms the public ear, as she cries her oysters (*Caller Ou*) has become quite a pictorial personage. She has been painted in oil, modelled in card board, made up as a whisky bottle, given to children as a doll, printed in numerous *Cartes de visite*, and generally, has been made much more public all over the world than any other honest woman. She is a familiar figure in the Café Greco at Rome, as well as in the print shops of Berlin and Venice; and although the praises of the Newhaven fishwife with passing compliments to her "shapely shanks," and the sweet voice that made the heart of the Ettrick shepherd "dirl" with emotion, have been celebrated by Christopher North in the *Noctes Ambrosianæ*, it has not spoiled her, nor yet interfered with her determined and ceaseless industry. She is ruler over her household and chancellor of her husband's exchequer; it is a saying, indeed, of the fishwives, that the woman who is not able and willing to work for a man ought not to have one.

The labour of the females in the olden time was heavy, but it is less so now that so much of the fish caught by their husbands and sons is disposed of at the side of the boat in wholesale fashion, to buyers from those large seats of population, which are always demanding supplies of fish, and are never able to obtain all they want. Some of the fishwives make excellent auctioneers; they possess a rude eloquence which is difficult to resist. The fishwives of Newhaven and Fisherrow in the days of old used to bear on their backs in baskets called "creels" large burdens of fish daily to Edinburgh, with which they wandered from door to door in search of customers—a practice that still to some extent prevails, but which has been largely rendered unnecessary by the increase of shops for the sale of fish. Their achievements in fish carrying have been often chronicled. When the boats were late in arriving, two or three of the women would join in carrying a heavy creel full of cod and haddocks, to Edinburgh. Each woman carried the creel in turn, and by this means fish have been heard calling in the streets of the modern Athens, that had only been brought into Newhaven thirty-five minutes before. Once upon a time, four women walked, or rather "trotted," with a creel full of fish, from Dunbar to Edinburgh, a distance of twenty-six miles, in five hours! And after all, each hundredweight of cod and turbot carried so gallantly could only realise a few shillings. A big cod-fish for tenpence in those days was an every-day bargain, whilst "fine caller herrin', three a penny," was a stereotyped call of the fish hawkers.

In addition to Newhaven there are numerous other quaint fishing communities in Scotland where the manners and customs of the people are worthy of study. Newhaven, from its proximity to Edinburgh, and the fame of its fish dinners is often referred to, and is frequently visited by strangers from the most distant places. All fisher folk, no matter where they are located, whether at "Fittie" in Aberdeen, or at Portel, near Boulogne, or in the Rue de Pollet of Dieppe, are largely imbued with a feeling of superstition; they can read the clouds at night or morning, and discern signs and omens in nearly every passing circumstance. They have their pet aversions, their likes and dislikes. In some villages the mere advent of a stranger would detain the men from going to sea for hours; the impression of a mysterious foot on the sand has before now caused consternation in a fishing village; the flight of a few harmless crows over their boats has struck terror to the souls of stalwart men who have faced death many a time and oft on the raging waters, and have courageously battled with the storm-king in the cause of the dear ones at home. In fisher villages it is the rule to wed within the community; no fisherman would think of bringing home a "stranger woman," to be jeered at by his friends and companions. In some communities there is a wonderful scarcity of surnames, and identity is preserved by the use of what are called "to-names" (added to), or "nicknames" as they may be called; thus a family of Fluckers, in which all the common Christian names have been over and over again exhausted, will be designated by some personal mark, as "gley'd Johnnie," or "dumpie (short) Johnnie," and so on *ad infinitum* through a long range of names of persons, places, and things; such appellations being necessarily recognized in courts of law, and in all kinds of civil and criminal deeds and documents. The following is a rather curious example of the way of using a *tee* name. A fisherman of the name of Alexander Mair, who rejoiced in the nickname of "Shavie," being confined for a debt in the prison of Banff, had occasion to write to his wife at Portknockie, and some wag thus addressed the letter:

Janet Euing, 'Shavie's' wife,
Pray pay the cash and save his life,
For poor auld 'Shavie' is in jile,
An' distant frae you sixteen mile.
Portnockie Cullen."

Often enough these cognomens lead to little mistakes of an irritating kind, but in all legal documents or communications of importance the nickname is always used as a mode of identification.

It was a cause of surprise, when on a recent occasion His Royal Highness the Prince of Wales entertained the fisher people who were visiting the International Exhibition, that the majority of those who had come from Scotland were teetotallers, who would neither drink beer nor Burgundy. It is not, perhaps, too much to say that at the herring fishery a large number of the vessels are now what are called "teetotal boats," on board of which no spirits are ever taken; and the men find they can fish quite as well without supplies of whisky as when they took two or three drams every night. It used to be a standing reproach to the Newhaven fishwives in the olden time that they "drank," and there was no doubt a little truth in the accusation; after carrying about a load of fish weighing from eighty to a hundred and twenty pounds they were sometimes, as the saying goes, dead beat, and resorted on occasion to "a dram" to restore their flagging energies. When Sir Walter Scott witnessed the work performed by the fisherwomen of Auchmithie—when he saw them rush into the water to bring their husbands and sons ashore on their shoulders—he was not surprised to learn that some of them partook of stimulants. "You take a dram, I perceive," said the author of 'Waverley.' "Oh, 'deed we dee that, an' we hae muckle need o' 't tee!" was the prompt and unaffected reply. Many of the Scottish fisher folk are deeply religious; in some communities the men and women conduct a service of praise and thanksgiving, and the unlettered eloquence of a rude preacher of that class would sometimes shame the cultured rhetoric of the pulpit.

The conditions of their shore life, till within these few years back, was shameful; the fishing villages of Scotland were as a rule devoid of all amenity, their sanitary surroundings were of the rudest and scantiest description; dirt—otherwise "matter in the wrong place"—obtruded itself at every corner. Some improvement in these matters has now been happily effected, and the thin end of the wedge having been inserted, more perfect sanitary arrangements will doubtless follow in a short time. As we propose to describe at some length the chief aspects of fishery labour in connection with the more productive fisheries, we need not here refer to the calumnies that have been directed against the fisher folk, such as the accusations of laziness and their want of thrift. It will be seen in the sequel that such accusations are either entirely untrue or have been grossly exaggerated. "It is no doubt considered by some to be an easy way to wealth to prosecute the herring or white fish fisheries, and secure a harvest grown on a farm where there is no rent payable, the seed of which is sown in plenty by nature, which requires no manure to force it to maturity, and no wages for its cultivation. But it is not all gold that glitters. There are risks of life and property that are unknown to the industries which are followed on the land." *

The fisher folk, taking them all over, will compare most favourably with other classes as regards the labours of the men and the virtue of the women; their humble homes, as a

* 'Harvest of the Sea'—third edition.

rule, are clean and tidily arranged, and in some villages a profane word is scarcely ever heard. The hospitality of the fisher folk is proverbial, and their charity, at times when a boat is wrecked, and the bread-winner of a family is drowned, is active and unbounded. In not a few of our fishing villages there may be seen in the houses of different families little boarders who have found a home with the other children of the place, their fathers having gone down in the waves on the occasion of a storm overtaking the fishing fleet and wrecking some of the boats. There is much that is heroic in these communities, and deeds of charity have many a time been done, which had they been blazoned by the press, would have excited the unbounded admiration of the people.

THE SCOTTISH HERRING FISHERS, THEIR WORK AND WAGES.

The capture of the herring, the principal fishing industry of Scotland —Money value of the herring—Scotland's share of the herring wealth enormous—Number of persons connected with the herring fishing—The curer the chief agent in the organisation of the fishery—Constitution of the herring fishery of Scotland—The fishing contracts—Bargaining—Extent of the netting used in the capture of the herring—Work of the fishery described—The gutters—The "hired hands"—Incidental phases of the fishing for the herring —The sprat fishery.

THE capture of the herring may be set down as the principal fishing industry of Scotland. The herring harvest gives employment, at certain seasons, to the whole fishing population, and the labour involved in the capture of that abounding fish is very much greater than most persons would think. Although the herring fishery is carried on at some place or another all the year round, we shall not visit the varied seats of that particular industry, but confine ourselves to one of those great centres which has become a rendezvous for the fishing boats of many smaller localities.

The wealth derived from the herring is enormous, the total value of these fish which are captured by boats of the United Kingdom has been set down at the handsome figure of about three millions sterling. Scotland long ago succeeded Holland as the seat of the "great fishery," and it has been calculated that more than 150,000 persons derive some portion at least of their means of living from "the herring," the capture and cure of which in many places of the United Kingdom, and also in Ireland, is a long established feature of fishery economy.

The chief agent in the organisation of this very onerous industry is known in Scottish fishing ports as "the curer," two-thirds of the herring which are caught by boats fishing from Scottish ports, being ultimately sold as *cured* herrings, the other third finding its way to market—by means of industrious "buyers" who are now to be found at every fishing port—as "fresh herrings." Herring commerce is still to a large extent centred in the curer, who finds the materials necessary for the cure, and engages persons to superintend the different processes which are incidental to its progress. Some curers carry on a really gigantic business, engaging to accept the fish which are caught by several hundred boats, besides buying, as occasion offers, from boats fishing on their own account. It is necessary to state this in order to show such features of the business as relate to the earnings of the fishermen employed, many of whom receive but a scanty share of the large sums, which at times are paid for the fish. It has to be said generally of the herring fishery as regards the remuneration of the larger number of those engaged in it, that it partakes greatly of the nature of a lottery, in which some few fortunate individuals secure most of the prizes, leaving the blanks to the majority of those who participate in the enterprise.

Before proceeding to give details of the really hard labour involved in catching the fish, it will be as well to describe in a few sentences the constitution of the fishery. We will assume then that Mr. Peterkin, of Wick—there is probably no such person, but we shall assume that there is—has set up business as a curer, has become the tenant of a space of ground, has erected upon it a cooperage, and has imported any quantity of barrel wood, and purchased salt with which to pickle the herrings, as well as numerous miscellaneous stores likely to prove useful in the course of the season, including dye-stuff for nets, nets, sails, oars and whisky. The curer is of course a man of some means; if not the possessor of ready money himself he is able, we shall suppose, to obtain credit at one or other of the local banks ("cash credits" on good security being a leading feature of the Scottish banking system). Every curer must have money at command, as in numerous instances many of his payments have to be made long before he can realise the goods which he deals in. As a matter of fact, the curer often bargains for his herrings months before he can obtain them—long indeed before it can be known whether or not there will be any herrings to capture; and part of the bargain made by the fishers is a stipulation for so much ready money—known in fishing circles as "bounty"—in addition to the sum per barrel (or *cran*, which is a measure capable of containing 36 gallons of fish) which he binds himself to pay for the herring, and perquisites of various kinds which he agrees to provide, such perhaps as cutch with which to *bark*, or dye the nets, drying-ground for the nets, and a quantity of tea, coffee or ardent spirits; although whisky, as has been already stated, is not nowadays so much in demand as it used to be, in consequence of the more temperate habits of the men. The curer usually contracts with each boat-master to supply him with two hundred barrels of herrings, if he can capture so many; and a curer may have twenty or a hundred boats fishing for him, according to the amount of capital at his command, and the means he may possess of disposing of the cured herrings. The striking of a bargain between the boatmaster—or, as we had better call him, the skipper—is often a rather tough affair; all parties, as we may say, are working in the dark; neither of the men who are engaged in the arrangement can tell how next year's markets will formulate—if herrings prove to be scarce, then prices will be high; if, on the contrary, there occurs a glut of fish, prices will fall at once to a probably unprofitable figure.

These are all features of the coming fishery which require to be taken into account; and, moreover, although the curer arranges for the supplying of two hundred barrels of fish by each of the boats fishing for him, he is not usually provided with a stock of salt sufficient to cure that quantity; he does not perhaps calculate that he will receive on the average more from each of his boats than from eighty to one hundred and twenty barrels—"crans" are however what are bargained for, but we prefer to use the word barrel, as the sale of the cured fish takes place in barrels. Generally bargains are struck on the figures of previous years, the curer trying as well as he is able to forecast the features of the season, and to picture in his mind's eye the fortunes of "the fishery." If all the fish bargained for were to be caught, the chances are that the curer would be "caught" as well; his stock of salt would rapidly run out, and his supply of barrels prove utterly inadequate, as has not infrequently proved to be the case during previous seasons when a glut of fish has occurred. Besides these *désagrémens*, his gutters would not in all probability be able to overtake the necessary work, and so a large proportion of the fish captured would in a sense be wasted, as to obtain the best official brand, it is absolutely necessary that the herrings be cured on the day they are caught.

Curers are often blamed for their desire to "force business" in connection with the herring fishery; and probably in the case of speculative curers the blame is in many instances deserved; and whenever misfortune overtakes a fishing community the curer is blamed as being in some way the cause of it. Young men anxious to become owners of a boat and to engage in the fishing on their own account, instead of continuing as the hired servants of other boatmasters, are often able to indulge their ambition by the aid of a speculative curer, who will supply all that is required—boat and fishing-gear complete—on credit entirely, or partly for cash, and partly on credit as may be agreed upon, but not of course without some distinct advantage to himself in connection with such a speculative transaction. He will charge a higher price for the boat and its gear, and he will make a harder bargain with the owners for the produce of their fishings. Such transactions occasionally terminate favourably for all connected with them; a series of fortunate seasons enables the buyer of the boat to pay off his debt and to become a free fisher, at liberty to dispose of the proceeds of his industry to whomsoever he pleases. This will not appear in the least improbable when it is taken into consideration that by one evening's work a boat's crew may draw from the water a hundred pounds' worth of herring. On the other hand, the owners of a vessel may work hard for a whole season, and scarcely obtain a larger sum than will pay the wages or shares of those hired to assist them. It is not to be expected that the industry of herring fishing will be barren of such incidents, so long as young men are ambitious and curers are willing to speculate. The cost of a boat and a suite of nets, it may be added, is much greater than it used to be; herring boats are of a larger build now, most of them being decked or half-decked vessels, in place of the open yawls that were in almost universal use for the shore herring fishery twenty years ago.

The herring boats of the period, with all their fittings, will cost on the average about £270, whilst nets will cost about £3 each.

When the bargain has been made, the labour of fishing begins at the proper season, the fishing on the Scottish coasts being at its height in the month of August. The fishing-boats engaged in the herring fishery are frequently being improved, and will doubtless some day be much better than even the best of them are at present, far ahead as these are of the old "Clinker" Leith built boats once so much in favour.* As has been hinted, many of the boats are "family concerns," and, that being so, come to be worn out in time, the money earned being all required for the use of those dependent on the vessel, and as repairs are not always made when necessary, the boat in due time becomes unfit for the work incidental to the herring fishery, and in the end is laid up a sheer hulk quite useless for any purpose whatever. A number of the boats engaged in the herring fishery are still the open

* As to the superiority of large boats over small ones, we have gleaned the following information from a report of the Scottish fishery board, in which the fishery officer at Eyemouth states that those crews who fished from large decked boats with some amount of perseverance, made from £200 to £300 for the season, whilst the crews of adjacent ports were not fortunate, not being so well prepared. In a few instances, sums of from £500 to £700 were earned by the decked boats. Open boats with inferior netting made only from £60 to £120. In a few boats homing pigeons are carried : they are let off as soon as the catch is determined, to let the curer know what number of barrels he may calculate upon. One drawback in connection with the use of the larger boats is that, should they be becalmed the herrings with which they are laden will not be received in time for the cure. Steam tugs should, in such cases, be kept in readiness to bring in the boats, till the time comes when steam vessels are regularly employed in the fishery. This, we believe, is now being done.

clinker-built boats that have been so long in use; they are usually manned by four persons in addition to the skipper, who may be either sole or part owner, and all on board find plenty of work to do on each evening of the fishery, for although the boat is provided with a large shoulder-of-mutton sail, it often enough happens that the oars have to be resorted to in order to reach the supposed haunts of the fish, and always as a general practice when the nets are being "shot"—that is, paid overboard. During late years the labour of herring-fishing has been greatly augmented by the increased quantity of netting which is thought to be necessary as compared with the net power employed twenty-five or thirty years ago. Some very interesting details regarding the nets used by the herring fleet were collected and published by the Commissioners who inquired into the condition of the Scottish herring-fisheries six years ago. As giving some idea of the labour which the nightly distribution of the netting entails, we beg to lay before our readers the following summary of figures, relating to the increase of net power, and the revolution which has been caused by the substitution of finely-woven cotton for hemp nets :—

Twenty years ago a boat carried 24 nets made of hemp, each net forty yards long, with 28 or 29 meshes to the yard, 10 to 12 score meshes deep, and weighing 25 lbs. Each boat carries now 50 to 60 nets made of cotton, each net 60 yards long, with 35 meshes to the yard, 18 score meshes deep, and weighing 12 to 14 lbs. A boat, in other words, used to carry 960 yards of netting; it now carries 3,300 yards. The nets used to be about six or seven yards, they are now over ten yards deep. They used to present a catching surface of 3000 square yards; they now present a catching surface of 33,000 square yards.

Such is the formidable instrument of fishing which the crews of the herring boats have to handle on each night they are at sea. The nets of the fleet of herring boats which on some nights may be found fishing off the coast of Aberdeenshire could reach six times across the North Sea, and in instances the suite of netting which is cast overboard from one boat will extend two miles in length. The herring-boats usually commence to leave the harbours for their fishing stations early in the afternoon; if there should be a favouring breeze they hoist their sail, and reap the advantage of a speedy run to the spot selected, which however is not always the place where they find the fish. Often enough a boat proceeds to fish at a place that may be from thirty to forty miles distant from the port of rendezvous, and it is all a matter of luck whether or not the men hit upon the shoal. The work of shooting the nets usually begins at sunset: the mast is struck, and, two men taking the oars, the boat is moved slowly across the tide; the skipper of course keeps possession of the helm, having first of all selected his theatre of operations; the remaining two men of the crew have the duty of throwing over the nets into the sea. As the writer is well able to testify, having more than once personally taken part in the work, it is a laborious process, and requires some care, occupying a considerable time, so that when it is concluded the men are ready for a little refreshment and a few hours' rest. They partake of a frugal supper, and in some boats the skipper will ask the men to join him in singing a hymn, and he may perhaps offer up a simple prayer, asking the blessing of God on his enterprise. Ordinarily the men who have been working at the oars, as well as their fellow-labourers at the paying-over of the nets, speedily fall asleep, and enjoy an hour or two of "blessed rest."

But the skipper, who may himself be either the owner of the boat or hold a share in it, seldom sleeps; he is all too anxious about the venture, and sits throughout the silent watches of the night speculating on the number of "crans" of herring that he may see brought into the boat when the hour of hauling in the nets arrives. Before that time however his curiosity as to the good or bad fortune of the night may have culminated in a desire to see whether his nets have been so fortunate as to hit the shoal, and so he pulls in a few yards of the floating fabric, to see if there be fish; or mayhap he may be tempted to examine the nets attached to a neighbouring boat, to find out what degree of fortune has attended it. Sometimes it happens that after the nets have been shot, and the boat has been drifting with the tide for an hour or two, there are no signs of the shoal having been hit upon, so that a new departure becomes necessary, and the whole of the labour has to be incurred a second time; the nets have to be hauled on board, the boat rowed to another pitch, where the huge fabric of capture is again cast into the waters in search of prey: again the men lay themselves down to their rest; again the boat, with the watchful skipper at the helm, floats about for an hour of two, when comes the final test of the night's fortunes. Let us assume that success has at length been achieved, and that the fifty or sixty barrels of fish which have been enmeshed adds to the labour of the enterprise. Two miles length of netting, often enough heavily laden with newly-caught herrings, have to be hauled on board, the fish have to be shaken or picked from the meshes, and the boat, wind or no wind, has to make its way home to port in order that the curer may obtain possession of the cargo. Many a time and oft the poor men have, on their way back to their harbour, to row a good part of the way; and when the sea is lumpy and the boat laden with fish—a delightful burden in the eyes of its owners—the toil is severe. Nor is the labour over when the port is reached, for then begins a new duty—the fish have to be landed, and it is the work of the crew to carry them to the curing stances, which may be at a considerable distance from the place in the harbour where the boat has found a berth. After the fish have been duly consigned to the charge of the coopers, the nets have then to be hoisted ashore and sent off in a cart to the drying ground; and not till all these duties have been duly accomplished may captain and crew seek repose.

And thus the toilsome work of the herring-fishers goes on day after day; on some happy occasions they may be so fortunate as to fall in with the shoal a few miles from the shore, and fill their nets with such speed as to enable them to return before breakfast-time, and so obtain a few hours of welcome rest; or, on the contrary, they may not find their finny prey till they are far, far at sea; and not infrequently, before their labour can be brought to a close, a fierce storm may break on the waters, causing the men to hurry to a place of refuge, if they can find one, in order to save their lives and property, a feat which cannot always be accomplished. Many a fishing boat on such occasions is swamped by the angry waters, and many a gallant husband and good father perishes whilst at the post of duty. The public are not unfamiliar with stories of the dread disasters which occasionally overtake the hardy fishermen of our coasts, although in Scotland it is happily the case that the death rate from such causes

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is considerably less than it is elsewhere, the hereditary Scottish fishers being an anxious and careful body of men.

But although the men who caught the fish are in bed asleep the industrial drama of the herring cure still goes on; as the boats reach the harbour a new phase of work begins. As has been stated, the greater portion of the herring taken are cured, which involves their being gutted and salted as well as being packed in barrels. These processes are all organised by the curer and his confidential assistant, the head cooper; the women who are entrusted with the disagreeable work of eviscerating the fish perform their part with great celerity, and will go on working for several hours in the most active way. They are paid according to the tale of work they do, which is a great incitement to industry. A woman has been timed to gut two dozen herrings in a minute, so that she can fill a barrel in the course of about thirty-five minutes. When it is considered that over a million barrels of herrings are cured in Scotland every year, and that each barrel contains over seven hundred and fifty fish, it will be apparent that the females engaged in the work of evisceration have plenty of work cut out for them, seeing that the season on the north-east coast of Scotland, where most of the herrings are cured, only lasts for about eight weeks. We do not know any other kind of labour for women that could be classed with the curing of herrings, and we dare say it would be rather difficult to find females in inland places who would consent to work at the herring troughs. The rate of payment for this kind of work used to be at the rate of fourpence for each barrel of herring filled with the gutted fish; and hundreds of persons fishermen's widows and others, were very glad of the work, so that they might earn a few pounds during the course of the fishery. At such times as there is a large fishing—"a glut of herrings"—active gutters are at a premium, whilst the wages paid for the work are increased; an expert party of six women will make up over one hundred and thirty barrels in a long day.

It may be as well, before going farther, to state more definitely than has been done the figures pertaining to the herring fishery, so far as wages and allowances are concerned. Premising that the terms agreed upon may not be alike in any two places, it may here be chronicled, that agreements at the rate of a pound per cran for the tale of two hundred crans with a bounty of perhaps thirty or forty pounds, and in some instances fifty pounds, have this season (1883) been entered into; various perquisites of the kind already indicated being also included in the bargain. Many of the hired men now prefer to share in the luck of the fishery and take their chance of payment at a certain rate per cran rather than accept fixed wages: say one shilling, or two shillings per cran, as the case may be, as also a fixed sum by way of bounty, as well as other advantages of various kinds. The terms made by the hired men depend, of course, a good deal on the state of the labour market; when a new centre of herring fishing industry arises, or an old one develops itself, as is the case in Shetland, both men and women flock to it in the hope of obtaining better terms than would be offered them at older established fisheries. These men are now much better paid than they used to be some thirty years ago, when, for the whole period of "the fishing," a five-pound note would perhaps be their utmost reward. These "hired men," it should be stated, are many of them mere labourers, and not expert fishers—they are a mixture of the small farmer, the village mechanic, and the sailor, glad enough to turn out in the herring season, the best that can be said of most of them is that they are hardy and willing labourers, anxious to earn a few pounds when "siller is a-going."

As to the women, the Fraserburgh correspondent of the *Scotsman* newspaper recently stated that, "Women, to work as gutters, are in great demand, and the wages offered them are quite unprecedented. The rates of arles for the eight weeks' work run from £1 10*s.* to £5 each, besides 8*d.* per barrel gutted and packed by the crew. It is only a few years since a woman considered herself highly paid if she got 5*s.* of arles. A number of women belonging to the town have gone to Shetland this season, and the present competition is, no doubt, due to that."

Mr. James Wilson's description (*Voyage Round the Coast of Scotland,* 1842) of the work of gutting is graphic: "though the gutters are not a few of them good-looking creatures, yet the appearance of the general mass after they have worked an hour or two, beggars all description. Their hands, their necks, their busts, their

'Dreadful faces throng'd, and fiery arms'

every bit about them fore and aft, are spotted and besprinkled with little scarlet clots of gills and guts, or as Southey says of the war horse of Don Roderick, after the last and fatal fight—

'Their flanks incarnadined,
Their poitral smeared with blood.'

Bloody and all begrimed with slime the gutter stands up with knife in hand, or stoops her horrid head 'with scaly armour bright,' and plunging her bare and brawny arms again into the trough, scatters her gills and guts, as if no bowels of compassion existed any more on this terraqueous globe. . . . Towards evening they carefully wash their faces, arms and legs, and slip on again their better garments. Thus they never appear except around the gutting board in otherwise than trim array. Indeed, many of the most magnificently fine females, whom we saw standing at respectable doors, or looking out of decent windows, or going sedately about their evening occupations from shop to shop, had been assiduously engaged in gutting all day long."

On some one or two days during every season's fishing, at Wick and other important herring ports—Fraserburgh and Peterhead are now rather before Wick as centres of the fishery—the delivery of fish from, perhaps, five in the morning till four o'clock in the afternoon will be so incessant and in such large quantities that the whole industrial resources and activity of the place will be called into requisition, as it is of the utmost importance that the herrings landed should be cured by set of sun, so as to secure the best brand. The close of a successful herring fishing season is always marked in Scotland by the great number of marriages which take place; in many of the smaller fishing ports the weddings of the young people depend on the fishery. If it should prove a failure, marriages are postponed in consequence, and men and women agree to wait for more prosperous times. We have not the means of determining exactly how many persons are employed throughout Scotland in the capture of the herring only, but, taking men and boys together, there will probably be not less than fifty thousand persons, whilst the amount of capital sunk in boats, fishing-gear, and the materials of the cure will probably not be less than a million sterling. According to an official document which we have examined there were over 14,000 fishing vessels of all kinds in Scotland in the year 1881, the larger number of them being employed in the shore fishery for herrings. Some fishermen make it their business to fish for the herring all the year round, and these, as the saying is, "follow the fish" from the far-away seas of Scotland to Yarmouth, and scarcely ever know an idle day. Wherever the herrings make their appearance the Scottish boats, with their hardy and industrious crews, are sure to be participating in the work of capture, whether at Cullercoats, Holy Island, the Isle of Man, or Yarmouth.

We have, so far, only endeavoured to show the round of labour incidental to the chief herring fishery of the year—there are winter herring fisheries in Scotland as well, some of which are very successful, but the great outlet for all persons interested in "the herring" is, of course, the fisheries of the autumn season. Then a large number of persons who do not fish all the year round, try to earn "an orra pound or may be twa" by assisting, at what is at that season an almost universal industry; cobblers lay down their lapstones, gardeners put aside their spades, and turn out with some one or other of the boats, in the hope of sharing in the bounty of the waters. At the chief herring ports a large number of persons other than the usual population find employment; an influx of men and women from the Highlands and Islands is one of the features of the fishing season. The hawking of fresh herrings from such places as Montrose, Peterhead, and Berwick or Eyemouth, also affords employment to a considerable number of persons, so that the bustle incidental to a herring port in the brief time devoted to the capture of the fish produces an exciting change in some usually quiet enough fishing communities. It is evident, too, that a sum of two and a half millions sterling, which it has been calculated should in recent years be about the value of the herrings caught in Scotland will cover a large series of distributions. The capture of the sprat in its season (a toothsome fish), for which there is always a great demand, would prove a remunerative winter fishery, were it not for the high rates of freight charged for its conveyance to the seats of population where it is consumed. As a profit cannot be made on the consignments, sprat-fishing is for a time somewhat in abeyance.

We have dwelt at some length on the industrial phases of the Scottish herring fishery, because it is of great moment as a food resource, likewise as an outlet for the employment of capital, in the catching and curing of the fish—as well as in the building of boats, the making of barrels, the weaving of sails and the making of nets. In the course of the year, at one place or another, the herring fishery of Scotland yields employment more or less remunerative to the whole of the fishing population of that country—hence its importance as compared with places where the capture of the herring only forms a portion of the general round of fishery work.

THE FISHERS OF YARMOUTH.

Herring fishing on the English coasts—Herring catch at Yarmouth—Size of vessels and modes of work—Mode of paying the crew—Yarmouth bloaters and kippers—Scottish boats at Yarmouth—Curing processes.

We do not propose to follow the herring-fishers to every place where there is a rendezvous for their boats—in other words, a seat of the fishery. The labour attendant on the Scottish system of drift-net fishing has been detailed in the preceding pages; but in Scotland, especially in Lochfyne, another mode of capturing the herring has been long in use. We allude to "seining," or, as it is called locally, trawling. It is not so laborious as the drift-net mode of fishing, and seems a suitable mode of taking the herring in such waters as Lochfyne. In some years seining has proved very remunerative to the men, in consequence of the fish being plentiful; but there, as elsewhere, the fishing is irregular, and no one can say how he has fared till the end of the season, a few lucky hauls on one or two days of the fishing may make all the difference between good and bad fortune. No other modes of fishing for herrings have been adopted in Scotland other than seining and drift-net fishing; and, as has been stated, the herring-fishery in Scotland is chiefly a shore-fishery, which of course adds greatly to the toil of the fisher folk. The practice of "yair-fishing" is now, we think, very uncommon, but we have seen yairs, or enclosures, in Lochbroom, into which the herrings enter and are left high and dry by the tide. There are a few decked boats in connection with the Scottish herring-fishery which have accommodation on board for carrying on the cure, but the leisurely labour on these vessels is less onerous than that of the shore-fisheries, where the work goes on at a ding-dong rate from sunrise to sunset, for the sake of securing the best brand to the greatest possible number of barrels.

There is herring-fishing in abundance on the coast of Northumberland, and the Isle of Man herring-fishing in some seasons is very productive; but we shall now take up our station for a brief period at Yarmouth, which is an important seat of fishing industry, and has acquired a great name for the extent of its commerce in cured herrings. The fish of that kind brought into the port of Yarmouth are not, however, cured as in Scotland, the herrings being mostly manipulated as bloaters and reds. According to some statistics published by Mr. De Caux, "during the last thirteen years the grand total of herrings delivered at Great Yarmouth has been at least 210,000 lasts, or the marvellous quantity of 2,772,000,000 of herrings." But a still better idea is conveyed of the magnitude of the fishery work which is brought to a focus at Yarmouth by a knowledge of the fact that during every season, on an average, the mere operation of counting the herrings landed at the fish-wharf costs upwards of £2,200, while for simply helping to lift the herrings from the ground on to the carts which convey them from the wharf to the various curing-houses, or to the railway-stations, no less a sum than £370 is paid. The number of fishers from all places congregated at Yarmouth during the herring-season will not, we think, be less than 12,500. At least a thousand boats went out day by day from Yarmouth in search of the herring in 1882. The crews are paid according to the number of herrings which they capture. The vessels engaged in the fishery are larger and better furnished than the usual run of Scottish herring-boats. This is necessary, because they carry a crew of from ten to thirteen persons, and remain out fishing a night or two. The boats are full-decked, have two, and sometimes three, masts, and are strongly built, so as to stand the stress of weather. These vessels carry each a suite of 100 nets, each net being 48 feet long by 30 feet deep.

The labour involved on board of these boats is considerable. The men shoot the nets and haul them in oftener than once in the course of the night—the fishing commencing at sunset. The mode of work is well-planned throughout, every man having his allotted duty to perform; one person looks after the corks and floats, another, with an assistant, pays out the netting, whilst another has charge of the warp-rope to which the nets are fixed. After being examined about every two hours, when it is thought a sufficient number of fish have struck, the nets are hauled on board by means of the steam-driven capstan, now generally used by North Sea boats, and being passed over a horizontal pole, the herrings are "shook out," falling into the hold: each net as it is emptied being carefully stowed away in its appointed place, to be ready for use when the time arrives to make another shot; in fact, the discipline in these herring vessels is about as exacting as on board a man-of-war. When the herrings are got on board there is still more work to accomplish: they have to be "roused" with salt, and, after that operation has been carefully performed, have to be packed carefully away in the hold; and, as on some occasions the nets are full of fish, there is plenty of work for all hands.

It is quite certain that the hardy fishers of Yarmouth do not eat the bread of idleness in the times of herring-fishing, which lasts, for winter fish, from the beginning of October to the end of November. It is perhaps almost unnecessary to say that the boats require to proceed cautiously while engaged in the operation of fishing; there is a large fleet employed in the work, and if the men were careless there might occur a series of entanglements of the nets that could not fail to be irritating, and probably result in the partial loss of the fish taken. On this head, Mitchell tells us in his work on 'The Herring,' that the greatest precaution is taken to prevent the nets from mixing. "No fishing vessel," he says, "anchors except during the day, when the nets are not out, or unless the weather is so calm at night as to prevent the possibility of shooting the nets; and during the night each vessel has a lantern at the bow, upon a pole sufficiently elevated to be seen at the distance of five miles." Should, for instance, a decided change of wind occur after the nets are shot, the whole business must be gone over again—the nets have to be hauled in and re-shot, to prevent the terrible confusion and loss that might result. Much fatiguing work is involved on such occasions, and the crews are sometimes very tired. As has been already stated, the fishermen of Yarmouth are paid by results; the curers arrange at the beginning of the season with their own crews to pay them a fixed price for every boat-load they bring in. This is instead of paying a regular sum of money monthly as wages; and it induces the men to do their best, as a considerable catch of fish is necessary to enable the curers to pay the expenses of their vessels and establishments before they can make any profit.*

As is well known, a considerable portion of the herrings which are brought ashore at Yarmouth are cured in a

* 'Deep Sea Fishing and Fishing Boats,' by Holdsworth.

peculiar fashion, which industry employs many hands at fair wages. The "Yarmouth bloater" is known all over the world. The story of the "invention," or rather discovery, of this mode of cure has been told by Mr. De Caux, in his little work on 'The Herring and the Herring Fishery.' We venture to abridge it for the information of our readers, without, however, entering into any details of the process of the cure; suffice it to say that a bloater is a fresh herring slightly salted and smoked, but not gutted; it will not keep beyond three or four days, and should therefore be eaten promptly. The mode of making bloaters was discovered by Mr. Bishop, a herring-curer of Yarmouth, about the year 1835, but the precise date at which it took place is unknown. The following account of the discovery is, we believe, correct: "One night, after his fish-house hands had left the place, Mr. Bishop found a small quantity of a prime parcel of fresh herrings which he thought had by some mischance been overlooked. To prevent the fish from being spoiled, he sprinkled them with salt, spitted them, and then hung them up in a 'smoke house,' in which oak billet was then being burned; and the next morning he was both astonished and delighted at their appearance, as well as with their aroma and flavour. Henceforth he made the cure of bloaters a special pursuit, and, as other curers speedily followed his example, in a very short time the 'Yarmouth bloater' became known far and wide." "Newcastle kippers" denote another mode of curing the herring, which affords employment to a large number of the women folk of Yarmouth. This branch of the fishery business we are told was introduced by Mr. John Woodger, formerly of Newcastle; and the late Mr. Buckland learned that as many as 1500 lasts of herrings were prepared in this manner (13,200 fish to the last). The first samples of these kippers were prepared for public sale in 1846, and now herrings cured in that style have a firm hold of the market.

In the year 1881 the take of herrings by the Yarmouth boats amounted, we are told, to 16,725 lasts, or 220,770,000 individual herrings. As to the curing processes in vogue at Yarmouth, it may be stated here that they vary according to the future of the fish. Bloaters are not "gypped" (i.e. gutted), but other kinds of cured fish are, just as in Scotland. The "curing works" at Yarmouth are well worthy of being visited when the herrings are on hand. They are perfect hives of industry. There are registered at the port of Great Yarmouth 621 vessels of all kinds, of 15 tons and upwards, and these boats employ 5160 hands on board; there are besides a large number of boats under 15 tons that rendezvous at the same port—there are, for instance, 300 boats from various ports of Scotland, that come south to the herring fishery; there are, including shrimpers, 150 other vessels, as well as 120 smacks, from Gorleston.

The Scottish boats which fish at Yarmouth, it may be stated, are smaller than the local vessels, and carry suites of finer netting. They fish for the fresh herring trade, and run into port with their catch for immediate sale. It is interesting to note that, if the number of herrings recorded above were to bring one halfpenny each to their captors, the sum would amount to £459,937. The herring fishery only occupies a small portion of the time of the Yarmouth fishermen; how the remainder of their time is occupied will be seen by consulting another division of this work —THE FISHERS OF THE GREAT NORTH SEA.

THE CORNWALL PILCHARD CATCHERS.

Importance of the pilchard—Catching pilchards by the seine net—Earnings of the pilchard-catchers—Cure of the fish—"The Pope and pilchards"—The pilchard Harvest—Drift-net fishing by Cornwall boats.

THE pilchard is an important member of the herring family, the capture of which may be said to form the staple fishing industry of the coast of Cornwall; and it may be said of the Cornish fisher folk that they greatly resemble the fisher people of Scotland, inasmuch as they are hereditary fishers, and conduct their business much in the same way as many of the Scottish fishermen conduct theirs. The boats in many instances are family concerns, and the profits made are divided in equitable proportions among the crew. These fish are in some seasons more abundant than others, and are anxiously watched for and industriously fished when found. It is not our cue in the present work to deal with the natural history of the pilchard, but we may perhaps be allowed to say that the circumstance of the fish frequently coming in shore in large bodies—"schulls" these bodies are called in Cornwall—affords an opportunity to the most stay-at-home fisherman to participate in the work of capture. This coming in of the fish to the bays has given rise to one of the modes of capture, namely, that mode which is carried on by means of the seine net, and which has been so successfully imitated by the herring fishermen of Lochfyne in Scotland. It may be explained, however, that the seine or sean net, either as used in Cornwall or in some modified form, is also used in various other fisheries than those for members of the herring family; in fact it is used occasionally for the taking of all sorts of fish, and not for one fish in particular. When conducted in that way seining is denominated "blind fishing." We may briefly describe here the labours undergone by the fishermen of Cornwall in connection with the working of a seine net, the use of which is so to enclose the fish of a shoal as to prevent their escape, and keep them alive till the men and women can carry them ashore to the curing houses.

The industry of pilchard catching by means of the seine net is pretty well organised, as may be seen in the bay of St. Ives in the months of September, October and November; with its many picturesque developments this mode of pilchard capture is well worth watching; when a shoal has been successfully surrounded by the nets, a period of great activity at once ensues, the work accomplished during which speedily makes up for many days of enforced idleness. About the period when the fish may be expected to come inland, patrols are appointed to parade the high places of the coast, and give notice, by means of preconcerted signals, of the approach of the pilchards. These persons are designated "huers," and are chosen for their qualities of quick-sightedness and general activity. These sentinels of the Cornwall pilchard fisheries take each a spell of duty of three hours' duration, there being two men to each look-out station. They used to signal to the fishermen by means of a branch held in their hand; but on the St. Ives stations there is a staff on which is fixed a movable ball of a white colour, by means of which directions are telegraphed to the boats to indicate the locality of the shoal. These men who raise the hue and cry on the approach of the fish have fixed wages for the period they are at work, of £3 per month, and a perquisite besides of every hundredth hogshead of the fish captured by the boats which they serve. The wages or remuneration of the fishermen employed in the same boats is at the rate of 45*s.* per month, one-ninth part of the fish caught being also their property. There are also men called "blowsers," whose duty it is to land the fish and carry them to the curing cellars—their pay is arranged in proportion to the catch of fish. The wages in "kind" are at once paid, the ninth part of the fish being promptly taken possession of and divided among those entitled to them. According to Mr. Thomas Couch: "The crew of a sean consists of eighteen men, and commonly a boy. The wages of the ordinary seaner have varied from eight to twelve shillings a week; the men who actually shoot the sean have a shilling a week extra, while the master-seaner's pay is a guinea, with a gratuity on each hundred hogsheads which he is so fortunate as to catch; besides which the crew are in common entitled to a third part of the fish sold fresh, and a fourth of that which is exported; in some places not even paying for the casks in which they are packed."

As there are 250 "concerns" (seines) in working order at St. Ives, it is obvious that they cannot all be at work at the same time, and it has therefore been wisely arranged among the proprietors that each shall take his turn at the fish, according to a scheme laid down to which all have agreed. The seines can only be worked from half-a-dozen positions, and, so that there may be fair play, all the seines are registered, individual owners agreeing among themselves to work on the co-operative system; and therefore at the beginning of each season a uniform plan of operations is agreed upon at a meeting of the seine owners, whereby each attains a turn or two turns, according to capacity, some concerns being much larger than others.

The pilchards are cured in a particular manner, and the cure affords plenty of work while it is in progress, those engaged in it being chiefly the women of the place, who also cure at home their husbands' share of the fish for family use; and these, with the accompaniment of potatoes, form a large portion of their daily food. The pilchards are exported for the behoof of foreign countries, where they are much esteemed. "The Pope and Pilchards" used to be a favourite toast in some parts of Cornwall.

As showing the continued work which results from a successful catch, it may be mentioned that as many as thirteen million pilchards have been enclosed in one seine. The advantage of using such nets is, that the fish, being securely tucked within the seine by means of an additional net, may be kept alive till the cure of the whole lot can be undertaken and completed, which is accomplished at leisure, so to put the case, although the people are certainly busy enough whilst any of the work remains to be accomplished. The oil which exudes from the pilchards while they are being cured is valuable, and is used chiefly by curriers in the preparation of some kinds of leather; the yield of oil is about two gallons per hogshead. As we have already said, the pilchard harvest fluctuates very much; the number of fish mentioned above is the largest ever taken at one operation. In the year 1881 the quantity of cured pilchards exported was close upon 14,000 hogsheads, and the price per hogshead to the curers averaged about 58*s.*—in one year as many as 45,000 hogsheads have been cured. But, as in the Scottish herring fishery, there is also a large consumption in Cornwall and other counties during the season of "fresh" pilchards, whilst there is likewise a local sale of cured fish.

Having said so much about the seine nets, we may now refer to the drift-net fishing, which forms a prominent feature of Cornwall industry. We do not know the exact number of the fishing population that find employment in Cornwall in connection with the pilchard, mackerel, and general fisheries, but there are 624 boats of all sizes, valued at £368,000. Some account of the drift-net fishing of Cornwall, so far as its industrial aspects are concerned, is contained in a recent official report of an inquiry, and from that blue book we are indebted for the materials of the following summary. On the drift-net fishery boats are employed varying in size from half-decked luggers of 15 tons and 26-foot keel, engaged in the pilchard fishery, to full-decked luggers of 30 tons and 46-foot keel or more, employed in the mackerel fishery. The pilchard drivers rarely go far from shore, and always return to their port within 24 hours. Mackerel drivers follow their fish into the deep sea, and sometimes fish more than 30 leagues from the nearest land; and as these are the boats principally affected by the inquiry referred to above, the remainder of this memorandum must be read as referring to them. Each of their voyages is usually completed within 24 hours when on the home fishery; but sometimes, when several boats are in concert, many remain out for a week at a time, one of the fleet running for port each morning with the night's catch of the whole lot.

These boats are owned by individuals, and never by a company. They are manned by crews of about seven men and a boy, raised from the fishing villages from which they hail, all well known to each other, and very frequently related;

and the owner not unusually acts as master—if he does not a brother or a son, or some other relative, usually does. The "boy" is almost always related to some one on board the boat.

These boats, in the seasons, go to Plymouth, the Yorkshire coasts, and the Bay of Dublin. They never go far enough from shore to make it necessary that their masters should know the science of navigation. Nothing is required in a master but a knowledge of reading (so that he may learn up the lights and work a chart) and good practical seamanship; and of boats on these voyages it may also be remarked that no one has ever been lost through want of these qualifications. The crews of these boats are never shipped at wages; they work on share. Each man has the privilege of bringing on board a certain number of nets (a "net" is a length of net varying in the different fishing villages), and the earnings of the boat after paying her going expenses are divided. A certain share goes for the boat, another share for the nets, and another for the crew. The division of these earnings takes place at entirely uncertain periods, according to the catches of fish, but it occurs at intervals during the fishing seasons, with a wind-up at the end of each.

Mr. Thomas Couch in a history of Polperro, gives some interesting particulars of the Cornwall pilchard catchers, and describes them as a hardy race of men, often leading a life of toil and privation, and as a body not deserving of the hard things which have been said about them. Their gains, despite occasional spells of hard work, never reach any considerable sum, whilst they are at all times precarious; and were it not for the produce of their gardens, and their store of salted pilchards, their fate in severe and stormy winters would be one almost of starvation. The fishers of the Cornwall coast, according to Mr. Couch, are remarkably shrewd and sagacious in all matters pertaining to their daily industry, but, like others of their class, they are imbued with a strong vein of superstition, and are wedded to old customs. No one can doubt the courage of the Cornish fishermen on occasions of shipwreck, or of other disasters. They have braved the dangers of the deep without the slightest prospect of being rewarded for their often successful daring, and their hospitality to those who have been shipwrecked on their iron-bound coasts is proverbial.

As regards domestic usages the fisher-folk of Cornwall lead a rather simple life, never interrupted by the celebration of the many fêtes one finds occasionally brightening the life of the same class of people in foreign countries. In his history of Polperro, the quaint and picturesque "little fischar toune with a peere," Mr. Couch tells us that "it was once the custom for women to take the corn to mill, see it ground, and bring home their grist, for, rightly or wrongly, millers have ever been a suspected race. Honest ones are popularly known, being distinguished by some mark or tuft of hair in the palm of the hand. Accordingly the Polperro housewives, like the two clerks of Canterbury, were accustomed for a little while—

'To go to mill and see their corn ground,'

and, as the quantity was small, to carry it home. Hence several women would be waiting for their turn at the mill, which, like the bakehouse, became a noted centre of scandal. A bit of doubtful gossip was proverbially termed 'a mill-house story.' The sale of bread, except as penny loaves, Easter and hot-cross buns, was unknown in these times."

FISHERS OF THE NORTH SEA—TRAWLERS.

The North Sea Fishermen not hereditary fishers—Severe apprenticeship—Length of apprenticeship objected to, and should be restricted—Bad behaviour of North Sea Fishermen—Extent of the German Ocean—Value of the fish it yields—Trawling the chief mode of Fishing—Fleets of Smacks—The work of Trawling—The earnings of the trawl men.

THE fishermen of the North Sea, so far at any rate as they hail from the chief English ports, cannot be called hereditary fishers. The fishing smacks belonging to Hull, Great Grimsby, Yarmouth, and other ports, take apprentices from whatever place they can obtain them, and such has been the practice for many years, the consequence being that these vessels are now manned by a body of fishermen who, although they have been bred to the business, were not, as the saying goes, "born to it." Many of the lads who are taken as apprentices belong to families of the local labouring classes, but a larger number are received from workhouses and charitable institutions, and in some instances, we believe, from reformatories. The masters of fishing vessels have usually come through the whole round of labour incidental to all the grades of service before being appointed to the command of their smack—the office of cook at an early stage being one of the appointments.

It has been ascertained by inquiry that the apprenticeship to be served on board the big fishing-boats is a severe one; and by several of the captains, and by the older hands on board, the boys have been, and doubtless sometimes still are, cruelly used. At whatever age a lad is bound, he continues to serve as an apprentice till he attains the age of twenty-one years; and, as boys are frequently apprenticed who are only eleven or twelve years old, they in many instances become heartily tired of their occupation before the expiry of their indentures. It has been suggested in consequence that indentures should not be signed for a longer period than five years. Grave complaints have been made against the trawl fishers—men and boys—many of whom apparently do not conduct themselves in a reputable manner. An official inquiry has been held, and voluminous evidence taken as to the behaviour of the fishermen who proceed to the North Sea in trawling vessels, and many interesting facts have been elicited as to their modes of life and round of daily labour. One important feature of the industry has been elicited, and that is, that through the trawling service an outlet exists for the employment of a section of the population at all times rather ill to manage, and for whom it might prove somewhat difficult to obtain suitable work. The fisherman's calling on the stormy German Ocean is a healthy one, but the work is rough, and much discomfort has to be endured, occasionally spiced with incidents of supreme danger.

Although comparatively speaking a small sea, the German Ocean is a gigantic fish-pond, having a surface of more than eighty-nine millions of acres, yielding, it has been calculated, to those nations which have the privilege of dipping their nets in its waters, fish to the annual value of about twenty-five millions sterling. One hundred thousand tons of wholesome fish-food, it has been estimated, are contributed by the North Sea every year to the commissariat of London alone; and, as may well be supposed, a large fleet of vessels and a vast number of men and boys are employed in the work of capture and distribution.

We propose to give a brief sketch of the chief modes of fishing in the German Ocean, where, as a recent writer states, "no class of men work harder, live harder, or endure greater peril of their lives." What we have to describe, however, must be taken in a general sense, as we have not sufficient space at our disposal to enter into minute details.

"Trawling," as is generally known, is about the cheapest way of procuring plentiful supplies of our larger table-fishes; no bait is required, and miraculous draughts are sometimes obtained. Great efforts are constantly being made to improve the vessels; at all events, they are now built on a much larger scale than they used to be, while the introduction of a steam-worked capstan helps to save the men from some of the harder work which is incidental to that mode of fishing; and in the course of few years it is highly probable that the North Sea fleet will also be propelled by steam. We have steam trawlers working on various parts of the coast, with all the appearance of success; and the general introduction of such vessels in the North Sea is only a question of time. That the fish should reach the market as soon as caught, in order to be sold when thoroughly fresh and bring the highest possible price, is a necessity of the trade; some of the single fishing-smacks have to run to port with their capture as soon as it is made, in order to catch the buyers who are waiting. If they were screws instead of sailing vessels it is obvious enough they would be able to make speedier voyages than they can make with every stitch of the canvas they can carry set to catch the favouring breeze. The fishing-places, it may be stated, lie far out in the North Sea, so that the distance to be traversed is considerable before the Great and Little Silver Pits, the Well Banks or Rodney Gut can be reached.

Most of the trawlers work in fleets, each under the command of an admiral, who by means of signals directs the routine of the fishery.

The nightly round of trawl work throughout the fleet is pretty much as follows: at sunset, as a rule, as soon as the signal is given, the work of trawling begins by the net being let overboard. It is a gigantic chamber of horrors: for the fish, when once engulfed within its capacious maw, cannot easily escape, while all that are captured are kept—great and small, prime and offal, a circumstance which, we may be allowed to state in passing, is much to be regretted, as the smaller fishes ought to be allowed to escape. The heaving of this gigantic net overboard is of course a comparatively easy matter; not so the getting of it on board. When the trawl has been placed the men partake of supper; and the crew, except one man, go to sleep for a few hours, till the signal is given to begin work. It is usually about eleven o'clock when the admiral sends up a rocket to announce that the nets of the fleet must be once more got on board. This is labour of an exhausting kind. The writer has known three hours elapse before the ponderous machine has been got on board all right, the men working away with all their power of will and strength of muscle. The trawl, as soon as it is hoisted on deck, is emptied of its piscine riches, which on some occasions, when fortune has been more than usually favourable, make a formidable display of fine fish; but the fishermen have no time to expend in admiration. Many a naturalist however would really enjoy the scene, and be delighted with the crowd of curious creatures of quaint forms that are struggling for their lives. The first operation that the men perform is to assort or classify the fish into "prime" and "offal," which are the two classes known in the markets, although why haddocks and some other really good fish should be classified as offal is not easy to tell. Anything that is absolutely worthless is at once thrown overboard; but all the cruel dog-fish, which in some seasons are wondrously plentiful, are carefully killed, they "die game" as the fishermen tell us, unless when "settled at once," by a strong blow on the head, which is seemingly the most vulnerable part of all fish. Such fish as turbot and brill live a long time out of water, but soles die quickly; it is astonishing however what a strength of vitality is exhibited by the smaller flat fish—which flop about for hours after they have been captured.

After a brief time elapses, the trawl is once more placed in the water for another shot, and is hauled in about break of day; and while it has been at work the previous haul of fish have been more carefully gone over, and packed in trunks or boxes, to await the arrival of the steam clipper, which comes to the fleet to carry the produce to market. A rather dangerous part of the fishermen's work is the ferrying of these boxes from the smack to the steamer in a small boat—too small certainly for such work; but as the fish must be got to market, the men must risk their lives, no matter how wild the water may be during the time that kind of labour is going on. The placing of the fish on board the steam carrier involves a great amount of work, as will be obvious enough when the reader is told that as many as 2800 trunks of fish will occasionally be brought to market by one of these steam clippers.

The preceding narrative presents only the merest outline of the labours undergone by the trawl fishermen during their spells of work, which vary in length in different districts, the number of voyages not being the same for every smack, nor are the rewards of labour always the same. As a rule the captain and perhaps his second hand share in the venture, and are remunerated according to the catch, but different smack-owners have different modes of dealing with their hands. In order however to give our readers some idea of the earnings of those engaged in trawling, we may refer to the terms of the Messrs. Hewitt, who own a large fleet of smacks. The writer obtained much valuable information about shares and modes of payment at Great Grimsby; but it will be better to take the latest authoritative information on the subject, and therefore we shall summarise what was said about the fishing fleet of Messrs. Hewitt by their manager, Mr. H. Harvey-George, when he was examined during October last year (1882), by the Sea Fishing Trade Committee. As was stated by that gentleman, the men employed by the Messrs. Hewitt (570), are all paid on the share system, the rates of pay for the different classes being as follows:—There is first the skipper; his standing wages and poundage is as follows: if the catch fetches under 100*l.*, 1*s.* in the 1*l.*; if under 150*l.*, 1*s.* in the 1*l.* on the 100*l.*, and a fifth on the 50*l.*; if over 150*l.* one-fifth on the total. The mate gets 14*s.* a week and his poundage is: under 100*l.*, 5*d.* in the 1*l.*; under 150*l.*, 5*d.* on the 100*l.* and 7*d.* on the 50*l.*; if over 150*l.*, 7*d.* on the total. The third hand has 14*s.* a week and 4*d.* in the 1*l.*; and the fourth hand 10*s.* a week and 3*d.* in the 1*l.*; the fifth hand 9*s.*, and 2*d.* in the 1*l.*; the sixth hand 8*s.*, and 2*d.* in the 1*l.*; and the cabin boy 7*s.* a week, and 1*d.* in the 1*l.* These per-centages are paid on the total earnings of the vessel; and the smacks of the firm are all excellent boats, costing when new from a thousand to twelve hundred pounds, whilst the value of the steam carriers will not be less than £6000 each.

The amount of capital invested by the Messrs. Hewitt is about £100,000, and their steam clippers take the fish direct to London. The time of a trawler at the fishing varies from five to eight weeks, during which of course the carrier collects the fish day by day. We have not the means of knowing the earnings of individuals for all the hard and dangerous work they undergo, but we question if, in numerous instances, it will amount to much over a guinea a week—no great sum, when it is taken into account that the men have to sail the ship and work in the rigging as well as attend to the trawl-net, which, as has been indicated, is a most formidable instrument of fish-capture. It can be gathered from the evidence taken by the Sea-Fishing Trade Committee, that many of the Grimsby men feel irritated at not receiving prompt payment of their shares, and, above all, at not being presented with proper details of the sales. In one case, where a man asked to see the settling bill, "the skipper threatened to put him out of the window." As to the food given to the fisher lads aboard the trawling smacks, it is very plain and roughly served, but it is good, and consists of fish in the morning, with biscuits and butter, beef and pies and duff for dinner, and fish again at night. There are other trawling fleets than those of the Messrs. Hewitt engaged in the North Sea—the Hull Steam Fishing Company and Great Northern Steam Fishing Company for instance have 250 smacks at work, the London Fishing Company works 125 vessels and four steam carriers, these in addition to the numerous vessels of the Messrs. Hewitt make up a fishing navy of large figures, and when the single boats fishing on "their own hook," that is boats unconnected with any of the fleets, are added, together with numerous Dutch and other foreign fishing ships, it will be obvious that the German Ocean is a wonderful arena of fishery work.

Having gone over the round of labour incidental to trawling, we shall now proceed on board a cod-man, in order to see how it fares with the line-fishers, who contribute a large proportion of the prime fish which are so much prized for table use.

THE NORTH SEA FISHERS—THE COD-MEN.

Angling on a wholesale scale—A fishing line eight miles long—The value of live Codfish—Small percentage of fish to hooks—Cost of the cod smacks—Remuneration of line fishers—Bait: its importance and scarcity—Mussels and Mussel culture—Fishermen of all work—The shell-fish fisheries, their money value.

ANOTHER branch of industry which yields employment to a large number of fishermen, and incidentally, in Scotland at least, to their wives and families, is line-fishing for cod and other fishes. This is a comparatively simple although probably a very ancient mode of fishing—it is angling on a wholesale scale. On board of the codmen we usually find a larger crew than we do on board of the trawlers, and while out on a voyage, the men, ten or eleven, find plenty of work; in long line fishing, for instance, it is a serious labour of itself to bait the hooks. A suite of lines is 7200 fathoms in length, or about eight miles long, and it carries the amazing number of 4680 hooks, which have to be carefully baited with whelks, or, as in Scotland, mussels, of which mollusk one Scottish fishing port alone requires over five millions annually. As the hooks are baited, which is a work of time, giving employment to the whole of the crew when not otherwise accomplished, they are very carefully laid aside on trays ready for use, each tray containing so many pieces. A large number of separate lines are used, each being fastened together as a string. At about half-tide the line is shot by being carefully paid overboard so that none of the snoods to which the hooks are attached may become fouled. After the hooks have been got into the water, the smack heaves to till the tide has about ceased, when the work of hauling in the lines begins, the vessel making short tacks along the course during the process, the fish are taken off the hooks as they come in; this is work that has to be very carefully gone about, as one living cod is worth a good many dead ones. To keep these fish alive is therefore the chief aim and end of cod fishing. As soon as a cod is safely secured, its air bladder requires to be punctured in order to admit of its keeping its equilibrium when, as is immediately done, it is placed in the well of the vessel in the hope of keeping it alive till the port is reached, where, along with all the others which have been captured, it is transferred to a wooden box or cage in the dock. We are speaking at present of the cod fishery as prosecuted from Great Grimsby, in one of the harbours or docks of which thousands of these fish are kept alive to await the orders of the dealers—they can be taken out and killed as required. These fish command an excellent price, and can of course be sold at times when, in consequence of squally weather preventing fishing, there might be none to meet the demand. With favourable weather and an industrious crew good hauls of codfish are obtained, as well as ling, haddock and halibut. A Great Grimsby master of a cod smack told the writer that he has come into port on two or three turns right off the reel with as many as twenty-two score of live codfish in prime condition. The skipper alluded to says a very small percentage of fish to the hundred hooks is now taken, "the dogs" are so voracious that they kill and damage a lot of the cod, whilst other animals seem to have a pretty taste for the bait and to be endowed with sufficient cunning to get it off the hooks without being themselves captured.

The long lines are used in the winter season in various parts of the North Sea, some of them very far apart, whilst there are vessels that venture to great distances in pursuit of codfish, not, however, with any view of bringing the fish home alive, as that would be impossible under the circumstances, and therefore they are salted or cured in some particular way, so that they may be marketable, and bring a profit to those who capture them. The vessels alluded to make a voyage to Iceland or the Faroe Islands, on these occasions the fishing is carried on by means of handlines. At home, what we may call the coast fishing for cod is carried on during the summer months, when the smacks (the same vessels as are used in winter) keep from about ten to twenty five miles off the shore, using the handlines. The number of men employed at this season is the same as in the winter fishery, and it is found that the best fishing is obtained about sunset, at which time all hands will be found industriously at work. We have not entered into any of the technicalities of line fishing, as the business we have now in hand is to give an account of the work achieved by the fishermen and of the remuneration which they receive for performing it. The cod smacks in England—we are speaking of those of Great Grimsby—of which we have personal knowledge, are all of them boats of considerable value, costing, with their appliances, as much probably as £1600, and it is only because of the high money value which codfish commands that men go to such expense to carry on what is at its best a very speculative business and of the small profits of which they complain very much. It is only the captain of a liner who is paid by a share of the profits, his proportion, we were told by one of the Great Grimsby smack-owners, is not quite ten per cent.—in fact, his share is an eleventh—of the proceeds of each trip; the hands are all paid fixed wages, the mate twenty-two shillings, and the men each 1*l.* per week. In addition to these wages they are provided with food.

Scottish fishermen industriously pursue the white-fish fishing at all times when cod and other round-fish are in season: in almost every little bay and firth there are boats that fish for the fresh-fish markets, and sell their produce on landing to the buyers for the English salesmen; some of these boats make pretty long voyages, and remain out for two or three days, but the necessity of selling their fish while they are newly caught, urges them to run to port as often as possible. The life led by such fishermen is laborious and hazardous, from the occasional sudden storms which prevail in the northern seas, where they ply their occupation. There are also persons on the coasts of Scotland who fish for cod and ling, but these fishers being far from the market have no alternative but to *cure* their catch, and this is one of the branches of fishing industry which is taken cognisance of by the Scottish Fishery Board, and of which statistics are collected every year.

One of the chief factors in the cod and ling fishery is "bait." Without bait the cod-men are unable to pursue their vocation, and throughout Scotland the gathering of bait used to be an "industry" of great pith and moment, and to-day the delay in procuring bait often keeps the men at home when they would willingly be at sea. In former times the women and children of every fishing community might be seen daily on the coast left bare by the sea, engaged in gathering mussels for the lines; the Scotch people have long been wedded to the mussel, as they consider it the very best bait for the purposes of fish capture. The labour endured was all the harder, as the women and children often required to trudge a distance of four or five miles, and then having filled their creels with the coveted mollusk they had to walk home again with their heavy loads, after which each family would have to bait perhaps a thousand hooks to be ready against the time of the men's departure to the fishery. Now, when all the accessible mussel supplies have been used up, the men have to procure their bait from private mussel-beds, going as far for it as the Clyde, or the Humber, and, what is of importance to them, they have to pay for what they require, which being taken into account with the time required to make a run to the Humber or the Clyde from the Firth of Forth, considerably diminishes their earnings. It is surprising the fishermen of Scotland do not manage to make a "new departure" in the matter of bait; there are other baits that would attract the fish as much as the mussel, such as a cut of herring or some other fish.* The Dutch, for instance, who are industrious fishers, use the valuable Lampern very largely, for the purpose of baiting their hooks, importing it even from the coast of England, whilst the Americans find excellent bait in the Menhaden. It is surely a curious incident of fishing economy that our men should export bait lamperns to Holland and import mussels from Hamburg! But if the Scottish fishermen who are slow to change will insist upon having mussels at all times for bait, they should

* They are now, we are glad to learn, finding out that the White fish when hungry, which is always, are not particular as to their food. The codfish is said to subsist mostly on herrings. Why then do not our fisher folk use the herring more liberally than they do as bait? It would surely pay them well, on the principle of throwing a sprat to catch a whale to buy two pennyworth of herring to capture two shillings' worth of cod or ling.

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project a mussel-farm, and grow these mollusks in quantities, sufficient not only to bait their hooks but to sell to the public as well. In this they can follow the fashion of the French, who have a fine mussel-farm in the Bay of Aiguillon, near La Rochelle, where large quantities of mussels are annually grown on a simple plan, which might very easily be copied by the Scottish fishermen, and so save them a world of labour, anxiety, and expense. In a "Report on the Fisheries of Norfolk," the late Mr. Buckland, in 1875, gave us some particulars of the value of a mussel-bed in the statistics which he published of the Mussel Fisheries of Lynn, these yield from three to four thousand tons in good years, the average price per ton being a pound. There is a very productive natural mussel-bed at Montrose in Scotland which yields a large supply of bait.

The Messrs. Johnston, a local and enterprising firm, the late Mr. Buckland told us in one of his reports, have wisely instituted Mussel culture there, and there is a great demand from Peterhead to Fraserburgh for Montrose Mussels, the fishermen of these places taking from 100 to 200 baskets, which they lay down on the rocks as store bait. The mode of measuring these mollusks is by heaping them in a conical form in a herring basket, twenty full baskets making a ton. The fishery officer at Eyemouth (Scotland) reported, in 1879, "the supply of mussels for bait is falling off greatly, and on several occasions lately our fishermen have been laid ashore for want of bait, and the want is becoming greater every day." It will afford an excellent idea of the labour involved in baiting, when it is stated that, in the course of one week, the Eyemouth and Burnmouth boats used for baiting their long lines 61 tons of mussels. That quantity of bait, it may be chronicled here, yielded these fishermen cod and whiting to the value of £2,500, which shows the importance of the bait supply. The labour to all concerned in using such a vast number of mussels must have been enormous.

The collecting of whelks, to serve as bait for the cod-fishers and other uses, is a regular trade on some parts of the English coast, in which a considerable number of small vessels are constantly employed. Each of the cod-smacks takes in a large supply as they start on their fishing tour; during the season of long-line fishing about forty *wash* of these buckies is required; a *wash*, it should be explained, is a measure which contains twenty-one quarts of whelks. These shell-fish are preserved alive in the well of the cod-smack, being kept in bags made of netting till required; they make capital bait, as when once properly affixed on the hooks they are ill to remove. The whelks are caught in various ways, and give employment to a large number of industrious persons, whose business it is to procure them; indeed, so actively is the taking of these animals engaged in, that the supplies of a district soon begin to fall off, so that new fishing grounds have to be sought for every now and then; in the sea lochs of the west of Scotland there are immense numbers of shell-fish, which might either be brought to the food market or be collected for bait.

The foregoing facts and figures, it is hoped by the writer, will enable all who peruse them to form an idea of the incessant work which is involved in the capture of fish. Besides the fishing industries which have been already referred to, as affording fields of labour more or less remunerative to the working fishermen, there are others, such as the mackerel fishery, which might also be placed in evidence, but drifting and seining, no matter what the fish sought for may be, is ever the same, and it would only be treading a beaten path to do more than say that. Happily enough the seasons for fish taking are so varied that industrious fishermen may at all times find abundant work, when wind and water prove suitable. Thousands of resident fishermen are men of all work taking the different fishes in their seasons, going to sea day by day with an anxious mind, and well pleased many of them are, if they can obtain a moderate catch of fish. It would surprise those persons unacquainted with the round of fishing labour, to know the extent of the shrimp fishery, and the money value of the shrimps which are caught on our coasts, then there are the annually recurring industries of Oyster dredging, and Lobster and Crab catching, which occupy the time of many persons who prefer that sort of work to the more laborious occupation of herring fishing, or trawling in the prolific North Sea.

THE IRISH FISHER FOLK.

Number of persons engaged in Irish Fisheries—Increase of Irish boats engaged in fishing for Mackerel—Abundance of Pilchards—Cost of carriage of fish—Irish Salmon fisheries—Shell-fish fisheries—The reproductive Loan Fund—Its success—Social habits of the Irish Fisher Folk—The Claddagh.

THE number of persons employed in the Irish fisheries in the year 1846 was 113,073, who were in possession of a fleet of 19,883 boats and vessels of various kinds. These were the persons supposed to be actively engaged in prosecuting the various fisheries of Ireland; were we to take into account their families and dependents we would be able, we daresay, to make up the total number to a figure beyond half a million.

The number of persons fishing and the number of boats have greatly decreased since 1846. According to the last published report of the Inspectors of Irish fisheries, it appears that during 1882, the number of registered vessels in Ireland fishing for sale was 6089, with crews numbering 21,597 men, and 794 boys. Of these 1978 vessels, 7310 men and 401 boys are returned as having been exclusively employed in fishing, and 4111 vessels, 14,287 men, and 393 boys as partially engaged.

These figures must not be accepted for more than they are worth; the Inspectors do all they can to ensure their being correct, but various difficulties lie in the way of obtaining accurate statistics. They explain in one of their reports that great irregularities had occurred in carrying out the registration of boats and vessels since 1842, so much so indeed as to render the returns of no practical value. "It was the practice some years ago," says the Inspectors in their report for 1876, "to register and return, as boats and vessels engaged in the fisheries, every boat in the different divisions, whether used for cutting seaweed, carrying passengers, turf, sand, or other commodities, fishing or pleasure, and a crew was assigned to each without ascertaining if such actually existed, no proper comparison can therefore be made between the numbers actually engaged in sea fishing during the past and former years." Since 1846 the number of boats, and, of course, the number of persons employed in their management as well, have steadily declined; in 1856 the fleet of boats numbered 11,069, manned by 48,774 men and boys; in 1866 the numbers respectively were 9444 (boats) and 40,663 (crews). By the year 1876 the reduction was still more marked, the numbers being as follows: Craft of all descriptions engaged in fishing for sale 5965, with crews numbering 22,773 men, and 920 boys.

In looking into the details of Irish fishing as conducted to-day, we find some reliable statistics of the number of boats taking part in the herring and mackerel fisheries, the latter in particular being a growing industry in the Irish seas, the importance of which has been largely divined by the local fishermen. At the various herring fishing stations, we find a total of 734 Irish boats engaged between May and December, the number of the crew in each boat not being given, but there would probably not be less than 4000 in all, men and boys together. The number of Irish vessels taking part in the capture of mackerel in 1882 was 263; as against 327 English and Manx and 25 Scottish boats. In 1876 the number of Irish boats fishing for mackerel was only 133, showing an increase in the fleet in seven years equal to about a hundred per cent., which is very gratifying, and proves that the Irish fishermen are prompt to seize upon an obvious advantage. The mackerel fishery gives employment to many other persons besides those who capture the fish. At the chief ports, Kinsale and Baltimore, vessels are employed in bringing ice: then there are the carrying steamers, each with a fair crew on board, whilst considerable employment is given to residents in the respective localities both in packing the fish and in other ways.

It is expected that the Irish fishermen will in time grow a pilchard fishery. Large shoals of these fish are known to be in the Irish seas, and a beginning of fishery enterprise in that line has already taken place, fifty-four hogsheads of Pilchards having been cured in the Cornish fashion (1882), at Baltimore, which were sold in Genoa, and realised at the rate of £4 14*s.* per hogshead. As the inspectors of the Irish fisheries say, there is abundance of room for this enterprise being largely developed off the county of Cork, and the foregoing should be an encouragement to others to embark in it; if judiciously managed by persons who understand the best methods of capturing and curing, it ought to prove most remunerative.

No statistics of a reliable kind are published as to the number of boats and men engaged in the round and flat fish fisheries of Ireland, but testimony has been frequently borne as to the abundance of many kinds of valuable food fishes in the waters surrounding the Emerald Isle, and of the field of industry thus presented to the Irish fisher folk. But although the finest turbot and holibut are to be had for the mere exertion of capture, the Irish fisher folk are not possessed, in most instances, of the necessary fishing gear with which to catch them ; at some places the boats and machinery of capture are of the most fragile description, and if improved vessels were to be provided there are no fitting harbours in which they could be received, whilst the distance of many of the seats of fishing from a profitable market is another serious drawback to the advancement of fishing enterprise in Ireland. Thus the fisher folks of Ireland are heavily handicapped in every way they desire to turn themselves. As an instance of how the men are held down we may state, on the authority of the inspectors, that in June 1881, two consignments, consisting of 19 and 30 boxes of mackerel respectively, each containing 120 fish, were sent up from the county of Cork to Dublin at a charge of 5*l.* 2*s.* 1*d.* and 7*l.* 14*s.* respectively, and the balances remitted to the senders were 11*s.* 11*d.* in one case and 1*l.* 6*s.* in the other, making a total of 1*l.* 17*s.* 11*d.* for 5,880 fish, or about three of these fine fish for a farthing. The value of the cod fish caught by the Irish fishermen, and exported to England during the year 1882, amounted, in round figures, to 389,240*l.* 10*s.*

The Irish Salmon Fisheries afford employment to many persons, the total yield of these fine fish being considerable, far in advance even of Scotland. The estimated money value of the salmon captured in Irish waters has been set down of late years (1882 excepted) as being considerably above half a million sterling, a fact which, we think, is not generally known. There is one branch of fishing which might, we think, afford remunerative employment to a large number of persons, namely, that for crabs, which might be carried on in such a way as to be independent of early markets, as these crustaceans might be stored in rudely constructed ponds to be kept till called for. Could the crabs of Ireland be brought to English ports they would undoubtedly command a ready sale at remunerative rates. Lobsters, too, abound amid the rocks of the Irish seas, they are well known to commerce, but still larger quantities of these delicious crustaceans might we think be brought to market; traps for their capture are easy to construct, and any kind of garbage will do for bait.

An interesting feature of fishery economy in Ireland is centred in what is called the "Irish reproductive loan fund," by which sums of money are advanced to the fishermen to be repaid at a given time, the amounts received being again advanced to other fishermen. Much good has been by this means achieved. We have not space in which to trace the history of the fund, or to describe the machinery of distribution, but we may, abridging the information given by the inspectors in some of their annual reports, state that in particular instances the poor fishermen who have been obliged with loans have been able to turn the money to excellent account in providing the necessary fishing gear of which they were utterly deficient. "In vast numbers of cases," says Mr. Inspector Brady, "but for the loans, I believe the people on the west coast would have been obliged to abandon fishing altogether, and if so had no other resources." The Irish fisher folk have also had the advantage of obtaining substantial assistance from another fund, namely, the money voted by the Dominion of Canada for the relief of distress in Ireland. This fund amounted to £20,500 and was placed in the hands of a Committee who devoted nearly £10,000 to the promotion of piers and the improvement of harbours, and £11,000 to the purchase of fishing gear and new boats and the repairing of old ones. This loan has been the means of effecting a great amount of good: in one locality, to which £200 worth of nets was sent and distributed among fifty men, over £1,200 worth of Mackerel were taken in one month. In another locality a very poor man to whom a boat and net were given, costing only £12, realised in three nights by herring fishing, nearly £60. The inspector, after great experience of their working, says, "every year's experience still further convinces me of the great importance of these loans to poor fishermen. In my opinion their fishing pursuits are far more valuable than their farming, and both can be carried on together with great advantage, not only to the people themselves who follow this pursuit as a part of their means of living, but to the country at large by the production of a large quantity of valuable food." It is to be hoped, from what is known of the really beneficial results flowing from such aid, that still more will be forthcoming; there is undoubtedly a great field of enterprise open to the Irish fisher-folk, even taking into account the poor harbour accommodation, and the distances at which profitable markets have to be sought.

The Irish fisher folk, as a class, are singularly honest and virtuous, not so much given to dissipation or riotous behaviour as has been asserted, and whenever a prospect of fair reward is held out for labour expended, they will embark in any fishing enterprise. As was recently said of the Irish fisherman, the man who voluntarily seeks his living on the sea, cannot be wanting in aptitude for work, courage, or perseverance against adverse circumstances. The Irish fisher folk are much the same to-day in their social habits as they were centuries ago. Their sanitary surroundings are not of the best, and their superstitions and prejudices are much the same, more intensified, perhaps, if that be possible, than those of their Scottish and Cornish brethren. A well-known member of the Society of Friends (Mr. Allen, Black Rock, near Dublin) it is interesting to know, has borne important testimony to the good behaviour of the Irish fisher folk ; being asked if he had ever known any cases of Irish fishermen being implicated in agrarian outrages, his answer was to the effect that during a period of fifty years he had not known a solitary case of an Irish fisherman being charged as an accomplice in any of these crimes.

At the Claddagh—in a portion of Galway situated on the right of the harbour, we find all that pertains to the social habits of the Irish fisher folk brought to a focus ; the colony of fishermen which is there established still retain among them the customs of their remote ancestors. The town is a peculiar looking place, an extraordinary collection of cottages thatched with straw, and the people who inhabit these abodes are totally distinct in dress, habits, and customs, from those of the town (Galway). The peculiar dress of the women imparts a singularly foreign aspect to the streets and quays, and the person elected by the fisher people as their Mayor, is implicitly obeyed, he is of course one of themselves, and is able to regulate the community, and settle disputes according to their own peculiar laws and customs. On occasions of difference, his decision is so much valued, that law is seldom resorted to. Like the fisher folk of the Scottish and Northumbrian coasts, the people of Claddagh are great believers in luck, and in signs and omens, and in all matters of dispute, they stand firmly by each other, even when one of them is wrong. Strangers are not made welcome as residents in the fisher quarter of Galway, in fact, they are not allowed to reside within the bounds of the Claddagh. The people intermarry, and no marriage, we believe, is considered to be properly brought about unless preceded by an elopement ; the bride is presented by way of dowry, with a boat or share of a boat, according to the means of her parents, and the wedding ring is an heir-loom of the family ; it is transferred from mother to daughter, the first married, and so on to their descendants. The Claddagh people, after the fashion of their foreign brethren, hold occasional fêtes and make merry on the occasion of electing their Mayor or King and sheriffs. The Mayor is completely one of themselves, but when at sea he acts as admiral, and, as we have said, his word in most things is law. When out fishing, the Claddagh men carry in their boats no strong drink of any kind—no spirits or malt liquors.

With these few details of this curious place, we take our leave of the Irish fisher folk, heartily wishing them a great increase of prosperity.

THE FOREIGN FISHER FOLK.

Peculiarities of the Foreign Fisher-folk—Roman and Athenian Fishwives—Fêtes of the Foreign Fisher people—Italian Fishers—French Fisher-folk—Madame Picard the poetical fish-wife—The Dutch Fishwives—The Norwegian Fishers—Chinese fishery arrangements.

HAVING sketched at considerable length the round of labour from day to day of our own fishermen, we may now refer to the foreign fisher folk, who are quite as peculiar in their habits and modes of life as the persons we have just been describing—they are people, in fact, no matter in what country we find them, who live for themselves among themselves, steadily transmitting from one generation to another their stereotyped manners and customs; their vices and their virtues, their belief in signs and omens, and the varied traditions of their ancient calling. From the earliest days of Greek and Roman civilisation, those who gather the harvest of the sea have formed in every country where they dwell a caste by themselves, and to-day they are much the same as we read of their being centuries ago—for fishing is a vocation of the remotest antiquity.

In all matters pertaining to their modes of life and commercial dealings the ancient fishwives were very much alike—no matter to what country they belonged the family likeness was marked and unmistakable. Thus the Roman fishwives were a counterpart of those of ancient Athens, and those of the "Modern Athens" of to-day may be taken as tolerably exact copies, if not in costume, at least in manners, customs and language, of their classic prototypes. Juvenal of course satirises the fish dealers of ancient Rome, taking for illustration a tender point of their character—namely the freshness of their wares. He depicts a dealer in fish as praying that he may be fed :—

> "On the loved features of his infant's head
> Soused in Egyptian vinegar, if aught
> Against his fishes' freshness can be brought."

A fondness for fêtes and demonstrations has ever been a marked characteristic of foreign fishers. When Pope Leo the Tenth was summoned to the Papal throne in 1513 the Roman fisherwives held a fête ; going in a body in order to offer his Holiness their congratulations, and flatter him by a declaration of their loyalty. In a graceful speech the Pope returned his best compliments and thanks, telling them that, as the successor of an ancient fisherman of the sea of Galilee, he took a particular interest in their calling, which, had for its object the providing of many chief necessaries of daily life as well as a large portion of the luxuries of the table. The Venetian fishwives used also to hold grand Carnival every year during the season of Lent. Their merrymaking lasted for three days, and, whilst it continued the women dressed themselves in their richest apparel, displaying at the same time as great an array of costly jewellery as they possibly could. The Venetian fishwives were likewise noted for their uncivil tongues and their tendency to get into "rows" of all kinds, as well as for their constant and exceedingly voluble vituperation of the authorities.

Scattered allusions to the Italian fisheries may be found occasionally in the pages of the classic writers of the fifteenth century ; they are all of the same tenor, and harp on the bad manners and worse morals of the fishwives of the period, dwelling more especially on their unruly habits and powers of extortion. Another fisher-fête of the olden time (and one indeed which is worthy of mention, and is still perpetuated with many of the old ceremonies) was that held by the men and women who dwelt amid the great series of lagoons at Commachio at the mouth of the river Po, just where that river falls into the Adriatic. The great eel farm of Commachio is one of those "specialties" of fishing industry which were common a few centuries ago. It is still in existence, and the manners and customs of its inhabitants are said to be almost unchanged, being nearly the same to-day as they were four or five centuries ago. On the day following the nights during which they obtain a great catch of their particular fish—the eel—the population of the lagoon usually hold high festival, and indulge in a fête, with church-going processions and other rejoicings. The fisher people of Commachio are much like those of other fishing communities, "they have," to quote a graphic but vulgar phrase, "a spice of the devil in their constitution."

The fisher folk of the Italian coast are still very much like what they were five or six centuries ago; they deal, as a matter of course, in the same goods as their ancestors dealt in, their business being of an hereditary nature; and to-day they trade in exactly the same fashion as their forefathers traded five hundred years ago. One has only to visit the fish-markets of the coast towns to be convinced of the fact. The fishermen of the period pat the tunny in the same way as their predecessors did. They do this while the fish is in the net, just in the same way as one would pat a favourite dog or horse; they say it makes the giant fish more docile than it would otherwise be. It is said that the old fishermen used to ride on the back of the fish within the circumference of the net!

The scenes to be witnessed in many of the Italian fish-markets are exceedingly grotesque, and the noise of quarrelling and the general loquacity that seems to be incident to the sale of the *frutti della mare* in the fish-market of Venice in the nineteenth century is of the very choicest order of "Billingsgate," and certainly cannot even be surpassed by the notorious fish-hawkers of Dublin of whom Dean Swift wrote—

> "All mad to speak, with none to hearken—
> They set the very dogs a-barking;
> No chattering makes so loud a din
> As fishwives o'er a cup of gin."

A large portion of the Italian population earn a livelihood by fishing, some of the men using the frailest of boats, craft which can only be used in the finest of weather. The number of men engaged in sea fisheries on December 31, 1869, with the exclusion of the then Papal States, was 60,000, employing 18,000 boats, and giving a mean annual produce of forty million lire. In addition to the sea fisheries, there are lagoon and estuary fishing industries, which employ many persons; whilst some of the fishing products, as the Sponge, Pinna and Coral, bear of course no relation to the food supplies. As a matter of act Italy imports fish from Great Britain and other countries, to the extent of more than twenty-one million lire.

Taking leave of Italy, we come to France, where a few hundred years ago many different laws were enacted for the regulation of *les poissardes;* and they undoubtedly required to be legislated for, as they too were in the habit of exercising the same vehemence of rhetoric which is the common inheritance of the piscatorial sisterhood. The *poissonières* of Paris have often figured in the history of that turbulent city. Certain parts of Lutetia had, in the olden time, a most pronounced "fish-like smell," and remains have at various times been found which indicate the antiquity of the fishmongers' craft in the capital of France. At a very early period the fishwives of Paris were divided into two classes, the one being called *harengères* or sellers of salted herrings, the other class, known as *poissonières*, being dealers in various kinds of fresh fish. The two classes, as may be readily supposed, were always quarrelling; and at times, their rancour was so fierce that their quarrels often ended in bloodshed and murder. Some curious laws were enacted by St. Louis for regulating the sales of fish. First of all, the right to sell had to be purchased from or be granted by the king. Wise men (*prud'hommes*) were appointed by his Majesty's *chef de cuisine* to look after the fish dealers, and to amerce in a fine such as sold without permission of the king. The grand cook of his Majesty likewise forced all the *prud'hommes* who were chosen, to take an oath that they would see to the price of the fish supplied to the royal tables, being fixed upon "soul and conscience." The French fish-dealers of those days were so far happy, inasmuch as they were officially blessed by the Cardinal of Paris, his bishops and clergy, once every year; the occasion of course being chosen for the celebration of a grand fête by the fish-sellers, the boatmen of the river, the fisher-folks of Havre, and those of other ports near the mouth of the Seine. Such ceremonies are still, we believe, observed at Marseilles and other portions of the continental seaboard. Similar fêtes and processions used long ago to be of frequent occurrence in various Scottish fishing towns, but although the fisher people of some particular fishing ports may march once a year in a procession, the custom of general holidays is falling into abeyance.

It is interesting to learn that one hundred and seventy three years since there was a commanding fish-selling population in the French capital. Of oyster-women there were at that time no less than four thousand, and if so the sale of the toothsome bivalve must have been so enormous as to warrant speculation as to where they all came from. It is not surprising with such a *corps* of vendors that the natural oyster scalps of the French coast came in time to be exhausted! It is almost superfluous to say that the Parisian fisher-wives, like their sisters all over the world, "enjoyed" a rather bad character, and were stigmatised as adepts at cheating their customers. They could, by the exercise of a little *finesse*, deprive the ready-eating buyer of two or three of the best oysters out of every dozen he might purchase, by pretending they were bad, and kindly eating them for him. They used also to introduce into their commercial system a few empty shells, the oysters of which had just been sold to another customer, and, counting them, pretend their patron had eaten the full tale of his bargain. It would be unjust to omit mention in this chronicle of Madame Picard, a Parisian fishwife, famed for her wit and poetic talents, who flourished in the middle of the last century, and who, being frequently in their society, was personally known to Voltaire and other great authors of the day. Her poetry, if we may believe the critics of the period, was not devoid of genius; it was chiefly of an amatory and sentimental description. Her poetical works were published in the year 1768. Madame ultimately left her fish-stall to become the wife of a silk and lace merchant, in which position she was much respected.

There is to-day a large fishing population in France, all of whom as a rule are good at their business, and many of them fish so near us that we are able to judge. The fisher-folk of France are much like their brethren of Scotland and Northumberland, superstitious and peculiar. The French have an extensive fishing fleet, over twenty-two thousand vessels, which require more than 80,000 fishermen to work them. As in Scotland, the French fishers are always aided in their business by their women folk, and in all fishing communities on the French coasts, the round of fisher life and labour is much the same as we know it at home, there are times of consuming anxiety for the women, when the men are at sea, and have been delayed in bringing home their catch by a sudden storm. The short and simple annals of fisher life in France, and other foreign lands, are as much tinged with melancholy, as the lives of the toilers of the sea on the coasts of Great Britain and Ireland. Each little village has experienced its terrible tragedies arising out of the fateful work of those who draw their daily bread from out the waters.

Holland, the cradle of fishery enterprize, can of course boast of its fishwives ; the fishing villages on the sea board of the German Ocean, as well as those on the coast of the Zuyder Zee, are well worth a visit from the curious. The fisher quarter of Schevening is exceedingly quaint and peculiar, and the fishwives of Holland, and Belgium as well, are just as peculiar as those of the French or Scottish coasts, having their own specialties of living, and being largely imbued with the familiar superstitions of their craft. We cannot say if a Dutch fishwife can find "tongues in trees" or "books in the running brooks," but we do know that she can read the clouds and interpret the mists that veil the heavens : and the wailing of the water-fowl or the plaintive cry of the curlew will raise a vein of superstition that cannot be allayed except by cessation from work. The Dutch fisherman has ever the recollection of a crowd of death-dealing disasters upon his memory as he lazily whistles for a wind or murmurs a prayer to hush the rising breeze. The fisherwives of Holland are exceedingly industrious: they carry the fish caught by their husbands, brothers or sons to market, and negotiate the sales. The work of the husband is finished as soon as he comes on shore, the work of the women then commences. The wives undergo great labour, and take much pains to render it remunerative; but the fisherwomen of South Holland do not look so happy or prosperous as their sisters located on the shores of the Zuyder Zee, who, as a rule, are in a far more flourishing condition. At Moniekendam, and on the opposite island of Marken, the fisher people afford ample scope for study and portraiture. They are quaint in their dress, peculiar in their manners, and exceedingly simple and pious. The men of Marken are very temperate, are the finest sailors in the world, and live to a good age. The colony of fisher folk established there is similar to some of those in Scotland: it is a kind of family community, like that of Newhaven near Edinburgh. The people intermarry each with the other, and thus beget habits as stereotyped in many respects as those of the Chinese, or the nest-building birds of the air. Their wants being few and simple, and the temptations to expend money rare, the people of the very remarkable island of Marken happily find themselves passing rich.

The Dutch fishers are always at work when wind and tide are suitable, and that they fish for other markets than their own is well-known; they send us a liberal share of their catch in the shape of Turbot, Eels, &c. Even so far back as half a century ago, we paid them nearly £100,000 per annum for the "Aldermanic fish," and the lobsters of which the sauce was made. The Dutch cure their herrings on board of their fishing luggers, which industry keeps the fishermen very busy, the Dutch cured herring are very fine, they are pickled with the crown, gut left in them, and are much relished. The "busses" remain at the fishing all the season, the fish being collected from the fleet by small steamers or "Yagers" as they are called, which bear them rapidly to port, and the herrings which first come to hand of the year's fishing, are highly esteemed and command a high price, a barrel specially prepared being sent for the use of the royal family. In former times a substantial reward was always bestowed on the fishers who were earliest in the market with their herrings.

We have not space in which to describe even in the briefest possible manner all the foreign fisheries, but by way of giving variety to these memoranda, we may here indicate the labour which is incidental to one phase of the cod fishery of the Lofoten Islands, namely, "the gill net fishery," and we hope that mode of taking cod-fish will be introduced by our own fishermen who are so often put to straits for that expensive property of their work—*bait.* Gill-net fishing for cod is a Norwegian industry of considerable antiquity, it is reputed, at any rate, to have been introduced as far back as 1485, and is now practised extensively along the coasts of Norway, but especially at the islands we have named, where cod at certain seasons resort, it is said, in literal millions, the inward "rush" of the fish being hailed by those interested with great delight; it is almost needless to say that the time of capture is the spawning season of the fish. Gill-net fishing is carried on from open boats, each with a crew of six or eight men, and carrying from sixty to a hundred nets, which, however, are not all used at once, the greater part of them being held in reserve to fill up the place of those which are lost from accident, or which are being dried after use. About twenty-five of the nets, however, are fastened together, to be set by each boat. These are joined by being riveted at top and bottom, and are kept taut in the water by means of iron sinkers, and floats made of hollow glass, and are so arranged as to be either close to the bottom, or a few feet from it. The men at a signal all start in the afternoon to set their nets in the way described, placing them across the current, the fishermen usually returning to the shore after that work has been satisfactorily accomplished. Then after a few hours' rest, and in the darkness of a night that may be both stormy and bitterly cold, the men start again for the fishing ground, to gather in the fish that may have been caught. This is both exciting and hard work, but it is work which must be accomplished, no matter how the winds may roar, or the waves may leap. The heavily weighted nets are ill to haul on board, especially when well laden with fish, which happily they sometimes are. The catch, however, is exceedingly variable, ranging from a few dozens in a day to a few hundreds for each boat—five hundred fish is thought a good take, and the fish captured in this manner are the very primest of the prime, 200 of which will be equal to 350 of cod taken by the hooks, whilst the livers of the gill-captured fish yield more liberally of oil than those which are taken by means of the trawl.

These fishermen earn more money at the Lofoten cod-fishery than their brethren who handle the lines, or manipulate the trawl, and in consequence there is a growing desire to prosecute that branch of cod fishing. It is stated that in 1879 there were 2532 boats engaged in that style of fishing, with crews numbering in all 14,322 men ; in the preceding year the total catch of cod at the Lofoten fishery numbered 24,660,000 fish, and of that quantity upwards of 14,000,000 were taken in the nets. The Norwegians are mighty fishers, industrious and careful, possessing all the virtues of their fellows in other countries ; the fisher folk of Norway number eleven per cent. of the population, about 80,000 persons being employed in getting in the harvest of the sea.

Much curious information about the social condition of the Chinese fishermen, and the economy of the fisheries, so far as the use of gear is concerned is contained in "the Yellow Book," or catalogue of the Chinese collection in the Fishery Exhibition. We shall not, however, spoil the interest of what is told by any attempt at abridgment—it would require indeed a book as large as this to contain all that might be said descriptive of the Chinese and Oriental fisheries, such as the pearl-diving industry of Ceylon, and the sponge and coral fisheries of tropical seas.

SUMMARY. CONCLUSION.

FROM the details which have been given in the preceding pages, the reader will have learned that no fisherman is able to rule his ways of life, or govern his daily work after the fashions of our land industries. Those who work in factories, members of the building trades, and persons who follow similar occupations, can regulate their hours of labour, so as to begin and leave off work at fixed periods, and to eat their food at fixed hours. Not so the poor fisherman, who is a slave to the winds and the waves: he must wait till the passing storm has exhausted its fury, and the waters have become comparatively calm, before he dare venture in his boat from the harbour, in order to enrich the national commissariat with the "bounty of the waters," and earn the daily bread required by his wife and little ones. And even when he reaches the seat of his labour he may in vain cast his lines into the water. He cannot compel the fish to swallow his lure, they may not indeed be in that part of the waters into which for the time he has dipped his nets, so the disappointed fishers frequently return from a toilsome journey no richer than when they spread their sail to the favouring winds two or three days previously. It is curious that men who have been all their lives at the business will time and again fail to hit upon the fish. There are no certain rules, however, by which they can be found, and he would be a shrewd fisherman who always obtained miraculous draughts. As we have shown, herring fishing is very much of a lottery; of two boats which may side by side be plying their trade, one may find a hundred barrels of fish in its train of netting, while the other may not capture a hundred herrings! So in line fishing and in trawling, the fortunes of the catch are upon occasions singularly varied, huge piles of the fruit of the sea may fall into the nets of Tom, whilst Dick may also obtain a share of the finny spoil, but poor Harry in vain woos fortune on the deep—never a fish—round or flat, comes near his machinery of capture, no gigantic member of the Gadidæ family, no aldermanic turbot rewards his zealous labours.

"Why," it is being asked in various quarters, "should we accord our sympathies to fishermen in a greater degree than to other men, who gain their bread by the sweat of their brow?" That is a question which it is not, we think, difficult to answer. Fishing is an industry by itself, and those who woo fortune on the waters but seldom find it; fishing being a perilous occupation, which yields but an unsteady reward. It has been said by economists of the Gradgrind school, that "no man is compelled to fish," which is a truism, but if the advice implied in the sneer were to be taken, it would bode no good to the country. Happily, it is advice that never will be taken, there have been fishers on the sea since the miraculous draughts were taken from the waters of Galilee, and there will be fishers probably for centuries to come, fishing, we hope, under improved conditions. At the present time the fishing population is still largely leavened by men who are descendants of hereditary fishermen, and who, as well as their fathers before them, have known no other occupation—it is an occupation with which their lives have been mingled, and which they could not change if they were willing. A frequent charge made against fishermen is that they are lazy and extravagant, living when they have the chance a riotous life. The charge is a strained one. As has been indicated, they cannot regulate their hours of work by the sounding of a factory bell, they can only go to sea when the condition of the water is favourable, and when men have had a continuous spell of work, lasting from sixteen to sixty or seventy hours, they require corresponding rest. No fisherman has the privilege of an eight hours' day, like the well-timed mechanic or factory worker; nor has any fisherman a share of those amenities which fall to the working-class population of towns; no institutes or cheerful clubs; no well-filled libraries. The dwelling places of many of the fisher people are often remote from the haunts of civilisation, in hamlets that are utterly destitute of any means of spreading knowledge, and when the fishermen congregate at the larger fishing-ports their work is a work of emergency, which has to be prosecuted with great rapidity, and admits of no time of recreation.

The heroism of such a life as is led by our fishermen from day to day all the year round has never, we think, been so much appreciated as it should be. The dangers of the deep are proverbial, and of these, the toilers of the sea, who bring to land such a magnificent contribution to the national commissariat have a full share, the danger being not a little aggravated by the want of good harbours. The value of the food which is annually brought to us from the waters has been estimated at various large sums—ranging from five to fourteen millions sterling, and taking even the smaller figure, it betokens an amount of enterprise and work which is not a little remarkable—it is so much wealth to the nation got at first hand—for which we are indebted to the fishermen. At the very least there are on the coasts of the United Kingdoms half a million persons dependent on the fisheries for the necessaries of life which they obtain, and it is their hard fate that only by unceasing work can the fishers keep up their homes, and feed and clothe their children, who, along with their mothers, are called upon to share the daily round of labour, to take part in the toilsome work of net shooting and hauling, or of baiting the hooks, and who in the end, by means of this combined industry, often do not earn the wages of a single well-employed mechanic, who pursues his vocation on the dry land, in a comfortable workshop, with abundance of light and heat at his own command.

It is not every labouring man who could be a fisherman even if he were to try, fishing is a business which requires experience, and can only be acquired by training, so that our best men in this department of industry are those who are hereditary fishermen. These only have in the largest measure the properties of endurance and skill which must ever be incidental to their peculiar occupation. The fisherman must not only have physical strength, he must have moral courage as well, for at every hour of the day he knows he is fighting for his life. Whilst his hand must be occupied on sail or line, his mind, too, must be actively at work gathering those scraps of knowledge which are constantly required for the prosecution of his business, and by means of which he is endowed with that cunning and skill which he finds so necessary.

It is not alone the contribution made by our fishermen to the national commissariat, that falls to be considered in connection with our fishing fleet. Other benefits accrue to the nation which cannot be ignored in a work like this, sketchy and unfilled up, as it may appear; the building of new boats, and the repair of those now in use, the weaving of nets and the manufacture of sails afford remunerative labour to hundreds of persons. The bringing of salt and barrel-wood to the curing stations, and the exporting of the fish to foreign places, also affords employment to those engaged in that line of business. Nor is the money earned by our fisherman hid away in a napkin; it is at once put in circulation, and all manner of tradespeople feel the benefit thereof, the owners of their cottages and houses,—many of these, and we regret to have to state the fact, being in a most unsanitary condition—derive their rent, whilst the baker, the butcher, and the clothier, find their tills swelled by the money of the fisher-folks. There are few, indeed, who do not directly, or indirectly, derive some benefit from the "Harvest of the Sea."

In penning these remarks we have no idea of going against the usual dictates of political economy. We know that men are not "forced to fish" against their wills. But, as has been shown, many of these men know no better, having been born to the business—never in fact having had an opportunity of trying their fortunes at another trade. It has been asserted by public writers and economists that, fish being so dear, fishermen must earn a great deal of money; but that reasoning does not avail with those who are behind the scenes. It is too often but a very scanty share of the price which the public pay for the produce of the sea that actually falls to the share of the fishermen, who incur all the dangers incidental to its capture. Still the public are the gainers; they derive a large amount of wholesome food from the unfathomed caves of ocean, the sale of which helps in some degree to keep down the price of butchers' meat. And to some extent the fishing interest is of use to the State, as it provides a hardy population of sailors from which the mercantile navy is occasionally recruited, and from which our ships of war, were they not nowadays chiefly manned by mechanics, in the persons of their engineers and stokers, might obtain a supply of sailors. It may be said of our fishing craft generally that they afford a fine training in habits of industry and discipline to thousands of persons who in after years season the population with that independence of character and that love of personal liberty which is so desirable for a free people; and it is a pitiful circumstance that in so many instances a lifetime of arduous labour should only end in abject poverty; it is sad to find, as not infrequently happens, that many a man, whose everyday heroisms would in some other calling have made him famous, has landed in the days of his old age in the workhouse.

We cannot prophesy with any certainty as to the future of our fisheries, but it may be predicted that steam-fishing craft of all kinds will come more into use than has hitherto been the case; and if that should happen, it will in some degree better the position of the fishermen. With steam power they will be able to accomplish their work with a greater degree of speed, and will also be better able to battle against the elements with which they have to contend. Occasional dread catastrophes occur every now and then to our fishing fleets; they are of kin, in their suddenness and terrible fatalities, to the explosions which take place in our coal mines; and at such periods the aid of the charitable is demanded for widows and orphans. It is not our purpose to say one word that would freeze the fountains of benevolence, but is it not time that the fisher folk should accumulate a fund, to be in readiness for such times of need? In some fishing communities there are, we know, "friendly societies" that offer aid to the distressed, that give a sum for funeral expenses and an allowance in periods of sickness; a small payment implies the right to such help as has been arranged for. But, grateful as such aid may be in a time of need, it is not enough; and for such a body of men as the British fishermen to be appealing on every occasion of calamity for eleemosynary aid is anything but seemly. If they could but learn to appreciate the power of the pence, they would find that, with a small weekly contribution from the hundred thousand persons who are regular fishers such a sum would in the course of three or four years be accumulated as would set up anew their wrecked boats, provide for the widow, and educate the fatherless. We would say to the fisher folk, Do this yourselves; have your own accumulated funds managed by your own people. One penny per week from each one of a hundred thousand persons would produce, roughly speaking, a sum of over twenty-one thousand pounds per annum which would be more than ample for all that will ever be required of it.

It is not the business of the writer to do more than indicate that such a scheme is quite practicable; the details may be worked out at leisure, but the sooner the better. It might even be taken in hand in conjunction, perhaps, with the issuing of a licence to all fishermen, by some of our government departments. We have a government which sends our telegrams, forwards our letters, carries our parcels, takes care of our savings, and sells us annuities; why should it not arrange to assure the lives of our fishermen and to replace their boats when they are destroyed by the storm? A small sum charged annually for a "licence to fish" would provide all the funds which are necessary. Five shillings a year from forty thousand fishermen would amount to ten thousand pounds per annum—

all that might be necessary. With such a sum and its accumulations to fall back upon, fishermen would be independent of the bestowal of public charity. We know that associations of different kinds have of late years been organized for the insurance of fishing gear, chiefly the boats, and smack owners have joined their forces in this direction. We should be glad to see the fishermen acting in combination to obtain both a provision for accidents of all kinds, but for the time of old age as well.

We offered recently in the pages of a popular periodical, the following suggestion for the benefit of the Scottish fishermen. "There is another way of solving the question of how the fisher-folk might provide for a rainy-day. Taking the herring-fishery as the typical fishery of Scotland, an industry at which, during some portion of the year, every unit of the fishery population assists, we may state that the value to the fishermen of the herrings which they capture can scarcely be less than two millions of pounds sterling per annum. A million barrels at least are cured, and large quantities of herring are caught in addition, and sold fresh. Accepting the value of the fish to their captors as being two millions sterling—a barrel, it may be stated, contains about seven hundred and fifty fish, and these, at the price of a half-penny each, come to a sum of thirty-one shillings and threepence ; so that the figure we have given is by no means an exaggeration—is it too much to ask of the fishermen that they should devote a sixpence of the price obtained for each barrel to insurance of boats and lives? How much do a million sixpences come to? A million sixpences amount to the very handsome total of twenty-five thousand pounds ; a far larger sum than would, one year with another, be required ; so that to all appearance, an assessment of threepence, or at the most fourpence, per barrel on the cured fish alone would yield all that is necessary to replace boats and fishing-gear in times of adversity. The Scottish Fishery board—the usefulness of which is sometimes called in question both in parliament and elsewhere—might be intrusted with the collection of the money. The Board has already in active work an organisation for collecting the fees on every barrel of herrings that is branded; it would not be difficult, therefore, for the officers of the Board to collect whatever sum may be agreed upon from the fishermen."*

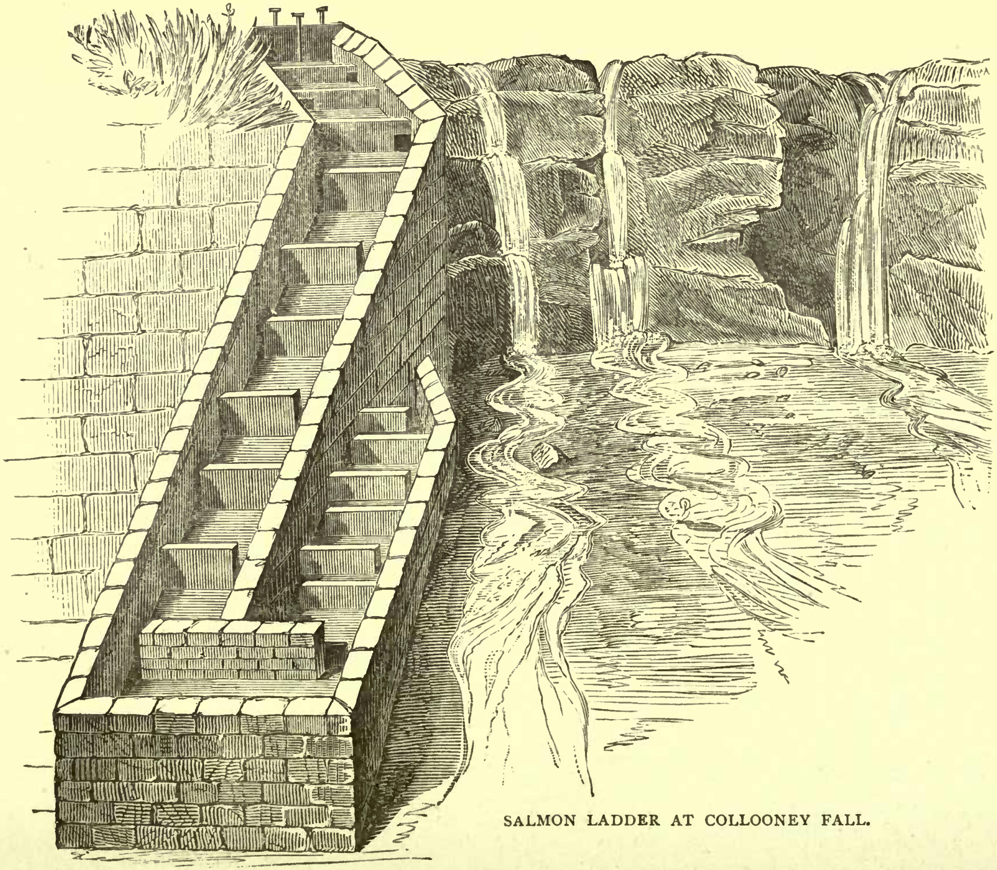
In making such suggestions we will probably be met by the answer, that fishery boards, with whom would rest the business of collection, have not the power to interfere in these matters; but the power, we fancy, will not be ill to procure. In Ireland, as has been shown, the fishery inspectors carry on similar work, they administer a fishermen's loan fund, which has been productive of good by enabling persons to obtain boats and fishing gear who could not otherwise have obtained it. There are other means by which fishermen may provide a fund for the proverbial rainy day; other devices might easily be fallen upon, but we daresay it will be found, in this as in other matters, that the simplest means are best.

Some unkind remarks have recently been made regarding the want of intelligence shown by fishermen in following their calling. They are accused of knowing nothing, or at least very little, about the natural history and habits of the animals they capture; the accusation is most gratuitous, seeing that it is by means of their knowledge—be it much or little—that we obtain all the fish which are brought to market. The writer in his time has passed many days with the fisher folk, and has found them with regard to their

* "Chambers's Journal," Feby. 18, 1882.

occupation just about as intelligent as others of the working class with whom he has been brought into contact, and with far more natural shrewdness, and no men are more ready in a time of peril to do all they know to save a life. Now that the means of education have reached even the remotest fishing villages, we shall soon find the rising generations of fishermen upsides with their more learned brethren of those inland towns which have provided literary institutes and free libraries for behoof of the artisans and labourers who inhabit them, and many of whom a few years ago were as ignorant as our fishermen are accused of being to-day.

With improved harbour accommodation and more steam power to aid them in their business, and both of these "wants" we are pleased to know are in course of being gradually supplied, the fisher folk of all grades will find their condition ameliorated and their future looking brighter. We heartily wish them more of the sunshine of life and less of its storms: they have been at all times a gallant, although a peculiar people, and now that attention has been roused to their condition, we trust their earnings will be increased and their sanitary surroundings improved, and that the dangers attending their calling will be fewer in the future than they have been in the past: in that hope we close this imperfect record of "the round of fisher life and labour."



SALMON LADDER AT COLLOONEY FALL.

THE SALMON FISHERIES

BY

CHARLES E. FRYER

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THE SALMON FISHERIES.

CHAPTER I.

Importance of the Salmon Fisheries—Former abundance of Salmon —Salmon in the Thames—Present Value of the British Salmon Fisheries—A Salmon River under Natural Conditions—Abundance of Salmon in American Rivers.

THE great interest which has more or less for the last six centuries, or even longer, centred round the Salmon Fishery question is due to two causes :—first, to the esteem in which the flesh of the salmon has always been held ; and, second, to the necessity for protecting the fisheries against the continually increasing array of interests inimical to them with which they have become surrounded, and which have from time to time threatened their existence.

Distributed, roughly speaking, over the greater part of the Northern Hemisphere lying north of 35°, the salmon of different countries, and even of different rivers, present marked peculiarities, according to the temperature of the water, the nature of their food, and other local circumstances. The salmon of the British Islands have always had the reputation of excelling in quality those of any other country; and until neglect and abuse had brought them to the verge of extinction, and before the progress of settlement in the New World had opened up the vast wealth of fish of the North American continent, they probably held the first place in point of numbers as well. These islands, indeed, watered by numberless moderately rapid streams, with gravelly beds and capacious estuaries, and surrounded by seas teeming with just such living creatures as form the favourite food of the salmon, would, if only the natural characteristics of the rivers could be restored, still rank, area for area, second to no salmon-producing country in the world.

What the salmon fisheries of this country were in times past may be partly gathered from old records, and may be partly imagined after a comparison of their condition, within living memory, with their condition now. Take the Thames for example. The old legend which connects the dedication of Westminster Abbey with the salmon fisheries of the Thames is worth recalling here. According to the version given by the late Dean Stanley in his "Historical Memorials of Westminister Abbey," "It was on a certain Sunday night in the reign of King Sebert, the eve of the day fixed by Mellitus, first Bishop of London, for the consecration of the original monastery in the Isle of Thorns, that a fisherman of the name of Edric was casting his nets from the shore of the Island into the Thames. On the other side of the river, where Lambeth now stands, a bright light attracted his notice. He crossed, and found there a venerable personage, in foreign attire, calling for some one to ferry him over the dark stream. Edric consented. The stranger landed and proceeded at once to the church, standing ready for its impending consecration. The air suddenly became bright with a celestial splendour. The building stood out clear, without 'darkness or shadow.' A host of angels descending and reascending with sweet odours and flaming candles assisted, and the church was dedicated with the usual solemnities. The fisherman remained in his boat so awe-struck by the sight that when the mysterious visitant returned and asked for food he was obliged to reply that he had caught not a single fish. Then the stranger revealed his name. 'I am Peter, keeper of the keys of Heaven. When Mellitus arrives to-morrow tell him what you have seen and show him the token that I, St. Peter, have consecrated my own church of St. Peter, Westminster, and have anticipated the Bishop of London. For yourself go out into the river; you will catch a plentiful supply of fish, whereof the larger part shall be salmon. This I have granted on two conditions, first, that you never again fish on Sundays; secondly that you pay a tithe of them to the Abbey of Westminster.'" Whether or not disobedience to the injunctions of the saint has had any share in the combination of causes which have led to the general result, it is certain that the "plentiful supply of fish, whereof the larger part shall be salmon," is no longer to be obtained in the Thames. This grand river does not at the present moment contain a single salmon; yet so recently as the beginning of the present century—when a single netmaker in Fenchurch Street is said to have been paid £800 a year for salmon nets to be used in the Thames—it was nothing unusual for twenty salmon to be taken at a single haul in Chelsea Reach. Again, a fisherman stated in evidence before the Royal Commission on Salmon Fisheries in 1861 that so recently as 1820 he frequently took "some hundreds" of salmon at Laleham, where a boy in a ferry-boat used to take 60 or 70 a day with a rod and line, which he hung over his boat while plying to and fro across the stream. The same witness deposed to having seen "twenty salmon lying dead" after spawning "along the course of a hedge not more than 200 yards long." Another witness handed in documents showing that from 15 to 66 salmon were taken nearly every year between

1794 and 1814 at Boulter's Lock near Taplow, and that ten years later the "last salmon" was taken at this fishery. In 1816, however, 6 cwt. of salmon were taken in the River Lea.

In the Wear, again, which is now seriously polluted, and has by other causes been almost denuded of fish, salmon were at one time abundant. In 1348, the monks of the Priory of Finchdale, near Durham, according to ancient documents, after supplying their own wants, sold salmon, the produce of their fishery, to the value of £9 12s. 8*d.* How many fish this sum represented may be gathered from the fact that there is an entry, made at the same time, of the purchase by these same monks of a bull and three cows for £1 12*s.* In 1439 they sold £39 6*s.* 8*d.* worth of salmon, and in 1530 they sold to the convent of Durham alone 396 salt salmon and 38 salt grilse. In 1532 the convent of Durham bought from other persons in the neighbourhood 550 fresh salmon, at prices ranging from 6*s.* to 8*s.* per dozen.

Instances like these might be multiplied, but enough has been said to show how vastly more productive of salmon our rivers must have been in olden times than they are now.

Their present condition, however, is a marked improvement upon the state of things that prevailed a quarter of a century ago, and may be said to bear somewhat the same relation to their state prior to 1861, when the existing laws for their protection came into force, as their natural capabilities bear to their actual productiveness. In 1863 the whole produce of the salmon fisheries of England and Wales was estimated, from data collected by the Inspectors of Salmon Fisheries, to be worth no more than £18,000 a year. In 1868, after seven years of protection, their value was calculated to have increased to £30,000 a year, and, under the more stringent and efficient laws of 1865 and 1873, their value has gradually improved till it can hardly be placed at less than £150,000 a year.

The fisheries of Scotland and Ireland, under similar protection, have—though never reduced to quite so low an ebb as those of England and Wales—also revived, and the gross produce of the salmon fisheries of the United Kingdom may be put at not far short of three-quarters of a million sterling. It is doubtful whether this figure conveys an adequate idea of the importance of the salmon fisheries of the United Kingdom as a commercial industry and as a valuable form of property. For the last fifteen years an average of nearly 3,500 men have taken out a licence to fish for salmon with instruments other than rod and line, in England and Wales alone. This figure does not include either all the "hands" occasionally employed by the actual holders of the licences, or the number of men employed by private individuals, or a considerable number of men fishing outside the limits of the various fishery districts. These omissions would probably bring up the total to 4,000 men employed in the commercial fisheries of England and Wales. The Inspectors of Irish Fisheries estimate that about 9,000 net fishermen are engaged in the salmon fisheries of Ireland. For Scotland, where no licences are necessary, the number cannot be put at less than that given for Ireland, so that we have a total of 22,000 men employed directly for profit in the salmon fisheries. To this number must be added the anglers, of whom about 3,000 in England and 2,000 in Ireland take out licences for salmon fishing every year. An estimated addition of 5,000 salmon anglers in Scotland would give a total of 10,000 rod fishermen fishing for salmon in the United Kingdom every year. The annual revenue from licence duty paid in

England and Wales has, for the last ten years, exceeded an average of £7,000, and in Ireland has exceeded £9,000 a year in the same period. So that we arrive at the general result that, with 22,000 net fishermen and 10,000 anglers in the United Kingdom, 13,000 of the former, and 5,000 of the latter thought it worth while to pay between them £16,000 for a mere licence to fish for salmon; the remaining 9,000 net fishermen and 5,000 anglers in Scotland being exempt from duty. When it is remembered that these licences are available over only the limited area of the district in which they are issued, the actual value of the fisheries will be still more apparent.

The value of the nets, boats, and other gear of the 22,000 net fishermen can hardly be estimated at less than £20 per man, which would give a capital of £440,000 invested in the commercial fisheries, while the 10,000 rods at only £1 a-piece would add another £10,000 on account of capital invested in the rod fisheries. The £16,000 paid annually in licence duty, capitalised at only ten years' purchase, would add £160,000, and would bring up the total estimated capital invested in the salmon fisheries of the United Kingdom to £610,000. Either this is an excessive under-estimate, or salmon fishing must be a very profitable industry; for, if the 22,000 net fishermen realised only £1 a week each for half the year, their earnings from this industry would amount to £572,000 a year. But last year over 50,000 salmon, worth, at only 10*s*. each, £25,000, were taken by about 550 net fishermen in the Tyne alone, or an average of nearly 35*s*. as the weekly earnings of each man for twenty-six weeks, so that the above estimate of £1 a week is well within the mark. To estimate the value of the catch of salmon by anglers it is fair to credit each rod with at least three salmon in the year; this would give 30,000 fish, worth, at only 10*s*. each. £15,000. But on the Usk alone ten fish fell to each rod and on other rivers sport was even better, so that this estimate also is palpably insufficient.

Another means of estimating the value of the salmon fisheries of the United Kingdom is afforded by the returns of salmon sold at Billingsgate. In 1882 there were sold at that market 22,968 boxes of salmon from Scotland, 1,412 from the Tweed, 4,720 from Ireland, and 2,186 from England and Wales, or a total of 31,286 boxes of an average weight of one cwt. each. This, at 1*s*. per lb., would give £34,415 as the gross value of salmon, the produce of the British and Irish rivers, sold at the metropolitan market alone. But £25,000 worth of salmon were taken in the Tyne alone, £7,500 worth were taken in the Severn alone, £5,000 worth were taken in the Dee alone, and £12,000 worth were taken by a single company in the Tweed; and when it is remembered that such great centres of population as Newcastle, Carlisle, York, Leeds, Doncaster, Sheffield, Manchester, Liverpool, Chester, Huddersfield, Bradford, Birmingham, Bristol, Southampton, and Plymouth, and others in England—to say nothing of the large centres of consumption in Scotland and Ireland—situated in the neighbourhood, if not on the banks, of the most productive rivers, all affording ready markets for the sale of the fish before it finds its way to the metropolis, it will easily be supposed that Billingsgate did not receive one-tenth, perhaps not one-twentieth, of the total quantity caught. The estimate, therefore, which places the value of the salmon fisheries of the United Kingdom at about three-quarters of a million sterling, annually, is probably fairly accurate. As will be shown further on, this sum by no means represents the quantity of salmon which our rivers could produce if their natural capabilities were not handicapped by artificial drawbacks.

For the *beau idéal* of a salmon fishery, we must look to a country where Nature reigns supreme; where man has not yet had time or opportunity to interfere materially with her processes; and where he does not overdraw the large account which she has placed to his credit in her bank. A few of the streams in the remoter parts of Scotland approach very nearly to this standard: but to see a salmon river in the fulness of its abundance we must cross the Atlantic and visit the western slopes of the Rocky Mountains. There we shall find the waters of the Columbia, the Fraser, the Sacramento, the Homathco and other rivers literally swarming with countless hundreds of thousands of salmon.

Speaking of the salmon of the River Fraser in his work on "Vancouver Island and British Columbia," Mr. Matthew Macfie, F.R.G.S., says:—"At certain times the cañons or gorges of the river are so crowded with salmon that the navigation of canoes is virtually impeded. The Indians catch them with a pole, attached to one end of which is a transverse piece of wood. Into this are stuck tenpenny nails. Leaning over the gorge they strike the nails into the fish, impaling one or two at each descent of the pole."

Again, the same writer says of another river:—"An officer in the service of the Hudson's Bay Company, who resided on the Columbia River (Oregon) for many years, states that on a sudden falling of the waters the numbers of salmon left on the banks are so immense as to cause the river to stink for miles."

Still more recently Mr. Livingston Stone, whose name is so well known in connection with fish culture in the United States, describes the enormous shoals of salmon in the

Sacramento River. In order to facilitate the capture of large numbers of salmon, for the purpose of collecting their eggs for artificial breeding, Mr. Stone erected a solid dam across the McLeod, a branch of the Sacramento River, which effectually barred their progress up stream, and he thus describes the first appearance of the salmon at this unwonted obstruction :—

"It was announced that the salmon were making their first assault upon the dam. It was a sight never to be forgotten. For several rods below the bridge the salmon formed one black writhing mass of life. Piled together one above another they charged in solid columns against the bridge and dam, which trembled and shook continually under their blows. Not daunted by their repeated failures they led attack after attack upon the fence, one column succeeding as another fell back. Finding the fence impassable many fell back a little and tried to jump the bridge. This some succeeded in doing, sometimes violently striking the men on the bridge in their leaps, and sometimes actually jumping between their feet. For an hour and a half this fierce assault continued, when, exhausted by their efforts and discouraged by many failures, they fell back to the deep hole just below the rapids, arrested, for the first time since the McLeod River formed its channel, in their progress up the river."

On another occasion he says, speaking of the same dam, rebuilt for a similar purpose in the following year :—

"The salmon were collected in vast quantities below the dam. There were so many that in a space of 20 yards wide by 100 long I have counted 100 salmon jumping out of the water within the space of a minute. When one reflects that this is at the rate of 6,000 an hour, an idea can be formed of the great number of fish collected there."

These are no hearsay stories, no mythical rumours of the days when apprentices were said to be so surfeited with salmon that they stipulated with their masters not to be supplied with this diet more than a limited number of days a week. The fish are there now, and can be seen by any one who goes to look for them; and they are an indirect confirmation of the ancient reputation of this country as a land of salmon: for there is nothing beyond their size in the rivers of the Pacific slope that gives them any natural advantage over those of Great Britain, and the marvellous stories which reach us of the abundance of salmon in America may in all probability have applied with equal truth to the rivers of this country in former days—

'When wild in woods the noble savage ran;"

when a few thousands of our blue-stained ancestors were, like the scattered Red Indians of the North American plains, the only inhabitants, and when the "resources of civilisation" had not yet been thrown into the scale against the powers of Nature.

CHAPTER II.

Fecundity of the Salmon—Its Life History—Egg—Parr—Smolt—Grilse—Salmon—Its Enemies—Kelts—Salmon dying after Spawning—Alleged curious Fate of Salmon in Rivers of North-West America.

LIKE most other kinds of oviparous fish, the salmon is wonderfully prolific. A full-grown female fish will produce at every time of spawning from 600 to 1000 eggs to every pound of her own weight. A single female salmon, therefore, of 20 lbs. weight, may yield as many as 20,000 eggs, every one of which has an equal chance of developing into an adult fish of similarly reproductive powers. When it is remembered that salmon of 30 and 40 lbs. in weight are not uncommon, and that specimens weighing up to as much as 70 lbs. have been occasionally captured, the prolific nature of the fish will appear still more striking. And this extraordinary power of reproduction may be exerted by each individual female fish, if not every year, probably at least, on an average, every second year, for a period of possibly ten or twenty years. The extreme limit of age in the salmon is unknown, and is probably impossible of exact determination; but, taking the average duration of life at only six or eight years, a single female salmon, spawning only four times and depositing, at a moderate computation, an average of 20,000 eggs on each occasion, may become the mother of 80,000 young fry, *in posse* if not *in esse*. But such fecundity implies more than a rapid multiplication of the species. It implies an enormous "waste" of salmon life at the hands of natural enemies. The perils which the egg and the young fish have to encounter are so numerous and so formidable even under the most favourable conditions that only a small percentage of them ever arrive at maturity. A glance at the life-history of the salmon will explain this.

Although to all intents and purposes a sea-fish, living in salt water and feeding there on small crustaceans, fish fry, lug-worms and other marine creatures, the salmon has recourse to fresh waters for the purpose of breeding. While in the sea it lays up on its body and on the internal organs known as the *cæca* or pyloric appendages a store of fat, which is afterwards absorbed into the system and goes to assist in the development of the roe.

When the proper time arrives the fish leave the salt water and make their way into the fresh water of the rivers, ascending the remotest tributaries which it is possible for them to reach, and selecting shallow streams with a quick current and a gravelly bottom, where they deposit their spawn. On finding a suitable spot they scoop out a shallow hole with their tails; into this the female fish drops, a few at a time, her eggs—the hard roe—while her male companion fertilizes them, as they fall, with his milt—the soft roe. But many eggs fall to the bottom unfertilized, and thus the first toll is levied on the fecundity of the parent fish and on the possible future increase of salmon in the river. Greedy trout are lying in wait to feed on the dainty fare, and even the salmon themselves are not free from the suspicion of cultivating cannibal tastes by dining off their own or their neighbours' eggs. Even when the fertilized ova are safely deposited, and have been carefully covered beneath a thin layer of gravel, they have probably not lain long before another pair of breeding fish arrive, and incontinently sweep them away, as they make their nests on the very ground already selected by their predecessors as an eligible breeding site.

Then water-fowl, insects, and water-rats work great havoc among the eggs. Accidents of nature again—such as a deposit of mud or a heavy flood washing away the spawning bed and its contents; or a drought, dwindling the stream and leaving the eggs exposed to the air; or a severe frost, binding water and river-bed into one solid mass—are fatal to enormous quantities of ova, of which,

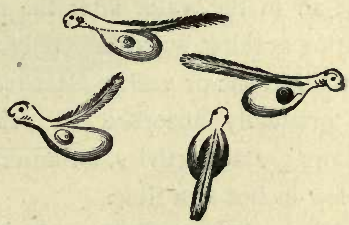
Fig. I.

SALMON EGGS.

Fig. II.

SALMON EGGS, SHOWING EYES.

Fig. III.



SALMON, JUST HATCHED. (LIFE SIZE.)

at a liberal computation, not half the quantity produced ever develop into young fish.

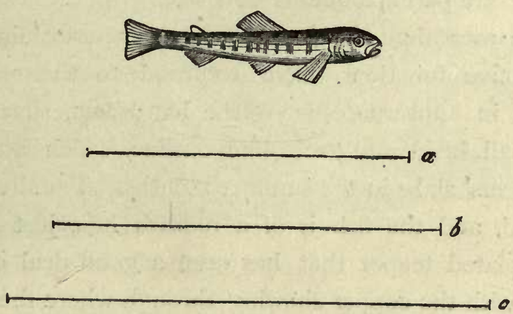
The "hatching" of the young fry takes place according to the temperature of the water, in from 50 to 130 days. The egg, on being first extruded from the mother, is a small transparent globule, looking somewhat like a pellucid bead of red coral (*Fig.* 1), but elastic to the touch, consisting of a somewhat hard pellicle, containing an oleaginous liquid. At one point in the thin horn-like shell of the egg is—as is the case with the eggs of all true oviparous fish—a tiny orifice, called the micropyle, through which one of the *Spermatozoa* of the "milt" or soft roe of the male fish enters. When thus fertilized and left in water of a suitable temperature, from 40 to 50 degrees, the embryo in the egg gradually develops, the first sign of life being two little black dots, representing the eyes of the nascent fish (*Fig.* 2). These are followed by a "thin red line" denoting the vertebræ: and the development of the fry continues till the shell of the egg bursts, and the newly-hatched salmon makes its appearance on the world of waters in the shape represented in the accompanying drawing—like a tiny strip of gelatine, with a little round head, and a large bead of yellowish red colour attached underneath (*Fig.* 3).

For six weeks or so it is a helpless infant, breathing the air in the water after the manner of an adult fish, but eating nothing, subsisting only on the oily contents of the umbilical sac or vesicle attached to the abdomen. As this is gradually absorbed into the system, the young fry shows greater activity, swimming about in a lively manner a few inches at a time.

When the umbilical sac is quite absorbed, the fry, which looks like a fish for the first time, begins to search for food; that is to say, if it lives long enough to reach this stage of its existence, for the movements of the little animated bags attract crowds of fresh enemies, by which the motionless eggs had been overlooked. Fish of many kinds find in them a congenial food, both abundant and easy of capture. Kingfishers and other birds join in the feast, and still further reduce the possibility of the thousands and tens of thousands of eggs deposited by each female salmon doing much to keep up the future supply.

Those that are fortunate enough to survive the onslaughts of a long array of natural enemies increase pretty rapidly in size. The accompanying cut (*Fig.* 4) and the lines *a, b,* and *c*, represent the average rate of growth between the time when the fry has completely absorbed the umbilical sac, at about six weeks old, and the second, third, and fourth months of its existence. When about a couple of years old the young samlet prepares for his first visit to the sea, and dons a new tourist suit for the purpose. The dark bars on his side—the "finger"-marks, which are characteristic of the "parr" or young salmon—become covered with a coating of brilliant silvery scales, and thus arrayed, like a knight in silver armour, the young salmon, now known as a "smolt," makes the best of his way down-stream. In favourable

Fig. IV.



SIZE OF SALMON FRY AT 1, 2, 3, AND 4 MONTHS.

seasons the rivers literally swarm with these young fish, which, eagerly devouring such insect life as they chance to meet with, may easily be caught with rod and line. The May-fly is out in abundance, for, as the old couplet has it—

> "The first floods in May
> Take all the smolts away,"

and no bait is more tempting to them. Before the present salmon laws came into force angling for smolts was a recognised form of sport. A basket of them could often be taken without difficulty in an hour, and the destruction of young salmon in this way was so great that the Legislature interfered, and the capture of smolts is now prohibited under heavy penalties.

It is a remarkable fact that the male smolts, even at this early age, have milt not only largely developed, but actually capable of fertilizing the ova of adult salmon.

On reaching the sea the smolts are about eight inches in length: but once in fresh water their growth is exceedingly rapid, and by August they may have developed into "grilse," as salmon are called on their first journey up stream to propagate their species, of four or five pounds in weight. Sometimes, however, this first upward migration does not take place till the following year, when the "grilse" are perhaps double that size.

In the meantime the parent-fish, after performing their reproductive functions, have returned to the sea very different in appearance from the handsome, silvery fish, with small head and yacht-like outline, which adorn the fishmongers' slabs in the summer months. The silver is all tarnished, and the fish is of a reddish hue, just like an electro-plated teapot that has seen a good deal of hard service, with the copper showing through where the film of silver has worn off. Its fins and tail are torn, its body lacerated, its plump back and sides shrunken, lank, and hollow —the very picture of starvation. Its head has assumed enormous proportions and a most uninviting appearance. The jaws are elongated, the tip of the lower one being armed with a horn-like hook, which prevents the mouth from closing, although the upper jaw is often nearly penetrated by it.

In this condition the fish is known as a kelt. A sketch of one is shown in the accompanying woodcut—for the use of which, as well as of those of the eggs and fry, I am indebted to the courtesy of the proprietors of *Nature*, in which journal they appeared in an article contributed by me some years ago.

The salmon is in primest condition when the eggs are least developed and the body is fattest. The development of the roe causes a serious drain upon the vital resources of the fish, which is the more severe because the greatest development of milt and ova takes place while the fish is in fresh waters, where it eats little or nothing. This drain is only met by drawing upon the supplies of fat which the fish has laid up while in the sea, and, according as it has been

Fig. V.

HEAD OF A KELT.

well fed or starved, so its progeny will be abundant and strong, or few, puny, and weak. The store of fat upon the *appendices pyloricæ* is gradually absorbed, and the fatty oils, with which the whole body is permeated, follow suit, till the flesh becomes hard, dry, and tasteless. The accompanying woodcuts represent the relative changes which take place in the pyloric appendages and the milt of a male salmon as the roe develops. Figure 6 shows the pylorics (*p*) large and full of fat, while the milt (*m*) is only partially developed, *œ* being the œsophagus and *i* the intestines. Figure 7 shows the milt fully developed and ready to be emitted, while the pylorics have shrunk to a shrivelled mass of membranous tissue.

A similar change takes place in the condition of the flesh, which loses all its "curd" as the roe increases in size. The late Sir Robert Christison compared the flesh of a kelt and of a "clean-run" salmon, after careful analysis, with the following results. The oil in the flesh of the kelt was only 1·3 per cent. against 18·53 per cent. in that of the fresh-run fish: the fibrin, albumen and extractive matter—*i.e.*, the nitrogenous nutritive principles—were 17·07 per cent. against 19·07 per cent.

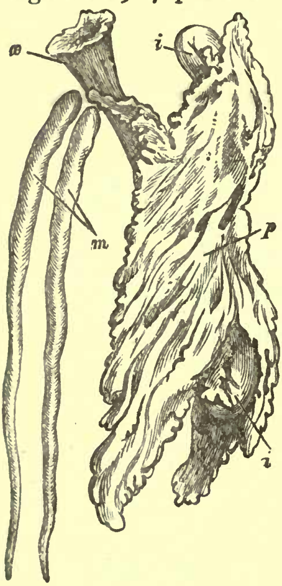


FIG. VI.—PYLORIC APPENDAGES WITH MILT UNDEVELOPED.[1]

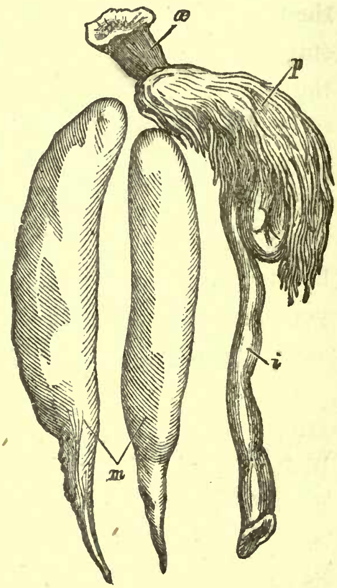


FIG. VII.—MILT OF SALMON FULLY DEVELOPED.[1]

But under the invigorating effects of a visit to the sea-side the kelt

"Doth suffer a sea-change"

hardly less striking than that experienced by Alonso's bones in Ariel's song. With renewed vigour and in-

[1] From Frank Buckland's 'Natural History of British Fishes,' by permission of the Society for Promoting Christian Knowledge.

creasing appetite the jaded traveller rapidly gains flesh and is ready a few months afterwards, unless it falls a prey to the seals and porpoises, or to the snares of man, to go through exactly the same experiences, with the same object in view, viz., the perpetuation of its species. But it often happens that the emaciated and exhausted "kelt" is unable to reach the sea. Worn out by the fatigues of the journey, and the exhaustion consequent on their prodigious efforts to perpetuate their species, large numbers of them perish miserably every year in the river, a prey to starvation and disease. The longer the river, and the farther the spawning places from the sea, the greater the probability of the fish being unable to withstand the fatigues of the return journey: and, although death after this fashion may be said to be equivalent in many cases to merely the mortal decay from sheer old age, which all fish, as well as flesh, is heir to—if disease or accident do not first do their work—yet a large proportion of fish so dying would undoubtedly survive if they could only reach the sea in time.

In the long and rapid rivers of the Pacific coast of North America, the Fraser and the Sacramento, and more particularly the Columbia, the quantities of spawned fish that die in their downward migration, and lie rotting on the banks or are carried in thick masses down stream, are so great as to give rise to the belief that the salmon in these rivers, or at any rate one particular variety of them, invariably die after spawning. This theory is firmly held by authorities competent to judge of its correctness. Among others Mr. A. C. Anderson, Inspector of Fisheries in British Columbia, has reiterated his belief in the truth of this assertion. He says most emphatically that the salmon of the Fraser, unlike their Atlantic congeners, "do not return to the sea after spawning: they perish after that natural function is performed."

"It follows," he continues, "that they must remain in the salt water until they attain maturity, when, impelled by the natural instinct, they resort to the places where they were bred, there to consummate the final act of their existence. I say it follows, for it is to be noticed that in the ascending shoals none but mature fish are to be discovered. The individuals of each distinct shoal — however much the several varieties of fish may differ from each other, as they do in size and quality—do not differ among each other. They are all of the same or nearly the same magnitude, but all of equal age so far as the conditions of size and maturity can guide the judgment. There is no variation of *grilse*, or other definition by which the salmon of the Eastern American, or European streams may be distinguished."

In support of his own testimony Mr. Anderson quotes the following passage from the Report of Professor Baird, describing the operations of Mr. Livingston Stone when collecting salmon eggs in the Sacramento River for the United States Commissioner of Fisheries :—

"A substantial timber grating was built across the stream (the McLeod branch of the Sacramento). The grating was an entire bar to the salmon, no opening being left to permit their passing above it, and the experiment satisfied Mr. Stone that salmon which ascended the river to spawn never returned to the sea. The number which had passed above the grating, before it was finished, he estimated at hundreds of thousands, while thousands crowded against its lower sides when completed, vainly attempting to pass. As to their return, he failed to discover a single live salmon, though thousands of dead ones lodged against the upper side of the grating."

This question is of so much practical importance that a digression may be made here to discuss the point whether this evidence is sufficiently conclusive to warrant implicit belief in a theory so out of harmony with the general course of nature. The difficulties of observing accurately the movements of fish are proverbial. Even in the small streams of this country we are far from having discovered all the secrets of the domestic economy of the salmon, and, with all due deference to eminent authorities on the spot, it may be questioned whether the inference drawn from the presence of great numbers of dead fish in the Fraser or the Sacramento is correct. These rivers are literally teeming with salmon, which find in them all the conveniences of nature without any of the impediments which man, in more populous countries, has placed in their way. The salmon have—or had until their abundance tempted settlers to establish the vast "canneries" where so many million pounds of salmon are annually preserved in tins—uninterrupted access to these rivers, in the upper waters of which they have heavy rapids to surmount: passing through these they get more or less bruised, while on the return journey they are hampered by ice above as well as by rocks beneath. Reaching the spawning beds in prodigious numbers, they fight just as their congeners do in England: and, where the combatants are so many, the wounded are of course numerous in proportion. The dead fish attract attention, because they come down in hundreds instead of by units and tens: but the thousands returning in safety beneath the shelter of a deep and muddy river are not noticed, because there is nothing to call attention to them. Mr. Stone says he saw no live kelts returning from above the dam; but this is not conclusive proof that they were not there. They would not show the same anxiety to get down as they had done to get up, and they most probably lay listlessly about in the deep pools, awaiting a flood to carry them down. The dead fish would naturally float and attract attention, and the very fact of thousands of kelts being crowded above an impassable dam would be likely —to judge from our own experience in this country—to engender disease and hasten death.

Mr. Stone says nothing as to the length of time during which the dam built by him across the river remained a complete barrier to the fish. His spawn-collecting operations usually occupied about a month or less. Whether he destroyed the dam, or made an opening through it for the later fish to pass, or left it to be washed away by the floods, he does not say. But, whatever the facts in regard to the fish that had passed above the dam, they are no proof of what happened to the fish that were kept below it; and Mr. Stone found that, when they became disheartened by their repeated attempts to pass it, they dropped down-stream to the spawning beds below, so that it became impossible to trace their after movements.

On the important question of the size of the fish, however, Mr. Stone's experience on the McLeod River is at variance with that of Mr. Anderson on the Fraser. He asserts, for instance, when speaking of his spawning operations in the autumn of the year 1873, that "at times the salmon caught would be mostly males, at other times mostly females, and at other times nearly all grilse . . . . The weight of the salmon caught (including grilse) varied from less than half-a-pound to 29 lbs." As the spot at which these fish were captured was over 150 miles from the sea, there can be no doubt that they were all going up to spawn; and if we are to accept the statement that they would all die after spawning once, we must account for the fact on the hypothesis, either that many of the smolts remain in the sea for several years before migrating up-stream as adult salmon, or that their rate of growth is either very much more irregular, or very much more rapid, than is the case in Europe. Otherwise, it is impossible to account for the large salmon which go up to spawn, and for the small salmon which accompany them on the same errand. Either the small fish are of the same age as the large, or the reproductive age varies, not by a few months, or even a year or two, but by several years, in different fish of exactly the same species living under exactly the same conditions.

CHAPTER III.

Power of Man over the Fisheries — Tinning Salmon on the Columbia River—Migration of the Salmon—Fixed Engines—Their Prohibition by Magna Charta—Stake Nets in Scotland—Movable Nets—Their Regulation—Mesh of Nets—Close Seasons —Salmon Spearing—Destruction of Fry.

WHETHER the statement that the Pacific Salmon spawn but once, and yet are able to maintain so enormous a stock of fish in those rivers, can be substantiated or not, the fact of such large numbers of fish perishing after spawning brings into fresh prominence two points: 1st, the extraordinary reproductive powers of this fish; and 2nd, the great influence that man can exert over the fisheries to their detriment in other ways than by mere legitimate fishing.

With all the drawbacks of their existence: with disease and accident dealing death in all directions: with enemies at every turn waiting for their prey: with the innocents subject to a perpetual massacre, so that the "survival of the fittest" seems to resolve itself into the "survival of the luckiest," it seems amazing that so many millions should ever arrive at maturity in a single river. On the other hand, it is hardly less surprising that man should be able, not to decimate but, to annihilate such abundance. There is little fear, happily, that the Canadian and United States authorities will blindly allow such a source of wealth to be sapped, but the same fate which has befallen the fisheries of the Old World will assuredly overtake those of the New if the same obstacles are placed in their way. The Atlantic salmon is naturally no less prolific than the Pacific salmon. If the breeding stock perishes in the one case after one act of reproduction, and still the rivers swarm with fish, how is it that in the other case, with the careful protection of the parent fish, which are known to be capable of breeding over and over again, the supply still falls short of what it was in former days? The natural enemies of the salmon are as active and as abundant in America as in England: indeed far more so, for, with a dense population, otters and wild birds in the fresh waters and seals and grampuses in the sea are far less numerous than formerly; while, as regards mere fishing operations, the legitimate fisherman has, for some ten or twelve years at any rate, been quite as energetic in his attempts to capture the fish in British Columbia and California as in this country. In 1876 it is estimated that the "canneries" at the mouth of the Columbia river sent away 40,000,000 pounds of salmon, besides which probably a fifth of that quantity was salted, and large numbers were taken by the Indians. But the forty million pounds of tinned salmon probably represent nearly double that quantity of salmon actually captured, since only the best parts of the fish are preserved, and large quantities often spoil, after an unusually good catch, before the canning establishments can keep pace with the supply. And yet, with this enormous take, the upper portions of the river are found, after the nets are off, to be swarming with breeding fish. The expression "legitimate fisherman" may probably give rise to controversy, though it is capable of fairly accurate definition The essence, so to speak, of the salmon question lies in the fact that the fishery is not conducted in the open sea. Very little fishing for salmon takes place more than two or three miles from the shore. The salmon saves the fisherman the trouble of pursuing him in the deep waters of the ocean. Regularly every year he comes close to the shore, feeling his way along the coast, and playing about in the estuaries of the rivers or in the sea immediately outside, where his capture is easy. If not cut off in the sea, he presses forward into the circumscribed area of the river, where his destruction is still more certain and easy. Indeed, the circumstances of his existence are such that he is practically completely at the mercy of man, for, if a due proportion of fish are not permitted to ascend to the breeding beds the fishery must fall off. "Legitimate" fishing, therefore, implies the use of such instruments and in such a manner that this essential condition is fulfilled, while the fish that are captured are taken in the best possible condition. Where a particular engine, singly or in twos or threes, may have no appreciable effect on the stock of fish in a river, its excessive multiplication and indiscriminate use may mean the ruin of a fishery. This is the argument in the case of stake-nets and other fixed engines for catching salmon. A stake- or bag-net may be, as the Scotch fishermen so stoutly maintain, the only instrument by which salmon can be taken in really first-rate condition for the table; and a single stake-net or two, of limited dimensions, will do no more than take toll of the fish as they enter the highway to their breeding places. But a dozen or a score or a hundred stake-nets, placed tier upon tier behind each other, working night and day, intercepting every fish that passes, and blocking the entrance to the river, do more than take toll. Like a turnpike gate in a leading thoroughfare, they obstruct the traffic and reduce it to a minimum. The salmon cannot, like their friends the Rebeccaites in Wales, pull down the obstruction: neither can they turn back and go by another road. They are on the horns of a dilemma, from which escape is impossible. They quietly submit to *force majeure*, and have their revenge by dying out altogether. Of course it is not only against fixed engines that this indictment may be urged. Movable nets, with small meshes, may be used in such numbers, and so continuously by relays of men, as practically to block the mouth of a river; but men's arms tire, and their intervals of rest give opportunities to the salmon which the fixed engines, never sleeping, observing no Sabbath, and always fishing, deny them.

Movable nets, again, are more susceptible of regulation than fixed engines. The use of fixed engines implies the use of the soil for erecting and maintaining them. In England and Ireland the law recognises the right of the public to fish, without let or hindrance, in the waters of the sea; but the employment of fixed engines practically restricts this right, so far as the area which they immediately control is concerned, to the persons erecting them. Such persons, therefore, when they do not enjoy the exclusive right to the foreshore by virtue of a royal grant or charter, are trespassers upon the public rights, and, apart from any injury they may inflict on the fisheries, the engines they erect are fit objects for the exercise of public indignation. But everybody's duty became nobody's duty in this as in other matters: fixed engines were tolerated, and, as the knowledge of their capacity to take large quantities of fish at little cost of time, trouble, or money, extended, their use became more and more general. The first great stand against the use of fixed engines, as such, for the capture of salmon, was made on the Tyne, where their use was introduced about the year 1838 or 1839. Simultaneously with their introduction, the

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produce of the salmon fisheries began to fall off in so marked a manner as to give rise to the impression that the stake-nets were at the bottom of the mischief, and a local Act of Parliament was passed, abolishing these engines within a distance of four and a quarter miles on each side of the mouth of the river. That the disuse of these engines was an advantage was proved by a large increase in the number of fish entering the river : but the benefit to the fisheries was nullified by the introduction of an almost equally destructive implement in the "hang-net" and by the erection of fresh stake-nets on the shore beyond the limits to which the Act applied. At length, in 1861, Parliament, satisfied of the injurious effect of fixed engines, again interfered, and prohibited the use of all such instruments throughout the whole of England and Wales, except such as could prove their legal right to exist by virtue of grant or charter or immemorial usage. This sweeping measure was justified on the ground that the engines in question, besides being a specific injury to the fisheries, were, as already pointed out, more or less a public nuisance, and, further, that they existed, so far as navigable rivers were concerned, in direct defiance of a long series of statutes dating from Magna Charta. This great "palladium of English liberties" stipulated that "all weirs in the Thames and Medway, and throughout all England, except by the sea-coast," should be "utterly put down":— "*Omnes kidelli*"—as Henry III.'s confirmation of the Great Charter has it (9 Henry III. c. 23)—"*deponantur de cetero penitus per Tamisiam et Medwayam et per totam Angliam nisi*[1] *per costeram maris.*" These "*kidelli*" were fishing

[1] Ruffhead's edition of the Statutes renders this "*but only* by the sea-coast." This is evidently a mistranslation of the word *nisi* in the original, which could only have meant "except."

weirs or engines fixed wholly or partly across the stream for the purpose of intercepting, among other fish, the migratory *salmonidæ*.

Not that this clause was prompted by a regard for the interests of the fisheries. The *kidelli* were a serious obstruction to the navigation of the rivers, then the principal, and almost the only, highways. The maintenance of an unimpeded waterway was the first consideration: the protection of the fisheries was only a secondary object, if, indeed, it was at that time thought of at all. The injury done to the salmon fisheries by weirs was not recognised till afterwards, and it was only by an afterthought, in later years, that the framers of Magna Charta were credited with a desire to protect the fisheries when they directed the pulling down of the weirs: for, although several subsequent statutes recite (as in 25 Edw. III. c. 4) that "the common passage of boats and ships in the great rivers of England be often times annoyed by the inhansing of gorces, mills, wears, stanks, stakes and kiddles, in great damage of the people"[1] and proceed to order their demolition, it is not till 1472 that the protection of the fisheries is claimed as one of the objects of the Charter. In that year the Act 12 Ed. IV. c. 7,[2] recites that the clause against kidels in "the great and laudable statute of Magna Charta was made for the

[1] Item pur ce qe communes passages de neefs & batelx en les grantz rivers d'Engleterre si sont sovent foitz destourbez par le lever de gortz molins estanks estackes & kideux en grant damage du people (25 Ed. III. c. 4).

[2] "Item come per le laudable estatuit de Magna Carta entre autres choses est ordeigne, de toutz Kidelx per Thamese & Medewey & per tout le Roialme Dengleterre serroient oustiez, sinoun per les coostez del mear. Quele estatuit fuist fait pur graund bien de tout cest terre, en outstant lez streitures des toutz rivers, ensi qe lez niefs & bateulx avraient en yceux lour fraunk & large passage, & auxi en salvation de tout frye de pesson procreez en lez mesmes."

great wealth of all this land, in avoiding the straitness of all rivers, so that ships and boats might have in them their large and free passage, and *also in safeguard of all the fry of fish spawned within the same*." Even here, indeed, it is not so much to the salmon in particular as to the "fry of fish" generally that these obstacles to navigation were felt to be at the same time detrimental. But, although the use—or rather the abuse—of fixed engines did undoubtedly play a large part in the deterioration of the English salmon fisheries, even here we fail to find an enemy necessarily fatal to them. That Parliament was wise in peremptorily abolishing them cannot be questioned: indeed it had hardly any option in the matter; for to have arbitrarily limited their number or position would have been to allow one man to exercise a public right in the use of a particular engine while denying it to another: and the only possible course was to deny altogether any public right—the nature of the engines themselves rendered doubtful the maintenance of any such right—and to save only the inalienable rights of property in private fisheries. Even so, the exercise of the right to use these private engines was made subject to the understanding that they should observe an annual close time, and was otherwise hedged about with stringent conditions which largely diminished their destructive powers.

If stake-nets and such like engines were, *per se*, necessarily fatal to the prosperity of a salmon river, then the fisheries of Scotland ought to be in far worse plight than those of England. By the peculiar conditions of the law in Scotland, the right to fish for salmon, not only on the foreshore but in the sea itself, is a private right, existing only in the Crown or in those who have derived their right from the Crown. "There can be little doubt," said Lord

Chancellor Chelmsford in a judicial decision,[1] "that salmon fishings at an early period of the history of Scotland were regarded as possessing a peculiar value over other fishings and were distinguished from them in a remarkable manner. They were classed *inter regalia.* They are only capable of belonging to a subject by an express grant from the Crown or by a grant of fishings generally, followed by such an user of salmon fishing as proved that it was intended to be comprehended within the general terms of the grant." The use of stake-nets and other fixed engines, therefore, which in England could seldom be practised as private right, and which, carried on by the public, was opposed to public rights at large, has always been recognized in Scotland, where all round the coast, and in the estuaries of the rivers, such engines exist, and form the most general mode of fishing for salmon. It is true that these engines have always been subject to more or less efficient legislative restrictions by which their destructive powers were to some extent kept in check. Indeed the old Scotch laws afford the earliest instance of a "weekly close season," for in an Act passed about the year 1220 the following curious provision occurs for maintaining a free passage through cruives or dam-dykes:—"It is statute and ordanit be King Alexander, at Perth, on Thursday, before feist of Sanct Margaret, with consent of the Erles, Barones, and Judges of Scotland, that the midst of the water sall be free, in sa mekill that ane swine of three zeares auld, and weil fed, may turn himself within it, in sic ane maner, that nather his grunzie nor his tail tuich any of the banks of the water. And it is statute that all wateris be fre, and that within tham na man sall slay fisch fra the Saturday efter the evin song, or evening prayeris, untill Monday efter the sone rysing." But it

[1] Gammel *v.* Commissioners of Woods and Forests.

is equally true that these legislative enactments were not always enforced, and a fixed engine in Scotland was quite as deadly an instrument as a fixed engine in England. A Select Committee of the House of Commons appointed in 1836 to inquire into the Scotch salmon fisheries reported that the provision of a weekly close time, or "Saturday's slap," had "from an early period formed part of the laws of Scotland, regarding salmon fishings, but certain novel modes of fishing not in rivers, but upon the sea-coast and near the mouths of rivers, having been recently introduced, the regulation has been evaded or disregarded." The amendments of the Scotch Salmon Laws which have taken place since the date of this report have resulted in the more strict enforcement of the law, and as a consequence the fisheries have improved. There is, therefore, nothing essentially and radically wrong in the use, under proper restrictions, of fixed engines, the abuse, as distinguished from the reasonable use, of which is, however, to be most carefully guarded against.

Turning now to the employment of other engines, such as movable nets, we have seen that, in any case, they are not open to the objections which may be urged against fixed engines, but they are equally liable to abuse in other respects. The employment of a series of nets reaching right across the whole width of a river may effectually bar the progress of the fish. The use of a mesh so small as to capture immature fish will be equally detrimental in another way; for if all the chickens are caught, no hens can be reared and no eggs laid. The advantage of stopping the use of nets at short intervals, to give a fair proportion of the fish a free passage up-stream, is as great in the case of movable nets as of fixed engines. All these points have received the attention of the Legislature. In

England the length of nets has been limited; their method of use is carefully watched and regulated by the local authorities; their mesh has been restricted to a minimum size of two inches[1] from knot to knot, or eight inches round, except under the special authority of the local Conservators, who may allow the use of a mesh as small as six inches round; a weekly close season lasting from 42 to 48 hours[2] has been established, during which all fishing, except by rod and line,[3] is prohibited; a licence duty is imposed on instruments used for capturing salmon in England and Wales and Ireland, though not in Scotland, the funds derived from this source being placed at the disposal of the local Boards of Conservators appointed to enforce the laws for the protection of the salmon; and, last but not least, an annual close season, never less than 154 days,[4] has been fixed, during which no netting whatever is allowed. But most of these regulations are of modern origin, and the stringent application of all of them dates from quite recent times. Under the old laws a weekly close time, in England and Wales at least, was unknown. The size of the mesh of nets was, at any rate until the time of Queen Elizabeth, an unconsidered trifle, and net-makers were under no obligation to carefully adjust their "mashes" to suit the requirements of an Act of Parliament; while the annual close season, if observed at all, certainly did not fulfil the object for which it was ordained, viz., the protection of the breeding fish. Indeed

[1] 1¾ inch from knot to knot in Scotland and Ireland.

[2] Thirty-six hours in Scotland and forty-eight hours in Ireland.

[3] In England and Wales, putts and putchers, owing to the difficulty of putting them out of gear every Saturday, and restoring them again every Monday, are exempt from the weekly close season on paying the penalty of an increased annual close season.

[4] One hundred and sixty-eight days in Scotland and Ireland.

the old close times were too often made to cover the best part of the legitimate fishing season, and allowed fishing to take place all through the spawning season. An Act of Queen Anne, for instance, fixed a close season in Hampshire from 30th June to 11th November, and this was "amended" by 1 George I. c. 18, which made the close season extend from 1st August to 12th November. This last-named Act again fixed a close time for the Severn, Dee, Wye, Wear, Tees, Ribble, Mersey, Don, Aire, Ouse, Swale, Calder, Wharfe, Ure, Derwent and Trent from "the last day of July to the 12th day of November for ever;" and it was not till 1750 that this close season was found "inconvenient as to the said River Ribble by reason that the time limited for restraining the taking fish therein is not properly suited or adapted to the fishing season there." The close season for the Ribble, it may be added, is now from 1st September to 1st February, and the close season for all the rivers named covers approximately the same period.

This question of close time, together with that of the mesh of nets, brings us from what has been called "legitimate fishing" to what we may call "illegitimate fishing"—the slaughter of breeding fish and of young fry. For ages the picturesque practice of "burning the water" for salmon was carried on in England and Ireland as well as Scotland, and the spearing of the gravid fish off the spawning beds long held its own as a recognised form of sport; yet there always seemed plenty of fish to be leistered, and plenty to be netted in the sea below. For ages the capture of smolts was carried on; yet every year the cry was still "They come;" and, as Macbeth fondly believed that his "castle's strength" could "laugh a siege to scorn," so the riverside inhabitants made no doubt that the strongholds of the salmon could long withstand such onslaughts as they made upon them. The smolts and the kippers were only the gleanings of the salmon harvest, the bulk of which was gathered by others in the sea, and were all the return that the proprietors of the upper waters got from the seed which was sown on their property.

CHAPTER IV.

Other causes of the Deterioration of the Salmon Fisheries—Dams and Pollutions—Navigation originally opposed to Weirs—Introduction of Pound Locks—Canals—Pollutions—Value of Mining and Manufacturing Industries contrasted with Salmon Fisheries—Evil of Weirs—Examples of the Advantage of their Removal.

THE old laws forbade in general terms the destruction of the fry of salmon, but their provisions were ignored, and they did not prohibit the killing of the spawning fish at all, except so far as an ill-regulated close season attempted to afford them protection. While the population was comparatively sparse, and the fish were plentiful, no very great harm was done; but, with an increasing population, the effect of these onslaughts became more marked, and Parliament stopped them in the interests of the fisheries. The spawning fish and the spawning beds were protected; the use of lights and spears was prohibited; and, as the enlargement of the mesh saved the smolts from destruction in the estuary, so they were saved from falling a prey to the hook of the angler in the river by a general prohibition of their capture. Throughout the country the adoption of these measures was followed by a remarkable increase in the number of fish, and all the evidence points to the conclusion that these provisions of the law are of as vital importance to the salmon fisheries as any of the other enactments to which we have yet alluded. Theoretically, the protection of the spawning fish and the young fry is the key to the whole problem. If we kill the goose we cannot have the golden eggs; if we would have chickens we must let the fledglings grow; and experience has shown that the provisions of the law relating to close time, spawning fish, and fry, which are based on this theory, are among the most valuable of all the enactments touching salmon fisheries.

But "over-fishing," whether by fair means or by foul, is not sufficient of itself to account for the depletion of some of our salmon rivers and the total ruin of others. All of them in this respect have been subject to the same disease; and all of them have had the same remedy administered, yet, while the patient in one instance has recovered, he has obstinately persisted in dying in another.

It is clear, therefore, that we must look for some cause over and above over-fishing as the principal factor in the deterioration of our salmon fisheries. This will be found in the artificial conditions of a densely populated manufacturing and mining country, whose rivers have been made to serve many other purposes, besides those of fish-production, in the furtherance of which the interests of the fisheries have too often been ignored. Dams for raising the water to supply a mill were among the earliest obstacles placed in the way of the incoming salmon, and, together with similar obstructions raised specially to facilitate the capture of the fish, barred their progress to the spawning grounds. Sometimes such dams were used to serve the double purpose of driving a mill-wheel and catching the fish. These obstructions, however, as already stated, very soon attracted attention, owing to the hindrance they caused to navigation. When, in 1215, the Barons wrung from King John the admission of the rights enumerated in Magna Charta, not the least important point on which they insisted was the demolition of all "kidelli," or fishing weirs, in navigable rivers. Later statutes enforced this provision, and extended it to "gorces, mills, wears, stanks, and stakes," or, as they are called in the old Norman French statutes, "gortz, molins, estanks, et estackes."

In these oft-repeated enactments the primary object was the maintenance of the navigation. The protection of the fisheries was a secondary idea; but, inasmuch as any obstacle to the progress of the boats was an equal hindrance to the ascent of the salmon, the navigation and the fishery interests were so far identical, and, in fighting the battle of the boats, the Barons first, and Parliament afterwards, fought the battle of the salmon. Although in non-navigable rivers dams could still be legally erected, their numbers were probably few, and in any case the main streams and their larger tributaries remained free to the fish.

This alliance of the fishing and the navigation interests lasted till the middle of the eighteenth century, when the link which united them was suddenly dissolved by the introduction of pound-locks. Dams, which had hitherto been under a ban as a hindrance to navigation, were now hailed as a boon to it. Rivers, naturally non-navigable, could be made navigable by the application of pound-locks, and the construction of these obstacles to the salmon, instead of being discountenanced, was encouraged for the sake of promoting the rapidly increasing commerce of the country.

But what was life to trade was death to the fisheries. In the enthusiasm of the moment the people, and the guardians of public interests, forgot all about the salmon; the "grantz rivers d'Engleterre" were divided by impassable weirs into short reaches of semi-stagnant water, no longer speeding in its downward course to welcome the incoming salmon ; and, though trade increased before the eyes of the people on the surface of the rivers, the fish below were being gradually choked out of existence.

The extension of the canal system, also, which resulted from the success of the Duke of Bridgewater's celebrated canal, led to a considerable extraction of water from the natural sources of supply to feed these artificial "cuts," and in this way, again, affected the movements of the fish and the still further capacity of the rivers to receive them.

But still further evils were in store for the salmon. The enormous development of mining and manufacturing enterprise which this country has witnessed during the last hundred years has not only interrupted the free flow of water in our rivers, but it has affected their purity ; factories and mines multiplying in all directions, and requiring large supplies of water, have necessitated new weirs for the purpose ; but, not satisfied with this, they have returned dirty the water that they took away clean, and have sent back poisoned that which they received pure. In this way whole watersheds, like those of the Mersey and Calder, the Rheidol and Ystwith, the Ebbw and Rhymney, have been utterly ruined as fish-bearing streams. Some rivers are actually named from the appearance they present in consequence of the pollutions that are poured into them. The Redbrook, in South Wales, is red with the refuse from tin-plate-works ; the Blackburn, in Northumberland, is black with coal-washings ; the Whitebrook, a tributary of the Wye, is white with the refuse chloride of lime from paper-mills. A man falling into one of the rivers into which dyeworks pour their parti-coloured refuse would run a great risk of carrying evidence of his mischance about with him for weeks in the colour of his skin. Even where they are not thus completely poisoned, the rivers passing through our great manufacturing and mining centres are so seriously affected by pollutions that the fish are often deterred from entering them till a heavy flood, or the cessation from work on Sundays, happily reduces the volume or the virulence of the polluting matter. But at best their movements are regulated, not by the promptings of nature, but by the accidents of art.

Land drainage again, by materially altering the conditions under which the rainfall finds its way to the rivers, has not been without its effect on the salmon fisheries; the rivers, instead of presenting a volume of water of fairly uniform average depth throughout the year, are affected by every shower: they are high in flood to-day, to fall to a lower level than ever to-morrow, and the movements of the fish are consequently rendered uncertain.

It needs no argument to show that fish cannot live in polluted water: the evil which was threatened by weirs has been intensified and consummated by pollutions, and these two causes, singly or in combination, have done more to ruin our salmon fisheries than the most incessant over-fishing.

And while the injury inflicted on the salmon fisheries by weirs and pollutions is far more serious than that caused in any other way, it is also immensely more difficult to mitigate. The mining and manufacturing industries of the country are of vastly greater value than the salmon-fishing industry. The annual value of the exports of British and Irish manufactures and produce is two hundred and fifty millions sterling. This enormous total takes no cognizance of home consumption, and against it the salmon fisheries of the three kingdoms can only show a gross estimated production of three-quarters of a million a year, towards which England and Wales contribute the modest sum of £150,000. But, no more than a quarter of a century ago, the value of the English salmon fisheries amounted to only one-eighth of that sum. The difference between £18,000 a year and £150,000 a year represents the effects of protection, in which the alleviation of the evil of weirs has played only a small part, and the mitigation of pollutions one still more insignificant. The contrast between the present condition of our salmon rivers and the same rivers in a state more nearly approaching their pristine purity and freedom from obstruction would be seen in an advance upon their present value far more enormous than is represented by the improvement from £18,000 to £150,000.

Two questions arise:—Is the removal of the evil of weirs and pollutions possible? and, is the "game worth the candle"?

To take the case of the weirs first; one or two illustrations will suffice. Twenty years ago the River Tyne was blocked near its mouth by a formidable obstruction in the shape of a fishing-mill-dam at Bywell. For many years this weir was an almost impassable barrier to the ascending salmon. Almost the only spawning ground of which the fish that escaped capture in the close season could avail themselves was situated in a small stream flowing into the Tyne immediately below the dam. All the fish that reached the weir during the fishing season were at the mercy of the owner of the dam, yet year by year the take fell off. In 1842, however, a local Act provided for a weekly "slap" at Bywell fishing-mill-dam from 10 P.M. on Saturday to 2 A.M. on Monday. Although the opening thus made was accessible to fish at only infrequent intervals, owing to its position and other circumstances, one result of its formation was that the fishing above the weir improved very materially, while at the same time the produce of the fish-lock at Bywell itself increased, and the salmon harvest of the Tyne generally improved. In 1862 a flood carried away part of the dam, with the immediate result that the take of fish in the river above again largely increased. The owner of the weir, the late Mr. Beaumont, having abstained from reconstructing the weir, the fish have since had uninterrupted access to several miles of spawning ground above the site of the dam; the fisheries above have so largely improved in value that the proprietors have been induced to take further steps to encourage the salmon by removing other obstacles to their ascent, and, although the Tyne is still seriously handicapped by the existence of weirs in its upper waters, and by terrible pollutions near its mouth, its salmon fisheries, which would in all probability have gone the way of those of the Thames, if Bywell dam had remained unremedied, are now more productive than those of any river in England and Wales, producing about 50,000 salmon a year.

A similar lesson may be learned on the Usk. A salmon river of splendid natural capabilities, its productiveness was for many years seriously affected by a formidable fishing-mill-dam at Trostrey, about seven miles above the head of the tideway. Except in times of heavy floods, this weir was impassable by salmon. To its existence the decrease in the fisheries of the Usk, which began to attract attention sixty years ago, was attributed. How far this was the case may be gathered from the fact that, the weir having been carried away by a flood in the winter of 1823–24, the catch of salmon in the fishery above was larger in the spring of 1824 than had ever been known before. Connected with the weir were three fishing boxes or traps, for which the occupiers paid a rent of £100 a year, and which were said to be worth five times as much. On the other hand, the value of the fishery in ten miles of river above the weir was at that time only £30 a year.

After the reconstruction of the weir the fisheries again began to decay, and twenty years later the value of Trostrey fishery, including the rent of a considerable mill, a house and garden, and a few acres of wood for the repair of the weir, had fallen to £27 a year. Some local gentlemen, forming themselves into an association for the improvement of the fisheries, rented and lowered the weir at Trostrey, and made several openings in the body of the dam through which the salmon could pass at almost any state of the water. The result was that scores, "and in some instances hundreds," of fish were taken with the rod in the neighbourhood of Crickhowell and even higher up, whereas formerly "there was hardly a salmon taken all the summer" above Trostrey weir at all. The seed thus sown has borne abundant fruit, and the salmon fisheries of the Usk, under careful protection, have so improved in value that, though the river is injuriously affected by town sewage, though three of its largest tributaries are absolutely ruined by pollution, and several others are more or less blocked by weirs, it produces on an average 10,000 fish a year, 1,500 of which are taken by anglers.

Of course, it is not possible to treat all obstructive weirs in the same summary manner as Bywell and Trostrey. A mill or a manufactory worth hundreds or thousands a year cannot be destroyed for the sake of a fishery non-existent, or of insignificant value. If our predecessors had foreseen the effect that weirs would have had on many a prosperous fishery, they might have hesitated before sacrificing a certainty for an uncertainty; they could at any rate have taken means to prevent the future industry from destroying the existing one, and fisheries which are now conspicuous by their absence might have been of great present worth —possibly equalling if not excelling in value the mills which have supplanted them. But we must deal with the question as it is, and not as it might have been: the weirs have acquired a right to exist, and we have to see how far their interests can be reconciled with those of the fisheries.

CHAPTER V.

Fishing Weirs—Fishing-Mill-Dams—Ordinary Dams—Newly Erected Weirs—Salmon Ladders or Passes—The Ballisodare Ladders—A Fishery created by Salmon Ladders—Other Forms of Salmon Passes—Salmon Passes *versus* Mills.

In dealing with the question of weirs, Parliament has drawn a wide distinction between those constructed wholly or partially for the purpose of catching fish, and those constructed solely for milling, manufacturing, or navigation purposes. In the case of the former it has made their existence and use contingent on compliance with certain regulations designed to prevent them from completely cutting off the run of the fish. The latter are permitted to remain in the state in which they existed when the first of the present Acts came into force in 1861, provided the obstruction they then offered is not increased in any way.

Thus no "fishing weir" extending more than half way across a stream can exist, unless it is provided in the centre with a "free gap" one-tenth of the width of the stream, and never less than three feet wide, through which salmon can pass at all times. No compensation was made to the owners of these structures for this interference with their property, although this provision affected their catching powers to a considerable extent, and effectually took the sting out of them as impediments to the passage of salmon.

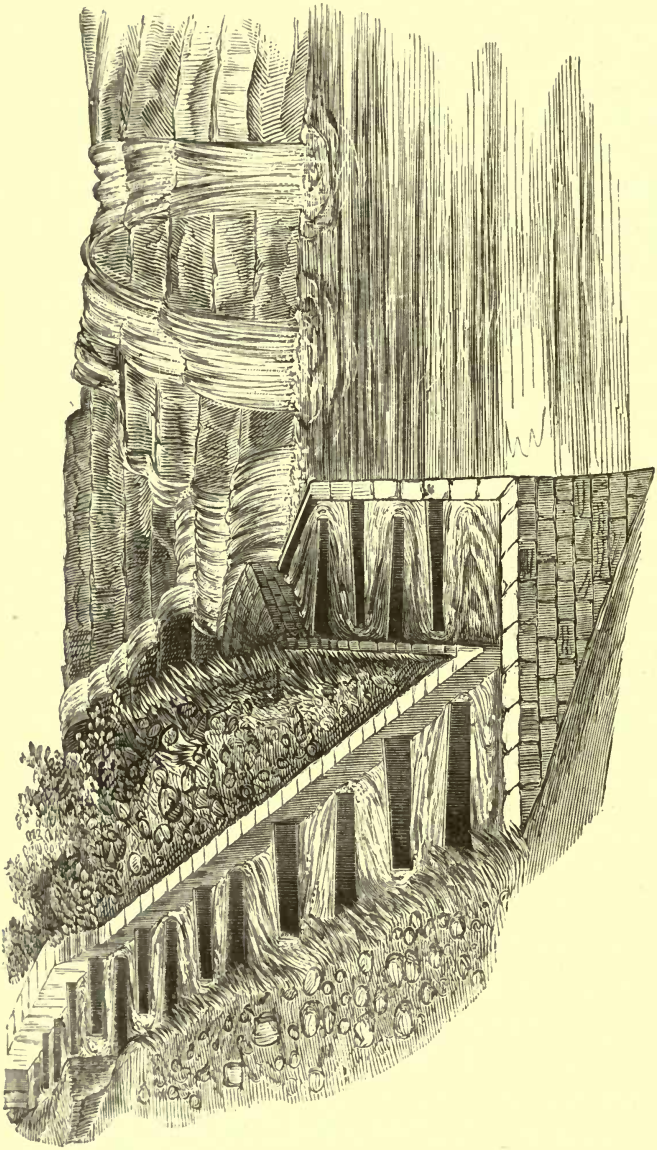
Fishing-mill-dams, *i.e.* dams used partly for fishing and partly for milling, were not interfered with unless the fishing right was retained, in which case the construction of a fish-pass was required, with "such a flow of water constantly running through it as will enable salmon to pass up and down such pass."

At the time when this statute was framed the fear prevailed that the construction of a fish-pass meant serious injury to the milling power, and as, in the then impoverished condition of the fisheries, the milling value of a dam was usually greater than its fishing value, the owner, having to choose between the retention of the former unimpaired, and its possible injury if he retained both, hesitated to sacrifice, as he thought, a real present value for a doubtful future one. The possibility of the fishery becoming—by the simple process of giving a few spawners access to the upper waters from which the dam cut them off—so largely improved as to far exceed, in future years, the value of the mill, did not present itself to the minds of dam-owners generally; and, acting on the principle that—to adapt a familiar proverb—a mill on the land was worth a good many fish not yet in the river, they in most cases preferred to let their fishing rights go, and to retain their milling rights intact. But the case of the fisheries was not improved. The neglect to make a fish-pass involved the forfeiture of the right to fish, but it left the obstruction caused by the dam as great as ever. Greater, indeed, than ever; for with the fishing right all direct inducement to the owner to pass the fish over the dam vanished; not only was the existing fishery abandoned, but the opportunity of increasing its value was abandoned too. Parliament overlooked the fact that it would have been of far greater advantage to the fisheries to allow but one fish to pass over the dam for every ten that might be caught there, than to take away the right to catch ten fish at the cost of not allowing one to pass up.

A fishing-mill-dam under these circumstances became nothing more or less than an ordinary dam, erected purely for milling or other purposes, without any view to the capture of fish. The position of such weirs is that, as their owners had no direct interest in the fisheries, they could not be called upon to provide a remedy for the injury which, with a sublime disregard for anything beyond their own immediate purposes, they had inflicted on the fisheries. However serious the effect of a weir, or a series of weirs, in a salmon river, they were held guiltless because the object for which they were erected was legitimate. The justice of this view cannot be questioned, however much the existing state of things may be deplored. If, when weirs first began to be erected, Parliament had foreseen their effect, and had insisted on proper steps being taken to prevent injury to the fisheries, it would have been a different matter; but, when weirs had been in existence for years, perhaps for centuries, it would have been impolitic suddenly to call upon the owners to do what might possibly prove to be an injury to themselves for the sake of benefiting an industry in which they had no interest.

With new dams, or old dams rebuilt or "enhanced," as the old Acts expressed it, the case is different. Parliament has insisted that all such structures in salmon rivers shall be provided with an efficient pass, on condition, however, that no injury shall be occasioned thereby to the navigation of any river or canal.

This proviso was a natural and a proper one, but—like another equally necessary proviso, that a fishery proprietor or a Board of Conservators constructing a pass in a dam belonging to another person is liable to pay compensation



SALMON LADDER AT LOWER BALLISODARE FALL.

for any injury to the mill or navigation in connection therewith—it has given colour to the prevailing impression that the construction of a pass will necessarily, or even probably, have a prejudicial effect on the supply of water for milling or navigation purposes. However direct the injury which the dam inflicts on the fisheries, the remote possibility of injury to the dam is sufficient to prevent the remedy of the first evil.

The experience of the last twenty years, however, has shown not only the advantages accruing from the construction of passes, but the facility with which they can often be erected, and the inappreciable damage they need do to the milling power. Although much still remains to be done in this direction, many good passes or ladders have been built over weirs in different parts of the United Kingdom, the system varying according to the peculiar circumstances of the case. Among the more successful passes in England and Wales, may be mentioned those at Penarth, Bevere, and Pool Quay on the Severn, at Clitheroe on the Ribble, at Acklington on the Coquet, at Erbistock on the Dee, at Newton Weir on the Usk, and at the Brân Weir on a tributary of the Usk.

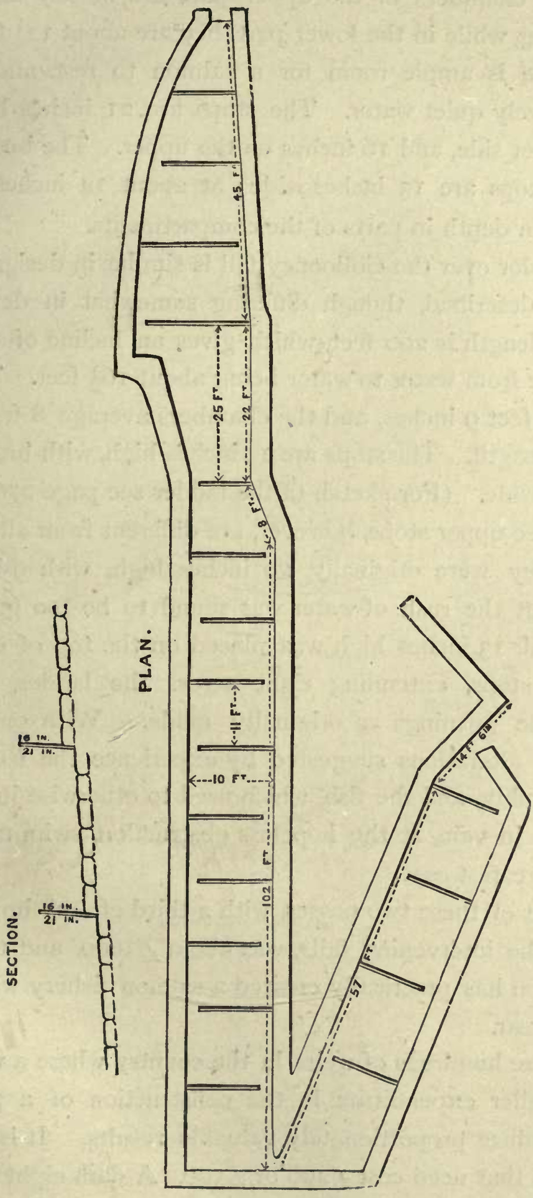
What a salmon pass can do has seldom been so strikingly illustrated as in the case of the Ballisodare River, County Sligo, Ireland. The history of the ladders on this river is remarkable. "Previous to 1856," writes Mr. Francis Francis in his pamphlet on 'Salmon Ladders,'[1] "the Ballisodare River, which is formed by the junction of two rivers—the Avonmore and the Arrow—held no salmon. Occasionally a few fish came into the bay, and made their

[1] Published at the *Field* Office, 346 Strand. I am indebted to Mr. Cox, the proprietor and publisher of the *Field*, for the use of the accompanying woodcuts, representing the Ballisodare ladders.

way to the lower falls, which are at low water 19½ft. high, and at high water some 5 feet or 6 feet less. Once in a way, in extremely high tides, a fish or two would contrive to scramble up the broken water on the left-hand side of the fall, where there are some broken ledges; but the fish never got past the Collooney, or highest fall.

"Mr. Cooper, having obtained an Act of Parliament for a 'several' fishery, and purchased up all the rights which could interfere with him, planned three ladders—one at the lowest, or Lower Ballisodare, fall; one (the upper Ballisodare ladder) at a place some distance above where there were a succession of rapids and small falls, which were not a very formidable obstruction; and a third (the Collooney ladder) further up, where the falls, though 2½ feet less than at Ballisodare, were so abrupt as to be quite impassable, being 16½ feet high. After some failures the ladders were completed. Spawning salmon were put up above the falls, and the place to a small extent was stocked with ova. Smolts appeared, and went down to sea. In due time grilse returned, and year by year increased, until now the river has become a regular salmon river, and one of a most productive character." In the year 1869 no less than 9750 salmon, worth, at one shilling per pound, nearly £3000, were taken in the weir below the lowest fall.

The accompanying illustration shows the ladder by means of which the salmon are enabled to scale the lowest falls. The ladder is described by Mr. Francis as being divided into twenty stops, the position of which is shown on the plan. Its extreme length is 248 feet, so that, with a fall of 19½ feet to overcome, the ladder shows an incline of 1 in nearly 13. The side walls of the ladder are built of rough-hewn stone 2 feet thick for the most part, for it is an exceedingly substantial erection. It is 10 feet wide in the



PLAN OF SALMON LADDER AT LOWER BALLISODARE FALL.

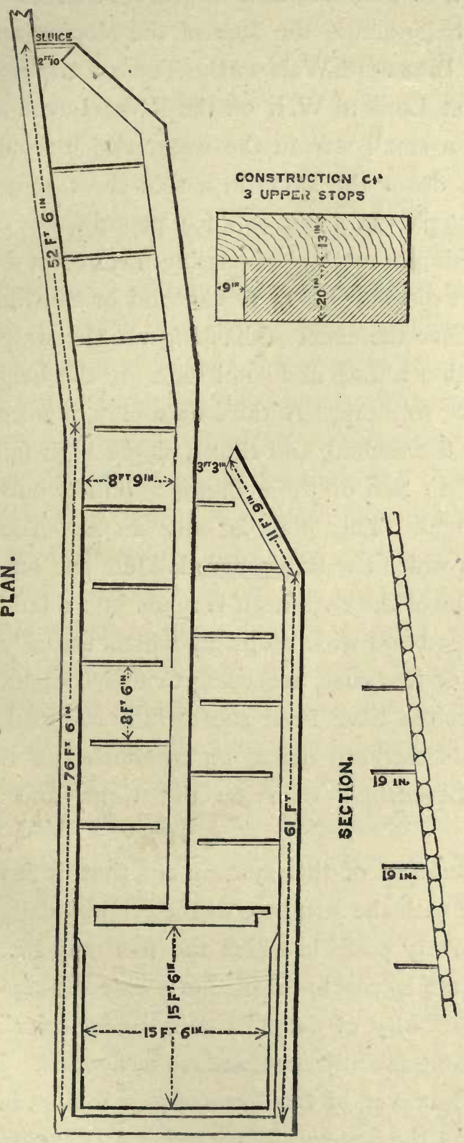
clear; the chambers in the upper part are mostly about 11 feet long, while in the lower part they are about 12½ feet. Thus there is ample room for a salmon to rest, and in comparatively quiet water. The stops are 21 inches high on the lower side, and 16 inches on the upper. The breaks in these stops are 13 inches wide; at about 14 inches or 15 inches in depth in parts of the compartments.

The ladder over the Collooney fall is similar in design to that just described, though differing somewhat in detail. Its entire length is 200 feet, which gives an incline of 1 in 12, the rise from water to water being about 16½ feet. The width is 8 feet 9 inches, and the chambers average 8 feet 6 inches in length. The stops are 19 inches high, with breaks 11 inches wide. (For sketch of the ladder see page 276.)

The three upper stops, however, are different from all the rest. They were originally 20 inches high, with 9-inch breaks; but the rush of water was found to be too great, and a plank 13 inches high was placed on the top of each of these stops, extending right across the ladder, but leaving the openings as originally made. With one or two minor alterations suggested by experience, the ladder acts admirably, and the fish, which used to otherwise jump, and jump in vain, at the hopeless obstruction, swim up it with the greatest ease.

The cost of these two passes, with a third of less importance at the intervening falls, was about £1000, and their construction has practically created a salmon fishery worth £3000 a year.

There are hundreds of weirs in the country where a very much smaller expenditure in the construction of a pass would produce proportionately valuable results. It is not every pass that need cost £400 or £500. A dam eight feet high can be rendered accessible to salmon at less than half



PLAN OF SALMON LADDER AT COLLOONEY FALL.

the cost of a dam double that height. A baulk of timber fixed diagonally across the face of the sloping apron of a weir—as at Bransford Weir on the Teme, a tributary of the Severn, or at Lowood Weir on the River Leven—so as to collect into a small stream the water which would otherwise trickle down the slope in a thin sheet, may make a very efficient pass at a cost of a few pounds.

Another simple method of passing fish over a dam is to erect a short distance below it a second or subsidiary dam, which will have the effect of backing up the water against the obstruction above, and so of reducing the height which the fish have to jump. A third dam may, if necessary, be built below the second, and thus a single high fall may be converted into two or three jumps of half or one-third its original height. This plan is only an extension of the principle on which the Ballisodare ladders are made. The whole volume of the river itself is made into a ladder with a series of broad and wide steps, up which the salmon leap with more or less ease, according to their height. Passes on this principle have been successfully adopted at Chollerford and Otterburn dams, on tributaries of the North Tyne, at Levenshall dam on the Kent, and at other places.

The advantages of this system are that it involves no interference with the structure of the original dam, and that it affords roomy pools in which the fish may lie. Its disadvantages are its cost in the case of a wide and rapid stream, and the possibility of the new weirs under certain circumstances causing the adjacent lands to be flooded. The great advantage, however, of this form of pass is that, in the case of a mill-dam, the first subsidiary weir may be built at such a spot as to intercept the water from the tail race of the mill; and thus the whole volume of the river, whether the mill is working or not, may be utilised to enable the fish to surmount the original obstruction.

The supply of water is, after all, the "bone of contention" between dams and passes. The miller appreciates the truth of the old saying that—

> "... You never will
> With water once passed by propel the mill;"

and he accordingly objects to any device that may possibly reduce the supply of water to the mill-wheel in dry weather. For the efficient working of a fish-pass, of whatever kind, a supply of water through it is essential. The easiest way to secure this is of course to make the entrance to the pass a trifle lower than the crest of the dam, but this would *pro tanto* diminish the effective power of the wheel whenever the level of the water fell below the crest of the dam. To compensate for this it would be necessary to slightly increase the height of the weir; the effect of which would be twofold. It would first of all ensure the full volume of water, that would otherwise fall down the whole width of the dam, passing down the pass, and it would, in the second place, increase the power of the mill by the additional weight of water that would be dammed up, as well as by the increased length of time during which the river would be held back for the use of the mill. In this way the requirements of the pass could be calculated to a nicety, and they could be served without injury to the necessities of the mill. But, even without cutting into the crest of the dam, it would in many cases be advantageous to gain the same end by slightly raising the level of the dam along its entire length, with the exception of that part where the mouth of the pass is situated; in this way, although the pass would be less efficacious than one built with its upper end below the original level of the weir, it would be better than none at all.

A point of law in regard to dams other than fishing-mill-dams and fishing-weirs is involved here which may be briefly referred to. Unless a pass "of such form and dimensions as the Secretary of State shall approve" be attached to any dam, and unless the fish-pass has "constantly running through it such a flow of water as will enable salmon to pass up and down it," no person may fish, except with rod and line, within fifty yards above and one hundred yards below such dam. This prohibition is intended to act as an inducement to mill-owners and others to construct fish-passes, but the condition that the pass must have water "constantly" flowing through it has acted as a deterrent. The expedient of raising the dam, to compensate for the making of the pass, would probably remove this scruple on the part of the dam-owner, and it is perhaps worthy of consideration whether the law might not be altered to empower a Board of Conservators to make such a bargain with a mill-owner, on condition of his exercising certain fishing rights, to be limited according to the efficiency of the pass. Every extra spawning fish that passed the obstruction would improve the productiveness of the river generally and of the fishery in question in particular; the mill-owner might make a satisfactory bargain by sacrificing to some extent his milling powers for the sake of an increasingly productive fishery, and the Board might make a not unreasonable arrangement in giving the miller a property in a part of the fish in exchange for the greater facilities that he might accord the remainder.

In any case, pass or no pass, the Conservators of every district should be empowered to net the waters below any dam and transfer the fish from the lower to the upper side of the obstruction. The Conservators of the Dart, failing the construction of an efficient pass at Totnes Weir, have for some years adopted this expedient, with very satisfactory results, considerable numbers of spawning fish, kept back by the dam, having been caught, and set free again where they could continue their journey to the spawning beds.

CHAPTER VI.

Pollutions — Extent of Salmon Rivers destroyed by them — Different Sources of Pollution—Means of remedying the Evil—Serious effects of Pollution on Health and Trade—The Sewage Question and the Thames—The Abolition of Pollutions—Suggested Scheme.

No abatement of weirs, however—no ladders, however expensive or effective—will avail much where serious pollutions exist. The injury inflicted by pollutions is enormous. Out of the 40,000 square miles of country in England and Wales, watered by rivers naturally suited for salmon, no less than 6000 square miles are destroyed by pollutions alone; 10,000 square miles more are destroyed by pollutions and weirs combined (and, even if the weirs were abated, the pollutions alone would still be enough to ruin the rivers); while nearly all the other rivers are more or less injured by the one or the other. The condition, therefore, of the salmon may be likened to that of the horses in the Grand National Steeplechase, if, besides having to jump a high hurdle every few yards, the animals had to breathe an atmosphere charged with carbonic acid gas.

Until within the last few years no legislative action has been taken to remedy the evil of pollutions, and the existing law on the subject is almost inoperative. It is fairly capable of dealing with new sources of pollution from factories and town sewers, but it does nothing to remedy existing impurities, and it does not touch the deadly "hush" from mines, whether new or old.

But Parliament and the public are becoming more and more alive to the necessity for purifying our streams, not merely for the sake of the fisheries, but in the interests of public health ; while manufacturers and others are slowly recognising the fact that they are often throwing away valuable material, capable of being turned to profitable account, when they blindly pour their refuse into the streams.

Pollutions are of two kinds, liquid and solid. The former, by chemical action, are most deadly and insidious, destroying the oxygen in the water which the fish breathe, and actually injuring their gills or breathing organs ; the latter choke by mechanical action, clogging the gills and suffocating the fish. Solid pollutions have an even more serious effect upon the fisheries by destroying the spawning beds, which become smothered with a thick muddy deposit, in which the fish will not spawn, or, even if they did, the eggs would not develop. China-clay works, mines, and collieries, are notable offenders in this respect. But it is perfectly practicable, by collecting in settling tanks or catch pits the refuse water which holds these matters in suspension, to allow the sediment to fall to the bottom, when the water will flow off practically clean. The sediment or "sludge" itself, in most cases, is capable of being converted into bricks, or applied to some similar purpose ; and, even if it is not, the cost of carting it away to a spot where it will do no harm would soon be repaid by the good done to the fisheries by keeping it out of the river.

Chemical poisons in solution are more difficult to deal with, but they are so much more deadly and far-reaching in their effects that there is still less reason for hesitation in compelling their diversion from the rivers, especially as they are, with probably hardly an exception, capable of such profitable utilisation by special treatment that their compulsory removal from our streams would more than pay the cost of the necessary works, without reference to the compensation that would be found in the improvement of the fisheries.

An instance may be found in the plan adopted by the Devon Great Consolidated Mining Company for the extraction of copper in solution in mine-water, with most excellent results. The water is passed through large filtering beds, to divest it of all earthy matter, and then conveyed over scrap-iron, which throws the whole of the copper down. The iron is occasionally turned over and brushed, to prevent it from becoming too thickly coated with copper, when it would cease to be acted on. The copper is caught in a catch-pit at the end of each water-course. The iron displaced by the action of the acid passes off in the form of ochre, which is caught in pits prepared for the purpose; and the water is again finally taken through a series of catch-pits and ponds before being thrown into the river.

The rivers of South Wales are all more or less seriously injured—many of them utterly ruined—by the refuse from tin-plate works. This refuse consists of diluted sulphuric acid, holding iron in solution. In order to make iron plate or wire take the desired coating of tin, it is dipped in a "pickle" composed of a strong solution of sulphuric acid, which eats away all impurities and roughness from the surface. This highly poisonous liquid, when it has been used several times, becomes so fully charged with iron that it can do its work no longer; and so the manufacturers, regarding it as an unprofitable servant, cast it disdainfully into the river, where it poisons the water, kills the fish—and anything else that happens to drink it—

and stains the very beds and banks of the streams the colour of a mahogany table. But Mr. Pughsley, of Kidwelly, has devised a means of utilising this waste "pickle," by the use of which, instead of dealing death and destruction in the rivers, it may be retained in the factories, and become a source of wealth. Mr. Pughsley simply evaporates the water from the pickle by boiling, and recovers the acid, so that it may be used over and over again, while the iron, combining with a portion of the acid, is precipitated in the form of green copperas or sulphate of iron, a valuable commercial commodity.

In much the same way the waste soda or chloride of lime from paper-works, the alkali from soap-works, the grease from wool-works, the waste from dye-works, and the thousand and one other forms of poison daily cast into our rivers, may, by the practical application of the teachings of science, be diverted from the streams which they pollute and converted directly into money. For example, the refuse from tan-yards is a fruitful source of pollution, but there is no reason why the rivers should receive this matter, which, if applied to the land, is a valuable manure. The dye-water from dye-works, consisting of a solution of sulphate of iron, with insoluble dye-matter in suspension, can be purified in a very easy manner, and the refuse used as manure; it can be clarified by simple filtration through ashes; or, if turned into subsiding pits or tanks, the addition of a little lime causes the colouring matter to be at once precipitated, and the superincumbent water is left clear, and may be drained off comparatively pure and colourless, instead of going to foul the river and unfit its waters for use by manufacturers and others below.

This last consideration is a most important one. Even if manufacturers had no inducement, in the actual value of their refuse, to keep it out of the rivers ; even if they were not influenced by the reflection that the fisheries would be benefited thereby ; even if public health reaped no advantage, and the causes of natural beauty were not served, manufacturers would be the gainers by having pure water instead of dirty water to use. Factory owners in South Wales, for example, find their engine-boilers rapidly destroyed by the use of water from the rivers impregnated with sulphuric acid ; and an enormous expenditure is incurred elsewhere in the country in the partial purification of dirty river water before it can be used for manufacturing purposes, or in the sinking of wells, which would often be needless if the rivers were kept even tolerably pure.

Manufacturers and mine owners, however, are not the only people who sin in this respect. The inhabitants of every town that casts its sewage into a river as the easiest and apparently the cheapest means of getting rid of it are collectively and individually to blame. It is a serious question whether so easy a means of getting rid of this and other polluting agencies may not be too dearly purchased. Not only are the fisheries injured or ruined, but public health is affected by the contamination of the atmosphere caused by the fermenting sewage ; the land is robbed of a valuable manure ; we are deprived of our natural supplies of pure water ; whole fields are destroyed by noxious waters carried over them by floods, and the very grass, instead of being benefited, is poisoned, so that the cattle that eat it are killed. Every one acknowledges nowadays that the proper place for the sewage is the land, not the water. It has already been satisfactorily shown that the sewage can be profitably utilised. The question is, how shall the principle be carried out? Irrigationists and precipitationists may fight over the bone if they will, and a very valuable bone it is; but in the meantime it does no one any good, and is the occasion for a vast deal of mischief. The inquiry now proceeding before the Commission on London Sewage has elicited very remarkable testimony as to the string of evils occasioned by the pollution of the Thames from this source alone. The estuary of the Tyne is badly enough polluted, but it is clean compared with the Thames. If the Thames were only purified to such an extent as to compare with the present state of the Tyne, and if its weirs were provided with passes, its ancient salmon fisheries might even yet be restored to it. With its waters completely purified it would, in its salmon alone, produce wealth far exceeding that of the golden sands of fabled Pactolus.

The difficulty of dealing with pollutions is in its legal aspect similar to that of the weirs. Prescriptive rights have been allowed to grow, and they have a legal claim to proper recognition. But when public opinion recognises, on the other hand, the full advantages of pure rivers, and when it understands that they can be secured without undue interference with other interests, it will demand that no single industry or group of industries, however important and valuable, shall be allowed unreasonably to override them. To pass a law that within a reasonable period—of, say, ten or a dozen years—all pollutions, solid or liquid, shall be diverted from our rivers, might seem at first sight an unreasonable proceeding. But, under the influence of such pressure, methods similar to those already referred to—which have been devised without any incentive beyond that of direct profit—would no doubt be found whereby the noisome matters now daily and hourly defiling the face of Nature could be disposed of, not merely at trifling cost, but actually at a profit.

If the policy be repudiated of casting on individuals the duty of removing, in the public interest, the nuisances which individuals have been allowed to create, then a competent public body should be armed with authority to deal with the question. Such a body should be formed for each watershed, or group of watersheds. It should have power to levy a rate on all property within its jurisdiction; to divert all existing pollutions of any kind, if the owners of the offending works did not undertake to do so at their own costs within a specified time (new pollutions being, of course, absolutely prohibited); to retain the right to deal with all waste substances thus thrown on its hands, however profitable they might eventually prove to be; to receive all profits arising therefrom; to dispose of the right to deal with such refuse, and generally to do all works necessary to secure the purity of our streams. Such a body should act in unison, if not be identical, with Boards of Fishery Conservators, and should have power to levy a rate on all private fisheries that might be created or improved by its action. This, with the enhanced value of riverain property following upon the purification of the streams, the increasing prosperity of the public fisheries, and the consequent revenue in licence duties, would enable the burden of taxation to be shared by at least one interest, in proportion to the special advantages it would derive from the operations of the Board. The Board could not levy a rate on the improved health of the neighbourhood, but in the services it would render to sanitation the public generally would receive a return for the taxation imposed upon it.

In the meantime the offending factories, the first cause of the levy of the new rate, and no inconsiderable gainers from the supply of pure water they would receive, might be made to contribute specially by a percentage on the cost of the works necessary to deal with their refuse.

Such a measure may appear drastic, but a serious disease demands a radical cure. The Hydra of river pollution requires a Hercules to end its days, and no half-measures will be really effective. Much, however, may be done by individual effort; and it is sincerely to be hoped that both manufacturers and mine-owners, as well as weir-owners, will unite in a real effort to benefit themselves as well as the fisheries by removing or abating as far as possible the obstacles they have placed in the way of a national industry. So long as pollutions exist, the fish and the fisheries must sicken or die. For weirs—however serious—a remedy short of actual demolition may be found; but for pollutions, if at all serious, nothing short of removal will be efficacious.

CHAPTER VII.

Artificial Breeding of Salmon—Its advantages—Extensively adopted in America and Canada—Is it essential?—Upper Proprietors and Salmon Angling—Scientific aspects of artificial Propagation—Non-migratory *Salmonidæ*—Classification of Salmon—Bull Trout *versus* Salmon—Study of Natural History—The Pacific Salmon Problem—Kippered Salmon—Natural Phenomena affecting the Fisheries—Legislation—Introduction of Salmon into Australasia—A glance into Futurity—Conclusion.

THE opinion is gaining ground that, as it is to artificial causes that the deterioration of our salmon fisheries is due, so purely artificial measures should be resorted to in order to revive them; that, instead of devoting all our energies to the restoration of our rivers as far as possible to their natural conditions, by remedying the obstructiveness of weirs, removing pollutions, and preserving the breeding fish, we should altogether supplant Nature, and take the hatching and rearing of fish entirely into our own hands.

Briefly described, the artificial rearing of salmon or of any other kind of oviparous fish consists in the following operations. The fish are caught when on the eve of spawning; a slight pressure causes the fully developed roe to escape from the ovaries—a process technically known as "stripping;" the ova of the female fish, being placed in a suitable vessel, are covered with the milt of the male fish, and, the two being carefully mixed together, impregnation is effected. The ova are then washed, placed in trays or troughs, called hatching-boxes, through which runs a stream of cold water, under the influence of which, as in the ordinary course of nature, the young fry are hatched. By dint of careful attention in increasing the quantity of water as the fry grow, in the supply of proper food, and in other matters of detail, the young fish are reared "by hand" until they are big enough and strong enough to fight the battle of life on their own account, when they are turned into a natural stream.

This system is so far an improvement upon Nature that as many as ninety per cent., and even more, of the eggs may safely reach the "fry" stage, instead of the vastly smaller proportion which, as we have seen, survive in the ordinary course of things. But here the advantage ends: the fry, to become salmon, must develop into "smolts," and pass down the river into the sea; brought up at the hands of tender nurses, they have lost much of their natural timidity, and so soon as they are turned into an open stream they are likely to fall an even easier prey to their enemies than if they had been born in the midst of them. This objection is only one of degree, and would lose all its force if the salmon fry were able, like trout fry, to remain in a comparatively restricted area of water, where an unrelenting war could be waged on their foes, and where they could be tended as carefully as a flock of lambs in a fold. But, instead of this, they have to go down to the sea and to face all the perils to which they would have been exposed had they been left to hatch out naturally; and the only real advantage which artificial hatching affords in such a case is that the number of fry reared from the eggs of a certain number of salmon, and started on their way to the sea, is many times greater than would have been produced by the same number of breeding fish if left entirely to Nature. Whether, in a river endowed with a fair share of natural capabilities, this is a practical advantage of sufficient importance to outweigh the expense and trouble involved in artificial breeding may be questioned. The marvellous abundance of salmon in the rivers of Western America suggests a negative reply ; and some of our own heavily handicapped rivers seem to show that artificial breeding is not necessary to the maintenance of a fair stock of fish. The Tyne, for example, with terrible pollutions in all directions, with most of its tributaries more or less obstructed, nevertheless yields, with ordinary protection, about 50,000 fish a year, and has within the last dozen years produced as many as 129,000 fish in a single season.

On the other hand, the reports of the progress which the artificial hatching of salmon and other fish has made in Canada and the United States are very alluring. Salmon, shad, and whitefish have been hatched by the million under the immediate direction of the government officials, and tens of millions of young fry have been turned into rivers whose stock was becoming exhausted, and even into streams where they did not naturally exist. The placing of some millions of young fry into the waters even of a river of such marvellous productiveness as the Sacramento, for instance, during the last ten years or so has been followed by such a large increase in the take of adult fish that the Honourable B. B. Redding reports that "with the aid of artificial breeding we have beaten the sea-lions, the canneries, and the fishermen combined." Altogether such remarkable success has attended the able and energetic efforts of the fish-culturists—both private individuals and public officers—in Canada as well as the United States, that it is hardly surprising that this system of supplementing the forces of Nature is looked upon in some quarters as the Alpha and Omega of salmon preservation, as if the whole secret of the salmon fishery problem were summed up in the injunction, "First hatch your salmon and then catch him."

But it is evident that, unless rivers are at least unpolluted, it will be useless to turn young fry into them. The abolition of pollutions is therefore, artificial breeding or no artificial breeding, a *sine quâ non.* To the bane of weirs artificial breeding may be a partial antidote, since the young fish can go down with comparative ease, where the breeding fish could with difficulty get up; but with efficient passes and with a reasonable stock of fish left for breeding, a fairly pure river will hold its own, as a salmon-producing stream, without artificial breeding.

For some years several hundred thousand young salmon fry were turned into the Thames by Mr. Forbes of Chertsey, the late Mr. Frank Buckland, and the late Mr. S. Ponder. But not one of those fry has ever come knocking at the door of Mr. Forbes' house at Chertsey, which they ought to have done if it be true that salmon always return to the spot where they were hatched; and which they might, metaphorically speaking, have done, if the Thames had been purified and its weirs provided with passes. When this is accomplished, and not before, artificial breeding may be of inestimable advantage in enabling us to sow the seed which shall produce the future salmon harvests of that river.

In what may be called the "politics," as distinguished from the "economics," of our salmon fisheries, the removal of weirs and pollutions is a matter of primary importance. The landowners on the head waters of a salmon river—in fishery parlance the "upper proprietors"—very naturally ask that they may have some share of the fish whose very existence depends upon their goodwill in preserving the spawning beds. If weirs and pollutions keep the fish back till so late in the year that they are completely "out of season," the upper proprietors show a not unnatural disgust, just as they would equally naturally do if the nets below were allowed to fish so late and so continuously as to practically reap the whole harvest. In the nature of things it is not possible for the upper proprietors to have a large share of the fish which they may be said to breed; and their demands are not unreasonable: they merely ask for the gleanings of the harvest; they are content if they can have a little sport when exercising this right. As anglers, they do not like to be condemned to hook full or foul fish, which they are obliged at once to return to the water under pain of heavy penalties. Indeed, the fact that the salmon, which usually observes an almost total abstention from food during his sojourn in fresh waters,—at any rate while proceeding up-stream to spawn—should so willingly take a bait composed of a bunch of feathers unlike any insect that ever existed, would seem to be a special dispensation of Providence to enable the upper proprietor to take out in sport what he cannot have in a commercial fishery. The angling rights on a mile or two of good water are often as valuable as a commercial net fishery taking ten times the quantity of fish; and the maintenance of a property of this kind, as well as of good feeling between all the riparian interests on a river, depends in large measure, first, on the removal of pollutions and weirs and, next, on the adjustment of fishing seasons and mesh of nets, and the proper regulation of the net fisheries. For these various reasons the artificial breeding of salmon can never advantageously supplant the method of maintaining a salmon fishery by the restoration of a river to something like its natural conditions. But, as an aid to the scientific study of the life history of fish and to the accurate determination of species, artificial propagation will prove an invaluable ally of the fishery legislator as well as of the fish-culturist; and it is in this, as well as in such work as re-stocking barren waters, and in facilitating an interchange of varieties between one district, or one country, and another, that artificial breeding will find its most useful functions. Not the least important service it can render is to aid in the accurate classification of the different varieties of *Salmonidæ.*

Scientifically the genus *Salmo* embraces two distinct classes of fish—those which migrate to and from the sea, and those which live entirely in fresh water. With the latter which include the fish known under the designations of trout, char, grayling, polſan, powan, vendace, and gwyniad the present treatise has nothing to do. The non-migratory *Salmonidæ* are a mere incident—though a not unimportant one—in the greater question of the Salmon Fisheries. The same may be said of the smelt or sparling, which, though a migratory Salmonoid, differs so essentially in its habits from all the other varieties of the *genus* that it is not, in effect, placed under the salmon laws, and may be at once dismissed—although in an exhaustive consideration of the salmon question this fish ought not to be overlooked, since it undoubtedly affords in certain localities a large supply of food for the salmon. All these fish, it should perhaps be added, are susceptible in the highest degree of all the advantages which practical and systematic artificial propagation on the largest scale can confer.

Of migratory *Salmonidæ* there is a large number of different species, and a still larger array of "varieties." *Salmo salar* is regarded in this country as the salmon *par excellence*, its cousins, the peal, sewin, or sea-trout—

whether these names are strictly synonymous or not is a disputed point—holding only second rank, though their flesh is red; while the "bull-trout," (*S. eriox*) comes a bad third, its flesh being decidedly inferior to that of any other English variety, white in colour, and comparatively flavourless. Here, as is too often the case elsewhere, the inferior race is the stronger; bull-trout are able to push their way up-stream, and to spawn where the weaker salmon is kept back; and in many rivers—notably the Coquet in Northumberland—the more aristocratic salmon is being elbowed out by its sturdier "poor relations." The problem of so regulating the use of nets that a closer mesh may be used to capture the bull-trout, which are smaller than the salmon, without capturing an undue proportion of the immature members of the larger and more valuable race, is one which is making more and more urgent claims on the careful attention of the authorities charged with the protection of the salmon fisheries.

In England the proper classification of the different varieties of salmon is still an open question. In new countries like America, notwithstanding the care lately bestowed upon the matter, chaos reigns in the nomenclature of the large number of varieties which that great continent appears to contain. When Yarrell made the fry of *Salmo salar* into a distinct species, under the name of *Salmo salmulus*, and when eminent French naturalists till very recently promoted the kelt, or spawned salmon, to a similar dignity, under the name of *saumon bécard*, or beaked salmon,[1] it is not surprising that the international classification of the different species of a genus of fish which are susceptible of such great changes in their appearance at

[1] *S. hamatus*, or hooked salmon, figures in some lists of American species of salmon, but is probably only the "kelt" of other species.

different periods of their existence, and according to the peculiar characteristics of the locality in which they may happen to exist, should prove a task of great delicacy and difficulty. It is not necessary, nor would it be possible, to enter fully into this question here; but so much depends, in salmon legislation and administration, on an accurate knowledge of the natural history of the fish in all its phases and varieties, and so much can be gained by an interchange of experience between different countries, that the importance of the question cannot be too strongly insisted upon; and the service which artificial culture of salmon can render in this matter can hardly be over-estimated.

Another such point, in which the aid of artificial breeding can be called into requisition, is the case already referred to of the supposed death after spawning of the Columbia and Fraser River salmon. This question is eminently worthy of complete investigation, and could easily be set at rest, if by no other means, at least by the expedient of marking the fish artificially spawned before they are returned to the river. If only two or three of the fish from which the spawn is taken artificially were found in subsequent years, the fact would at once disprove the theory that the salmon of the Pacific coast invariably die. Or a few of the spawned fish might be retained in an aquarium, where the fresh water was gradually replaced by salt water, to reproduce as nearly as possible the conditions under which the fish would naturally exist on its downward migration—if it really does migrate. Or some of the eggs, transported to this country and artificially hatched, would produce fry which might be marked and placed in some of our rivers, where their movements might be watched to see whether the shorter length of our streams increased their power to withstand the exhaustion attendant on their long journey to their native spawning beds.

The bearing of this problem, not only upon the future management of the salmon fisheries of the Pacific slope, but upon the whole question of salmon fisheries in all parts of the world, is very important. The belief that the kelts all die is relied upon by the advocates of artificial breeding as an argument in favour of the universal adoption of that system. And very naturally; for if the parent fish, having once fulfilled their natural functions, are to perish, it is far better that their flesh should be utilised than that their dead bodies should lie festering in the river, poisoning the atmosphere, and contaminating the water. In the upper part of the Fraser the quantities of dead fish found after the spawning season are said to be so enormous that the effluvium is perceptible for a great distance, and is quite sickening. There is nothing actually unwholesome in the flesh of a spawned salmon, notwithstanding the popular prejudice to the contrary; at any rate the Parisian gastronome, who is generally supposed to have a keen appreciation of the good things of this life, enjoys his diet of kelt, whether kippered or salted, or left to be disguised by the resources of the culinary art; and Paris has always been an open market for poached fish from the English rivers. So many million pounds of kippered salmon would be a not unwelcome addition to the food resources of many people besides the Red Indians of the American woods and prairies. But the legitimacy of such a course depends entirely upon the absolute proof that the spawned fish of 1883 die, and will not come back, in 1884 or 1885, increased from fifteen to fifty per cent. in size, if caught "fresh run," and in reproductive power if left to spawn.

The celebrated breeding ponds at Stormontfield, on the

Tay, and the still more extensive ponds belonging to Sir James Gibson Maitland, Bart., at Howietoun, near Stirling, have in our own country done what the "hatcheries" belonging to the United States and Canadian Fishery Commissioners have done on a larger scale on the other side of the Atlantic. By their assistance several disputed points in the history of *Salmonidæ* have been cleared up, notably the identification of the "parr" of different species. But many important problems have yet to be solved before we can claim to have an accurate knowledge of the habits of salmon.

How often, for instance, are we at a loss to account for the strange fluctuations in the harvest of our salmon fisheries. We have yet to ascertain the full effects of floods, of droughts, of severe winters, of hot summers, and of storms at sea, not only on the fish themselves, but on their enemies and on their food; how far their migrations are affected by changes of temperature, by rainfall, by electricity; what conditions favour an abundance of their natural food; what laws govern their periods of spawning; what is their average period of life—these are problems, hitherto unsolved, which artificial culture may help us to answer; and their solution is no less necessary in a practical sense than desirable from the point of view of abstract science. Legislation, to be effective, must be based upon accurate knowledge; to be beneficial it must be shown to be necessary. To blindly restrict fishing in order to check a diminished productiveness caused by natural causes is to misapply legislation. Fluctuations in the harvest of the water are as natural as fluctuations in the harvest of the land. When we have learned whether to attribute a falling-off in a particular fishery to natural or to artificial causes, we shall have got the essence of the question of the management of our salmon fisheries.

The very remarkable achievement of stocking the waters of Australia, Tasmania, and New Zealand with trout and salmon could never have been accomplished but for the discovery, first, that the eggs of fish could be taken and fertilised by artificial manipulation, and, second, that by the use of ice their development could be retarded sufficiently long to enable them to be carried in safety half round the world. It would be a striking, but by no means impossible, illustration of the destructive powers of man on the one hand, and the reproductive powers of Nature, aided by man's intelligence and constructive arts, on the other, if Great Britain, once the home of the finest salmon in the world, with her natural supplies poisoned and obstructed out of existence, were reduced to the necessity of receiving from the Antipodes, whose sparkling streams Nature forgot to include in the realm of the "king of fish," cargoes of salmon, caught weeks and months ago beneath the Southern Cross, but preserved fresh and bright by the aid of "refrigerating machinery" for consumption at the Englishman's dinner-table.

We have, on the other hand, within our reach the possibility of restoring the salmon fisheries of this country to such an extent that the very remarkable improvement in their productiveness which the last twenty years have witnessed shall be entirely eclipsed. But rivers now depopulated can only be restored by going to the root of the evil, and by remedying weirs and pollutions. If we are not careful, even streams now fairly productive may share the fate of the Thames and the Mersey; and, when Macaulay's New Zealander comes to perch on the broken arch of London Bridge, and finds no salmon leaping over the ruined piers, or lying in the eddies, he may possibly bethink him of the silver fish he has left behind in his native land: remembering, then, a legend to the effect that their presence there originated in the practical application of the system of "artificial propagation," he may possibly complete the circle by bringing back to the once more "silvery Thames" its long vanished stock of salmon. When historical research in the neighbourhood of South Kensington or Bloomsbury shall have revealed to him the fact that it was to weirs and pollutions that the former extermination of the fish in this country was principally due, he and his successors will no doubt be warned in time not to repeat the mistake which his predecessors made in abusing their rivers and neglecting the fish.

ANGLING

IN

GREAT BRITAIN

BY

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AUTHOR OF 'WATERSIDE SKETCHES;' 'BY STREAM AND SEA'
'TRAVEL AND TROUT IN THE ANTIPODES,' ETC.

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ANGLING IN GREAT BRITAIN.

CHAPTER I.

A GENERAL SURVEY.

THE opening sentence of this Handbook I should like to be the expression of a belief—to wit that, take it all in all, year in and year out, there is no better sport in the world for the angler than in Great Britain. The affected sighing after the good old times, and the gloomy apprehension that this highly favoured country is going to the dogs, with which we are all but too familiar, are shared in by him, of course, if he would live up to his privileges ; nevertheless, grumbling granted, and too much cause for grumbling granted in the same breath, he has not a great deal to complain of.

At a very interesting meeting last year at the Society of Arts, when a goodly congregation of anglers met to hear and discuss a paper by Mr. Marston on the propagation of coarse fish, we were all highly amused at a speech from an eminent American pisciculturist, who dilated upon the excellent qualities of the Black Bass, and suggested the propriety of introducing that sportive fish into certain British waters. He incidentally referred to some of the angling paragraphs which appear week after week in the English sporting papers, and raised an easy laugh by dwelling upon the fuss sometimes made over infinitesimal catches of fish. Doubtless, there is an element of absurdity in the published reports of an angling contest carried out upon solemnly promulgated rules, and with all the formality of supervision and directions from a responsible committee, yet which results in the gentleman who bears away the most valuable prize winning by an interesting roachlet seven inches long, and a small eel* to make the weight more imposing. Every week, as a matter of fact, if any one cared to search for them, a dozen reports of angling might be selected to support the one-sided view that in this ancient land we are, in the matter of sport, reduced to a very sorry plight.

Since that meeting was held, I have, however, employed myself in carefully noting the corresponding literature of the United States, and I find that the angling records there, where everything is so splendidly new and gloriously big, do not materially differ from our own. Time after time have American sportsmen assured me that the piteous cry, in lamentation for rivers overfished and sport destroyed, is familiar under the Stars and Stripes, and that the American angler has continually to push out to fresh fishing grounds. In New Zealand and Tasmania, where the best trout-fishing in the world will probably be found within a few years, that plaintive wail would also be echoed but for the obvious sparsity of population, and it will be heard when there are more fishermen to worry the fish.

In the angling waters of Great Britain we may at any rate fairly assume that we know the worst. With us, there is no pushing out west until we reach the Rocky Mountain trout. Our sport is confined within a comparatively tiny

* I believe in most angling clubs eels are not recognised as weighable game. But I saw a match won in the manner described.

ring fence of island surf. It is not possible for any angler to explore and discover a new river. But let us be thankful, if we know the worst we also know the best. We know that, by careful conservation, by spread of knowledge upon matters connected with fishes and their food, and by the possibilities of applying to their homes some of the sanitary principles which we are beginning to find out ought not to be neglected by human kind, angling in Great Britain has vastly improved, and may in the future be improved to an almost indefinite extent. There are, no doubt, streams once renowned for their sport, that have been as nearly overfished as any streams can be, and there would be room for despair but for the certainty that the evil can and will be remedied.

If a tenth portion, or a twentieth, of the sound advice given in the Papers and discussions of the International Fisheries Exhibition Conferences, and in the Handbooks published during the summer, were carried out with regard to our lakes and rivers, there would be no necessity to indulge in the unwholesome luxury of sighing after the sleepy old days of our grandmothers. And, in time, theory will have fruition in practice; rivers that are to-day polluted will sparkle clear; trout that are starved, ugly, and unhappy from causes well known *not* to be beyond control, will be as merry as the denizens of the Tennysonian brook; depleted streams will be once more dimpled with rises; and the 'prentice boys may again have the opportunity of protesting against too much salmon, and have that protective clause (purely imaginary, there is every reason to believe), of which so much has been written, inserted in their indentures.

In confirmation of the humble belief which is expressed at the beginning of this chapter, let me proceed to the recital of a few facts. A deceased statesman, who was himself extremely fond of felling his opponents with statistics, once, when such tough arguments went against him, contemptuously remarked that figures might be made to prove anything. My figures, I hope, will prove simply what they are intended to show, namely, that angling in Great Britain, up to the present moment, is anything but a played-out institution.

In the very last month of the present season some magnificent takes of salmon have been recorded from nearly all the Scotch rivers. The largest fish appears to have been taken on the Stobhall water, of the Tay, by Lord Ruthven. It weighed 54 lbs., and was of such fine proportions that it was reserved for preservation and setting up in the museum of the Perthshire Society of Natural Science. This, it is said, was not only the heaviest fish killed by the rod in the Tay during the season, but the heaviest since 1870, when a gentleman, on the Stanley Waters, killed a fish of 61 lbs. In one day upon the Stobhall water, thirty-four salmon were killed: and on the following day two rods landed two-and-twenty fish.

In the Tweed and Teviot the anglers also obtained sport, sometimes three, sometimes four, and in one instance Col. Vivian and Mr. Arkwright, on the Rutherford Water, killed nearly a dozen fish. On the Mertoun Water the Hon. H. Brougham had twelve fish, and on the Earl of Home's water (Bingham), a couple of gentlemen used their rods to some purpose, the result of a day's sport being fish of 24 lbs., 23 lbs., 23 lbs., 21 lbs., 16 lbs., 16 lbs., 11 lbs., 11 lbs., 8 lbs., and 6 lbs. In another part of the river, a day or two later, Mr. Brougham killed thirteen fish, and on the Floors' Water the Duke of Roxburghe, in one afternoon, had four—one of 22 lbs., another of 12 lbs., and two of 10 lbs. Up to the 11th November in the season of 1881 (the Tweed close time being from December 1st to January 31st), I read somewhere that one gentleman at one stand had killed 3,782 lbs. of salmon; while a few days after, 177½ lbs. fell to his rod in a single day, with nine fish. The same angler, in one day, in the next season, took nine fish weighing respectively 25 lbs., 25 lbs., 23 lbs., 19½ lbs., 16½ lbs., 16 lbs., 16 lbs., 14 lbs., 15 lbs.—total, 170 lbs.

The finest sport, probably, in this present season of 1883, was that on the Spey, which, after the removal of the nets, began to afford the rodsters a round of splendid sport. According to a report in the *Field*, from which paper I have also taken the figures of this year's Tweed fishing, General Gipps, on the 1st of October, landed seven; on the 2nd, five; on the 3rd, three; on the 4th, seven; on the 5th, five; and on the 6th three salmon. On another water, Mr. Todd killed seven fish; on the 2nd October, six; on the 3rd, six; and on the 4th, six. On the Gordon Castle Water the Duke of Richmond, the Earl of March, Lord Francis Gordon Lennox, Lady Florence Gordon Lennox, and several visitors every day made most enviable baskets. It is unnecessary to go through all the daily returns in the early part of October, but taking one day I find that the Duke of Richmond to his own rod had six salmon, weighing respectively 27 lbs., 24 lbs., 22½ lbs., 22 lbs., 20 lbs., and 19 lbs., besides a brace of grilse weighing 8 and 10 lbs. respectively. On another day His Grace got a 30 lbs. and a 20 lbs. salmon; and, on the same day, the Earl of March killed six fish—of 24 lbs., 19 lbs., 15 lbs., 21 lbs., 21 lbs., and 12½ lbs. On another day the noble earl must have been kept pretty well occupied with his seven salmon—of 15 lbs., 15 lbs., 17 lbs., 17 lbs., 16 lbs., 18 lbs., and 22 lbs., and four grilse, three of 10 lbs. and one of 9 lbs. Even a bishop who was fishing the Water (St. Alban's) got his three salmon and one grilse, while several ladies were quite as successful.

In another part of the country I read that on the Aboyne section of the Dee a gentleman, in one day, killed his eight salmon—from 8 lbs. to 37 lbs., and on the following day, with the natural minnow, he had four, the largest of which was 30 lbs. These returns are taken from one paper only, the *Field*, of October 13th, and they tell of sport that should surely satisfy the most rapacious sportsman. At the same time they convincingly indicate that while such fishing is to be had at home, there is no need to fly to foreign parts, even to try conclusions in the swarming rivers of Canada.

As to trout fishing, I do not happen to have on hand a suitable clipping from which to quote, but I can draw upon a recent experience of my own to supply all that is necessary for my argument. Within thirty miles of London, which I did not leave till eleven o'clock in the morning, I killed, mostly with a small alder fly, on one summer's day, ten brace of trout. The largest, it is true, was a very ugly fish of two pounds and a quarter, but the rest were beyond reproach, and ranged between a pound and a half and half a pound. This, I may be told by some friendly monitor, is nothing to boast about. Nor is it. But it is quite enough to satisfy my wants, and, indeed, the more modest basket of four brace and a half, which on my very last outing in August rewarded seven hours' hard whipping, made me as happy and contented as a man has a right to be in this vale of tears.

The business transacted with the Thames trout appeared in an authentic return prepared by Mr. W. H. Brougham, the Secretary of the Thames Angling Preservation Society in the summer. He gave the following captures as representing one week's Thames trouting between Chertsey Weir and Kingston only:—Chertsey Weir, four fish, weighing respectively $7\frac{3}{4}$ lbs., 4 lbs. 14 oz., 5 lbs., and $3\frac{1}{2}$ lbs.; Shepperton Weir, four fish, weighing respectively $5\frac{1}{4}$ lbs., $4\frac{1}{2}$ lbs., $3\frac{3}{4}$ lbs., and 2 lbs.; Sunbury Weir, two fish, weighing respectively 7 lbs., and $4\frac{1}{2}$ lbs.; opposite the Waterworks Sunbury, one fish weighing 10 lbs.; Hampton Court Weir four fish, weighing respectively 14 lbs. 10 oz., 7 lbs., 4 lbs., and 2 lbs.; Thames Ditton, one fish, weighing 7 lbs. 2 oz.; Kingston, one fish, weighing 7 lbs. Thus we have a total of seventeen fish, weighing together 99 lbs. 14 oz.

The coarse fish have also been kind enough to furnish me with ready examples of the quality of our English sport. Mr. Jardine, who is accepted as the most successful pike angler of the country, as the superb specimens shown by him in the western arcade at the Fisheries Exhibition will indicate, is thus spoken of in a newspaper paragraph:—"Messrs. A. Jardine and Knechtli had a magnificent catch of pike the other day, which were shown at the Gresham Angling Society. Ten fish weighed in the society's scales 135 lbs. This represented two days' fishing. This capture has no parallel in angling history, so far as London clubs are concerned, because the fish shown were only the largest, and they took thirty more, from 3 lbs. to 7 lbs."

In *Bell's Life* of January 7, 1883, I read—"We have seen or heard of some remarkable takes of pike and perch recently. One of the finest shows of pike to be seen this season was that of Mr. H. D. Hughes, jun., last Saturday. Fishing with his brother in a private lake, the united take was forty good fish. The largest, weighing 25 lbs., was caught on single gut, and was on view last Monday at Messrs. Alfred and Son's, Moorgate Street. Equally remarkable was another day's sport. Mr. Carter Milburn, fishing last week in private water (a lake), took, between eight and ten o'clock on the morning of Thursday, six pike weighing 20 lbs., 17 lbs., 15 lbs., 11 lbs., and 6 lbs. This achievement is all the more remarkable when we know that Mr. Milburn has been for years deprived of his left arm. The business was managed entirely with the snap-tackle."

Perch exist in such incredible quantities in many British waters, that we might almost pass them by, and take them, like official reports, as read. In the *Field* of August 25, however, an account appeared of the capture by two anglers, between eleven and five o'clock, in Slapton Ley, of more than 800 fish. This haul was made on a well-known piece of water which may be fished by all comers on payment of a small fee. The accuracy of the statement was questioned, but the evidence of subsequent correspondents confirmed it, one gentleman stating that he and a friend in five hours fishing took 476 perch.

What may be done amongst roach and barbel was duly set forth in the Paper on Freshwater Fishing read at one of the Exhibition conferences by Mr. Wheeldon. In the short space of five hours on a winter day, he killed, in the Hampshire Avon—a notable roach river from Ringwood upwards—75 lbs. of roach, numbers of which were considerably over a pound in weight. In another portion of his Paper he stated that he and Mr. Smurthwaite not long ago killed three hundredweight of barbel in one day, near Sonning Weir. In the tidal waters of the Thames during this present autumn, takes of dace of 35 lbs., 26 lbs., and 25 lbs. have been registered by the Richmond and Twickenham punts-men. During the month of July, according to the *Fishing Gazette*, in a lake near Swindon, open on payment to the public, Messrs. Wheatstone and Walker, of the Stanley Anglers' Club, caught 230 lbs. of tench in five days. One of these anglers, on July 9th, took with rod and line twenty-five fish, nine being over 4 lbs., nine over 3 lbs., and seven over 2 lbs.. The total weight of the days' angling was 89½ lbs.

These results, which speak for themselves, I give as they occur to me at the moment, and not by any effort at research. They fairly enough serve the purpose I have in view, and if I wished to extend the list of good baskets, the averages of the last five years, as they may be unearthed from the periodical literature devoted to the subject, would probably show as fine, and much finer sport in some of the branches of angling upon which I have casually touched.

But the rapidly increased and increasing number of anglers in Great Britain should be a continual stimulus to exertion in keeping up the stock of fresh-water fish. Such an impetus has been given to the culture of Salmonidæ of all descriptions (adding latterly to the fish indigenous to British waters, the brook trout of North America), that there is little fear that they will be neglected.

Private fish-hatching establishments have sprung up in England as well as in Scotland, from which our colonial rivers are being tenanted, and by which losses and deterioration at home may be made good at any time; and the interesting collection of fish cultural appliances at the Exhibition must have been, to hosts of observers during the summer, a serviceable object lesson that cannot fail to produce practical results in time to come.

The increase of anglers, however—and this is a point we are too apt to overlook in considering the general question

—has been chiefly amongst the classes of the population that cannot afford, either in time or money, to fish the best waters for the best fish. The anglers who devote themselves to salmon and trout can, in the main, look very well after themselves. Give them an adequate legislation that shall ensure fair play against the proprietors and occupiers to whom the netting of salmon is a business, and all other things will, without much trouble, be added unto them. They represent the higher branches of the sport of angling. They are the followers of Cotton rather than Father Izaak, the patron saint of what are termed general anglers ; and the time has gone by when the humble angler, who is content with a modest day's roach or perch-fishing, is regarded by them with contemptuous indifference. The angling-books of twenty years ago show that the fortunate individuals who could betake themselves to Norway, or across the St. George's Channel, or North of the Tweed, were given to looking down from a lofty pedestal upon their less fortunate brother sportsman, who was dubbed a Cockney, and held up, together with his floats, worms, maggots, and ground-bait, to derision. But that day is past.

If space permitted, it would be interesting to trace how the change has been brought about. Broadly speaking, it has been done by the printing-press, and during the last twenty years, not so much by angling-books, as by literature of a more unsubstantial character. The journalistic fathers in Israel are answerable primarily for the tens of thousands of members of angling clubs, who weekly obtain healthful recreation by the waterside. "Ephemera" aforetime of *Bell's Life*, Francis Francis, Greville, F., and Cholmondeley Pennell (too young to be a veteran yet, but still ancient enough as an angling writer to come within the category), by their contributions to journals and magazines awakened popular interest; and it happened that a revolution in the means of communication had come at an opportune time, to add to their teachings the necessary opportunities of putting them into practice. Anglers have now an organ of their own in the *Fishing Gazette;* Mundella's Act was passed for the especial behoof of bottom-fishers; railway companies are recognizing the brotherhood as of sufficient influence to be considered in the granting of special privileges; and the Fish Culture Association, of which the Marquis of Exeter is President, would never have been started, had not the necessity been felt of looking after the stock of coarse-fish in rivers frequented by the many. It must suffice, however, to take these things for granted, and so I pass on with the hearty wish that all societies, and all movements which aim at assisting and encouraging the fair general angler, may prosper abundantly. The man who is a fair fisherman, though his ambition soar no higher than a plate of gudgeon from the well-raked gravel, has his place in the common confraternity, and is deserving of consideration.

The general angler at the present time is not altogether without his apprehensions. Angling Associations have befriended him, but the awakened interest which he has himself helped to extend, threatens to curtail his privileges. Claims to the ownership of waters hitherto considered public are being advanced with the view of keeping him at a distance. As, however, the Defence Associations should be able to prevent wrong-handed or high-handed proceedings, this, though a vexatious sign of the times, is a difficulty that will be removed, one way or another, by appeal to the law. Still, it should be mentioned in a general survey of the English angler's present position. I confess I see most cause for alarm in the snapping-up of every available bit of water by societies of gentlemen who can afford to pay for it. For this there is no help. We live in a free country, and if the owner of a stream, which his forefathers permitted to be fished by his neighbours, chooses to let it at a rental, he has the right to do so. Equally have a dozen city gentlemen, who love the amusement of angling, and can, by their purses, command the means of indulging in it under agreeable conditions, the right, morally and legally, of securing it for a consideration, or without one if they have the chance. Nevertheless, the effect is to limit the waters available to the masses of anglers.

The larger rivers beloved of general anglers are open, under easy and equitable regulations. The Thames, Trent, Ouse, and others of that class, are not yet parcelled out into subscription waters, and of smaller streams, like the Lea, and portions of the Colne, it should not be forgotten that the small fee demanded for a day-ticket is more than counterbalanced by the advantages gained by watching and preservation. In the immediate vicinity of large towns, indeed, there is something to be said for the oft-heard complaint that open waters are scarcely worth fishing, unless they are under the charge of some such model guardians as the Thames Angling Preservation Society. The cutting down of ancient privileges is suffered mostly in rural or semi-rural districts, to which town anglers were wont to issue, attracted as much by the pleasures of the country surroundings, as the more direct operations of fish capture.

Of the joys of angling I have nothing at present to say, except to remark that it is a sport which, more than any other, owes much of its fascination to features that are only indirectly connected with it. Some years ago a masterly essay (by its editor) appeared in the *New Quarterly* upon trout fishing, and this sentence at once challenged my attention: "One apologist will talk of wandering amid pleasant scenery, rod in hand. The hypocrite! As if the scenery were the inducement, and not the rod, which he affects to speak of so lightly. The best of all apologies is Shakespeare's, and yet it is a poor one:—

> 'The pleasant'st angling is to see the fish
> Cut, with her golden oars, the silver stream,
> And greedily devour the treacherous bait.'"

In a couple of angling books which I had at that time cast upon the waters, I had endeavoured to remind the reader of the countless charms to be found in the lanes and hedgerows through which, on an angling excursion, we pass to the cornfield; and the objects of interest visible from the footpath amongst the waving grain; and the meadows "painted with delight" over which we brush through the grass to the river's brink; to say nothing of the harvest which the eye may gather in the intervals of fishing. Wherefore I began to hold court of justice upon myself, if haply it were true, after all, that we were indeed the hypocrites thus described. The verdict was one of "Not Guilty," and much was I comforted upon taking up the magazine, in fear and trembling as to what would follow, to find the accusing article itself flavoured with a very pretty sprinkling of poetry and sentiment. All in sweet form came the fine summer day, and the rill trickling down the remote hillside "among club rushes and the blue water-grasses, till it reaches the valley, finding its way along, a mere thread, half lost to sight at times beneath the herbage, then stagnating for a space into a little pool," &c. It was my turn now. "The hypocrite!"

mused I. "As if he climbed the hillside to catch trout in the thread-like trickle!"

The old names by which the pastime of angling is known are, it will be noticed, significant on this head. It is "The Gentle Craft," and "The Contemplative Man's Recreation." To be sure, there are plenty of anglers of all ranks who are pot-hunters pure and simple. They take their surly way to the water, doggedly settle down to slay, and are deaf and blind to the compensations which Nature, in her kindlier mood, offers against that too frequent ill-luck for which the angler in Great Britain, in Greater Britain, and all the world over, must be prepared. But the rule is otherwise; the majority of anglers in this country, at all events, *do* take appreciative note of the scenery; *do* keep a friendly eye upon bird, beast, and insect; *do* delight in the foliage of the coppice, the whispering of the sedges, and the long gay procession of flowers, even from the curious blossom of the coltsfoot, which is probably the first to greet him in the earliest spring days, to the yellow stars of the solitary ragwort, which shivers in the late October days.

It stands to reason that it should be so. Amongst out-of-door sportsmen the angler is peculiar. The deer-stalker has little to look at but barren hills misnamed a forest, or the broad sky above him; the fox-hunter has his horse and his own neck to study, and the briskness of impetuous advance to divert his thoughts; the fowler's eye has a definite duty to perform. The angler, if using a fly-rod, has frequently-recurring "waits," what time he moves from stream to stream; the bottom-fisher, too, has a superfluity of enforced leisure at his disposal. And over and above all the British angler lives in a country whose rural parts are unique in their winsomeness. Walton's famous old book savours of honeysuckles, hawthorn hedges, sycamore trees, and crystal streams. He was a typical angler, and the type remains.

We may now pass to a more practical branch of our general survey, and having glanced at some of the characteristics of the situation as concerning the angler, may take a birdseye view of the inland waters of Great Britain. I do not, however, pretend to attempt anything like a guide to the rivers, nor even to furnish a comprehensive list. *The Angler's Diary* deals in brief with all the fishing districts of the United Kingdom, and, indeed, of the world, so far as they are known, and to that useful little book shall the inquiring reader be referred. All that I am able to do is to hint at the main features of our chief angling resorts.

A bulky handbook might, for example, be written upon the one section comprising the lochs and rivers of the

> "Land of brown heath and shaggy wood,
> Land of the mountain and the flood."

Placing, as is but meet, the migratory Salmonidæ at the top of the list, Scotland naturally first claims our notice. To the ordinary angler, however, all but a few of the prime waters, which are a source of rich revenue to Scotland, are close boroughs. The fishings, like the shootings, are rented at enormous figures, although there are, here and there, given to the sojourner at particular hotels, the privilege of wetting his line in odd reaches of well-known salmon rivers. There is never so much difficulty in obtaining permission to fish for *Salmo fario*, or, as our Scotch friends call it, the yellow trout, and if some travellers complain of persistent refusals to applications for permission, I must personally say that I have always had reason to be grateful for ready kindness in various parts of the country.

On the whole, the angler visiting Scotland cannot do better than take his technical instructions about salmon fishing from Francis Francis's 'Book on Angling.' Perhaps no English angler has had more experience of the Scotch rivers, from the angler's point of view, than he. It is no secret to the initiated that the list of salmon and sea-trout flies, which he gives for the various rivers and lakes of Scotland, Ireland, and Wales, cost him years of labour, and that in compiling them he received the assistance of some of the most experienced of British anglers.

What the principal Scotch rivers produce I have already illustrated by figures. The Tweed is held in high esteem as an angling river, though it is not so long, and does not form so large a watershed as the Tay. The Kirkcudbrightshire Dee, the Cree, and the Luce, are small rivers in the south of Scotland, and the Annan and Nith, the former famous for its sea-trout and herling, also run into the Solway Firth. The Tay is a superb salmon river, and like the Tweed has, in its lower part, to be commanded from a boat. It yields, with its many tributaries, good spring fishing. Aberdeenshire is a famous county for the angler, for it can boast of its Dee and Don, and a number of smaller streams. Inverness, also, is a notable angling county, containing as it does the magnificent Spey. This river has peculiar characteristics for the angler, having high banks and much rough, rapid water, demanding the exercise of all his skill. In this county is also the Ness, where the public have access on given days to a portion of the water near the Highland capital. In the Beauly, some years ago, Lord Louth killed to his own rod 146 salmon in five days, and this beautiful river is still first-rate for fish.

Upon the Thurso, in the extreme north, the fishing opens earlier than in any other portion of the United Kingdom.

Argyllshire, the country of the Mac Callum More, has, in addition to its lochs, a number of small salmon rivers, such as the Awe, the Orchy, and the Leven. In Banffshire the best salmon rivers are the Deveron and Fiddich. In Berwickshire are the Blackadder and the Whitadder, two good trouting streams. The Findhorn, once a phenomenal salmon river, is in Elginshire, and it is on record that years ago 360 salmon were caught in the same pool in one day. This, however, was exceeded by another miraculous draught of fishes described by the Earl of Moray, who wrote to his countess that 1,300 salmon had been taken in a night. There is fair fishing occasionally even now in the Findhorn, but ruthless nettings below have considerably spoiled it. The Lossie, in the same county, is good for sea-trout and yellow trout. Forfarshire has the North and South Esk. The Clyde, whose falls are fatal to the ascent of salmon, is in its upper waters excellent for trout, and it is of additional interest to anglers since the experiment of introducing grayling into Scotland has there been successfully carried out. The best rivers of Perthshire are the Garry, the Tummel, the Lyon, the peerless Tay already referred to, and the Teith. Roxburghshire, besides the Tweed, which is famous for both trout and salmon, many of its casts being historical, and which has romantic historical associations with Melrose, Dryburgh, Norham, and Kelso, has also the Teviot, which, like the Ale, the Bowmont, the Jed, the Kale, the Rule, and other such minor streams, are of excellent repute for trout. Sutherlandshire, the paradise of loch fishers and the stronghold of the *Salmo ferox*, has the Brora, an early salmon river, where the fish run large; the Borgie, excellent for grilse and sea-trout; the Inver, where the wandering angler staying at Loch Inver can fish, for a daily payment; the Lexford, a short river, but that still is the second best salmon river in the county, and the Shin one of the best rivers in the Highlands.

As for the lochs, one might almost be pardoned for using the familiar expression that their name is legion. Loch Lomond, between Dumbarton and Stirlingshire; Loch Awe, in Argyllshire; Lochs Tay, Rannoch, Earn, and Katrine, in Perthshire; Lochs Ness, Lochie, and Lagan, Inverness-shire; Lochs Maree, Luichart, and Fannich, in Ross-shire, at once occur to us; while below the Grampians there are Loch Leven, with its wonderful fishing, and St. Mary's Loch in the Yarrow country. Some of these grand sheets of water contain the destructive pike, and perch, which are only less fatal to trout by reason of their smaller size. But in the hundreds of lochs which lie twinkling within the hollows of the bonny Scotch mountains there is an abundance of small trout, and heavy specimens of the *Salmo fario*, while many are inhabited by the great lake trout, the night prowler that so seldom takes a fly, and to which the name of *ferox* has been aptly given.

Ireland is not so much patronised by English anglers as Scotland, though there is more and cheaper general sport at his command. The Green Island, manifold as are its physical beauties and angling capabilities, has been not a little neglected. Of late years there has been some excuse, perhaps, for timorous tourists, though surely never was fear more ungrounded; but to the angler, for some incomprehensible reason, Ireland has never been such an attraction as Scotland, though, as I have hinted, a stranger who can only afford to expend a moderate amount of money in his amusements, and desires a variety of fishing, would do much better in Ireland than in Scotland. The largest pike in Europe, I believe, are roaming in the depths of the big lakes; it is the land *par excellence* of the white trout;

and all round the coast, from the merry but much preserved Bush, within easy hail of Giant's Causeway, to the early Lee, in county Cork, the salmon come and go with beautiful regularity. One of the most delightful angling tours I ever had was in Ireland, fishing my journey from Sligo through Connemara to Galway by easy stages, and taking whatever came in my way—perch, pike, brown trout, white trout, and salmon—with praiseworthy impartiality. Rivers, mountains, land and sea, the courteous people, even the pigs and wretched hovels—everything, in short, but the too freely weeping skies, contributed to the sum total of a pleasant holiday.

The angling in Ireland, though very good, is not what it was when the chapters of 'Wild Sports of the West' were written. The fish are, generally speaking, of the same class as those to be found in the Scotch rivers—salmon and trout everywhere, and in the larger lakes leviathan pike, and here and there bream. There are gillaroo in Lough Erne, and pollan in Lough Neagh. It goes without saying in these days, when the taste for angling has extended so much, that the free fishings are not numerous.

Still there are many bits of open salmon fishing, and lakes that are to all intents and purposes free; and the sea and brown trout fishing is plentiful enough to satisfy the most rapacious appetite. Boats are cheap and the boatmen very modest in their demands, and what is more, the latter are always satisfied with the treatment they receive, while their humorous sayings and doings are a source of continual amusement. One salmon fishing licence will do for the whole of Ireland, which is a great advantage. The open season, as elsewhere, is from February 2nd to October 31st, with the usual exceptions of special districts. The principal rivers in the south are the Blackwater, the Lee, and the Bandon, while upon the wild shores of Bantry Bay and by Glengariff there are plenty of trout streams. Close by, in county Kerry, there are the Killarney lakes, overrun during periods of the year by tourists, spoiled by the use of cross lines, but still, in early months, not hopeless for the rodster.

Continuing our way up the western coast, we come to the estuary of the magnificent river Shannon, which contains samples of most of the fish to be found in Ireland. Songs have been sung in praise of the salmon of this river, and it has obtained more prominence in the literature of sport than any other Irish river, which is but natural, seeing that it runs from Leitrim in the north, passing through a number of lakes, the last of which is the prolific fishing ground of Lough Derg. County Clare, being somewhat out of the way, and not much written or talked about, is but little frequented by anglers, but the best pike fishing in Ireland is probably to be obtained in some of its lakes.

Galway, according to its angling value, should have been mentioned first. In this county is the famous fishery of Ballynahinch, the white trout station of Glendalough, and the Galway river, in which the salmon fishery has been brought to a high pitch of perfection ; it drains Corrib and Mask, in the latter of which trout of the phenomenal proportions of twenty pounds are very occasionally taken.

From Galway the angling tourist makes his way through Connemara by Westport to Ballina, a famous centre on the Moy, with Lough Conn not far distant. Mayo is the country of which Maxwell wrote, and there are privileges in connection with its fisheries that make this station the most attractive of all for the man of moderate means, though the upper portions of the Moy are strictly preserved. Lough Arrow is in the next county, Sligo, but the best fishing is in the river which runs from Lough Gill through the county town.

Still further north, in wild and beautiful Donegal, we have on the southern boundary of the county the river Erne, with the grand lough of that name stretching down by Enniskillen into Fermanagh. The short length of water between Lough Erne and Ballyshannon used to be, and, for aught I know to the contrary, now is, one of the favourite salmon reaches in the country; and hard by, in Leitrim, we have the Bundrowes river and Lough Melvin, in which some good fish, at reasonable charges, may be obtained, especially during April and May. Across, in the other corner of Ulster, there is the Bann, with Lough Neagh. These are the principal angling resorts in the sister island; but we should not forget the Blackwater, the Suir, the Slaney, and the pretty trout streams within convenient distance of Dublin. As a rule, it may be taken that the angler, more particularly the angler who will be satisfied with sea-trout, brown trout, occasionally gillaroo, and lively pike fishing, can never very well do wrong in going to Ireland.

The principality of Wales is a delightful country for the trout angler who will be as a rule content with small fish, and who can make up for the rest with the most picturesque and beautiful scenery. In North Wales the principal rivers are the Conway (good occasionally for salmon), the Dee, the Dovey, the higher waters of the Severn, the Clwyd, and the Verniew; while in South Wales, where the sewin gives spirited sport in the autumn, and the brown trout run to a larger size than in the small lakes and mountain streams of the north country, we have the Ogmore, Taff, Taw, Teme, Towy, Usk, Monnow, and Wye. The salmon fishing of the Usk is proverbial, and I have in my possession a photograph given to me by the late Mr. Crawshay, of Cyfarthfa Castle, at the close of a day's successful trout fishing, during a frosty day in the month of February a few years ago, representing nine salmon killed by him on October 22nd, 1874, with the fly; and a singular thing in connection with this day's sport was that the three largest fish, one of 22 lbs., one of 19 lbs., and one of 16 lbs., were hooked foul, the salmon being, as they too often are, in a more playful than feeding humour; yet carried their gambols too far, and were nicked accordingly—two in the pectoral fin, and a third in the side. These fish were placed upon an unhinged door, which was tilted up by a couple of men to allow Mr. Crawshay, who was a very skilful amateur photographer, to take their likenesses.

Considering the amount of poaching to which the English rivers, up to within ten or fifteen years, were subjected, and the gross neglect from which they long suffered, it is marvellous that in all parts of the country the commoner kinds of fishing should be so good as they are at the present time; and considering the number of anglers who test their value upon every available day of the year, it would not be surprising if the rule was to toil all day and catch nothing, and if the language of every English angler was that of the prophet of old, "The fishers also shall mourn, and all they that cast angle into the brooks." But, as I have remarked on a previous page, we have more to be thankful for than to complain of.

It would be invidious to single out one county as better than another, were it not that our best trouting districts are limited. There is probably no county in England that has not a trout stream of some kind; and tributary streams and brooklets known only to a few, and very naturally kept secret by them, sometimes keep up very ample stores of surreptitious trout. But the true trouting counties are comparatively few. Beginning with the south, Cornwall may be passed by with a brief reference, although all the streams trickling down from the backbone of the hills which constitute the Cornish highlands, contain more or less of trout. Devonshire is quite another matter. Its larger trout rivers are numerous, and salmon are taken in Taw and Torridge, in Exe and Tavy, while the interior is intersected in all directions with lively little streams. There are a few strictly preserved trout streams in Dorsetshire, and a good salmon river in the Stour, which joins itself with the Avon at Christchurch, the Avon itself being swelled by a famous grayling river, the Wiley, from the Salisbury Plain region.

The largest river in Great Britain, and the one to which most importance is attached by the main body of general anglers, is, of course, the Thames, with its magnificent watershed representing a basin of over six thousand miles. It is not so long as the Severn by some twenty odd miles, but it is fed by a rich array of tributaries right and left. In its higher portions, under the influence of the Cotswold hills, there are the Windrush and Coln, both capital trout streams. In the Kennet, the most important of its southern tributaries, the richest specimens to be found in England of the *Salmo fario* are taken. To all London anglers the Roden, the Lea, the Colne, Wick, and Thame are familiar, while the trout and trout fishing of the Wandle and Darenth, the one on the west and the other on the east side of southern London, but both almost within hearing of the roar of its traffic, are traditional. In the midlands there are the brilliant Derbyshire streams, which may be considered midway, in physical characteristics, between the pastoral rivers of the Hampshire lowlands (the Itchen and the Test) and the mountain burns of Wales and Scotland.

The Derbyshire streams, being for the most part open to the purchasers of day tickets, are a good deal fished, but there are plenty of respectable trout and grayling yet to be taken, and the anglers of the big cities—London in the south, and Manchester and Liverpool in the north—have in them splendid opportunities of exercising the art of fly-fishing from spring, to the close of the grayling season, when spring comes again. The Derwent, Wye, and the Dove rising in the mountains that characterise the peak country, are tributaries of the Trent, from which a few salmon are taken, and which affords everlasting sport to the Nottingham anglers, who have founded a school of their own, and whose reserves of coarse fish seem to be little affected by the contributions levied upon them. A kindred river to the Trent, though running in a southerly instead of a northerly direction, and delivering its tribute, like the Trent, into the Humber, is the Yorkshire Ouse, into which, galloping down from the Pennine chain, are delivered a succession of first-rate trout and grayling streams, the Swale, the Yore, the Nid, and the Wharfe; and on the other side, easily commanded from Scarborough, and in its earlier waters running under the north wolds, is the Yorkshire Derwent, the grayling fishing of which is not inferior to that of the Wharfe.

Lancashire, in days long since passed, was probably an excellent angling county throughout, but the Mersey and the Irwell have been years ago pressed into the service of manufacture and commerce, and we have to go into north Lancashire to the Ribble, Lune, Hodder, and the waters of Ribblesdale, before anything like adequate sport can be obtained. The lakes of Cumberland, and its fine river the

Eden, still maintain their long-established character; and on the other side of the country, the north and south Tyne have not entirely lost their salmon, and certainly not their trout. Above Newcastle, the Wansbeck, the Coquet, Breamish and Till, keep up the reputation of the border streams for trout angling. The Severn I have not passed by intentionally. But it is as much a Welsh as an English stream, having a decidedly Welsh origin, and by its tributaries watering a good deal of Welsh country. At any rate, I do not mention it last because it is least, for we have to thank the Severn for some of the unsurpassed grayling rivers of Worcestershire and Herefordshire. The Teme and the Arrow, with the Lugg, a tributary of the Wye, are not second to those of any part of England for the quality and quantity of their grayling. On the eastern coast of England, other than the trout streams of the border, there are some coarse fish rivers in Essex and Suffolk, and three particularly good general angling streams, namely, the Ouse (Bedfordshire and Huntingdonshire), which is famous for its bream and pike, the Nen, and Welland. In east Anglia there is a special description of angling, to which reference will be made in another portion of this pamphlet, while beyond the Wash there is the fen country, with the Ancholme and Witham; upon these the Sheffield anglers swoop in their hundreds, and, when fishing matches are arranged, by their thousands, during the summer season, and, spite of the rows of rods, uncommonly good baskets are occasionally taken away.

The angling of England is more prosaic, taking it as a whole, than in either of the other countries that compose the national union. Until we get considerably north of the Trent, and within measurable distance of the lakes and mountains of Cumberland, our landscape scenery is softly pleasing rather than imposingly wild and romantic. Our rivers for the most part flow tranquilly through fat meadows, upon which the mildest mannered kine graze their fill. They are at every turn brought under tribute by the millowner, sometimes becoming hopelessly demoralised as a reward for the service they render. They do not thunder through gloomy granite gorge as, in some portion of their career, do the rivers of Scotland. With impetuous torrent they do not dash around massive boulders, as do well-remembered Irish salmon streams. They *flow* to the sea, seldom leaping, or boiling, or swirling, after the manner of rivers cradled in mountain heights.

Thanks, however, to the liberally distributed tributaries, and the drainage of the hill countries, the English angler has, in the wide variety of waters from which he may take his choice when meditating a piscatorial excursion, the opportunity of forming acquaintance with many a bright, swift-running river, making music in such solitary dales as those of Derbyshire, or amongst the rocky walls and overhanging foliage characterising many of the Devonshire streams. There is, in short, some sort of angling in every part of the country. Even the Isle of Wight has a trout stream if the tourist only knew it, and the trout of the Isle of Man have certainly outlived the animal which is the sign manual of the Manxman.

In an essay of this description the writer is confronted with the difficulty of deciding how to act, without dwelling too much or too little upon any one subject. Clearly the orthodox method of dealing with the many-sided topic of angling will not answer. Space would altogether fail me to deal in detail with the various methods of angling, or with the thousand-and-one appliances which are recommended for the successful prosecution of the art, and which have of late multiplied to a bewildering extent. I have already declined the duties of guide to localities, and in the same spirit I must put aside the pleasant functions of tutor in the rudiments. Nor would such a *rôle* be necessary even if it were expedient. There is nothing new to be said about practical angling, after such past masters as Francis Francis, Stewart, Stoddart, Cholmondeley Pennell, Manley, Greville F., Keene, Foster, Alfred, Martin, and others too numerous to mention have had their say.

Easy, therefore, is my conscience in shaking off the temptations which have beset me to attempt a technical disquisition upon the best method of tying a fly, making and fitting up rod and line, handling it from bank or boat, impaling a worm, or compounding ground bait, except so far as may point a moral or adorn a tale. These are most essential subjects to study and master let no man gainsay, but I will courteously ask the reader to permit me to deal with the subject, in what space remains, in the spirit—if I may employ the expression—rather than in the letter. This, after not a little cogitation, I have resolved to do by endeavouring, so far as in me lies, to conduct the reader through the Angler's Year, making spring, summer, autumn and winter develop the essential types of angling in Great Britain.

CHAPTER II.

SPRING.

THE boundary lines between the seasons, into which we will take the liberty of separating the angler's year, must for our present purposes be somewhat more elastic than those of the calendar. At the very beginning, for example, we shall find it convenient to assume that spring begins in February, for in that month both salmon and trout anglers have a legal right to commence operations; and we are bound by all considerations of honour and tradition to deal with them in the forefront. There is no British freshwater fish absolutely out of season in February. On the contrary, some of the coarse fish—a designation which, spite of its unsatisfactory character, we may continue to use for want of a better—are at this period in good condition, more particularly if winter continues to have a firm grip upon the infant year. It sometimes, but of late rarely, happens that February is a tolerably pleasant month, and in that case general angling is prosecuted with the ardour which comes of knowing that the fence months are hurrying on apace. The coarse fish just now, however, must bide their time, and be content with swimming about in other chapters.

Besides, who would forgive the heretic who suggested a thought of the common herd, while the kings and princes of our watery realm were at hand? It is a moot point with many anglers whether salmon or trout fishing be the highest order of sport. For myself, I hold the salmon to be the king of fish, but trouting to be the choicest form of angling; in the word salmon, including all the migratory species, and by trouting meaning also fly-fishing for grayling. This predilection for the trout rod is a whim of my own, I am aware, in which few will probably give me countenance. At the same time, there are foolish folks of some experience on lake and river who take a like view, and I mention the matter here to justify the statement that the point with some is an open one. But there can be no question that salmon and trout between them represent the science, ethics, poetry, rhetoric (and all the rest) of the delicious sport of angling.

Had every salmon-fisher a record to show like some of those transcribed in the preceding chapter, he might sing everlasting anthems in praise of that phase of angling. We should then all be salmon fishers according to our opportunities. But it is weary work toiling through the day with one "fish" as a result, and as often as not with nothing to show for the pains. That day, in the first weeks of the season, will probably be cold and wet and blustering, and the play uncommonly like downright hard work. Still the big rod is plied, the long cast essayed upon every likely pool, the fly changed (changed too often by some men), and every tactic observed. The angler loves his work, and when it runs in the direction of salmon there are many special breezes that keep his zeal alive. A coterie of anglers lounging round the smoking-room fire after a day's fishing, betray in a very brief conversation why they will not stoop to any but salmon angling.

The things we do *not* know about a salmon, for instance, would make, if not a book, a pamphlet of decent dimensions. How the noble *salar* spends his time at sea, and his tastes in the item of food, if any, are discussed. Fishing men are never tired of propounding, as a sort of conundrum, the question, "Why do salmon take a fly?" And after long years echo answers, "Why?" Next comes the unpleasant subject of *Saprolegnia ferax*, and then the conversation surely drifts down to those lower proprietors who are, in their greed, ruining all the honest sport. But the talk is most animated when out-of-the-way theories are advanced about flies. All anglers who are worthy of the name have some fancy or other about tackle. Frequently it is a "fad" rather than a well-grounded fancy, and to this all fly-fishers are very prone. The salmon-fly, being not a fly, in the sense that a March brown or Alder is an imitation of a natural insect, admits only of limited debate. There remains still, however, for settlement, the matter of gaff *versus* net, and when all else fails, old battles have to be fought over again with mighty fish, and new laments uttered over that phenomenal salmon that sulked at the bottom of the pool, and sawed away against the ledge of rock until the gut parted.

The salmon angler in action should be a strong, patient man, knowing the water he works, and the tricks and natural propensities of the game he attacks. But the process does not, in any of its stages, require such delicate manipulation as the trout angler must exercise. When you begin to handle the 18-foot rod, and run the heavy eight-plaited line through the rings, and affix the strong gut cast, with its gaudy Parson or Jock Scott, it may dawn upon the beginner, who has been accustomed to brown trout angling only, that salmon fishing, though an art, is scarcely a fine art. The downward casts, and the rough jerking movement of the fly worked through the water, do not tend to remove this impression from the mind of the angler who has been used to difficult trout fishing. The impression, in many such instances, is never wholly removed, though the capture of a few heavy fish has a wonderful effect towards creating an enthusiasm that shall abide.

But there is a majesty in a salmon river that helps to put the sportsman on terms with himself. All is movement. Born in the snow-covered mountains, the streamlet has bounded from rock to rock, whitening into cascades, broadening out into foam-flecked pools, streaming abroad over shallows and scours, gathering force down the headlong rapids, sweeping, in mature river-like dimensions, under lofty crags, eddying past dark masses of wood, and anon gently lapping yellow strands, in whose tiny wavelets children may play. Some day will come the roar of the spate, and the dark-tinted waters which call the angler to be doubly on the alert, with by-and-bye, in the dog-days, low bright streams, when his highest skill is requisite for even a small modicum of success.

February brings the opening day upon rivers such as these, with varying chances in this capricious climate—tempest to-day, north-easters, with driving sleet, and snow, and dirty water, to-morrow; but who cares if, with the fight with the elements there come at last mortal tussles with clean-run fish, though, intermingled, be the profitless hooking of foul, hungry kelts, which, be they never so well mended, must be returned to gain convalescence in the sea? Upon the banks of the Thurso, Tweed and Teviot, Tay, Lyon and Tummel; by Spey, Dee, and Don; on the turbulent surface of Loch Tay, with the shoulders of the surrounding mountains kept warm by their white mantles, the Scotch anglers ply their rods in the second month of the year, while in Ireland the lure is simultaneously cast upon the Lee and Blackwater in County Cork, the Suir above Clonmel, the Moy and lakes at Ballina, the Ballynahinch pools, the streams and lakes of County Donegal, and all kindred salmon haunts.

The trout angler who stands up for the superiority of his favourite amusement must, spite of his prejudices, admit that the capture of a salmon, upon legitimate terms, is the most exciting of all feats of piscatorial prowess. Afar off, as he fishes fruitlessly down the river bank, strewed with smooth-washed boulders, he espies the movement of a fish; not the dainty rise that scarcely attracts observation, but a heavy roll over. He has been long looking for some such token; has honestly worked every inch of the water, from the falls to the rapids, and from the rapids to this darksome pool. He has tried short casts and long casts; has humoured the fly slowly, now on the top, now sunken, and has jerked it with energy; has tried all the flies approved and recommended, small and large, and to no avail. Here at last is his chance. But nothing less than 20 yards will bring him to that unmistakable fish.

Now let him pause awhile, and run his fingers down the cast to the fly, making sure that unawares to him the tackle has not been frayed by the trial it has already undergone. Let everything be done leisurely and in order. The salmon will not move far from where the angler saw him gambolling. What he has chiefly to do is to take things quietly. He must not bother himself—I am assuming that he is not an old hand at the salmon business—by recalling all the advice he has heard and read as to the regulation conduct at this supreme moment, nor allow his attendant to disturb him with *his* advice. Let him take his own course. He has to dispatch his fly so that it shall introduce itself to salmo's notice in a genteel and natural manner. That is best accomplished by coolness; and if, coolness or not, his faculties are not at this moment all alive, and his pulses on the spring, true angler he is not.

So! The fly sped its distance, and alighted fairly well across and below, and if the angler allows the eddy from the jutting granite to take it in charge, it will be brought into position without any manœuvring on his part. Swish! It was a goodly rise, but the eager fisherman was too quick for the fish. To my thinking, that quiet intense boil in the dark current is *the* moment in salmon angling. There is a fervour in the mingling of hope, fear, and resolve that may be felt but not described, and that is not likely to recur during any of the subsequent stages of the contest. In this instance the moment of fervour would be followed by a temporary paroxysm of despair, to which the angler should not give way. He should put down his rod, seat himself on the rock, and smoke a cigarette. After all, it may have been that the salmon was too quick, and not the angler; and the fish may rise again.

The next attempt is successful, after two or three unheeded casts, but the fish rose more quietly, the fly not being so much under water, and though the rise was visible, the salmon sucked in rather than snapped at the Blue Doctor. Instead, therefore, of a boil, the fish went down with a swirling splash, and relieved the angler of half the duty of striking. Now for a brief space, to a great extent, leave the salmon to his own devices, the line never slack, the rod top well up and well curved, the winch free to respond to any demand. Nothing better could have happened than this. The fish has run at steady pace down stream. Next it may sulk or leap, requiring the angler, in the latter event, to lower his rod-point, and in the former to attach to the line the little ring which opens for the purpose, and which will run down and smite the salmon on the snout. It will be astonished and angry, but will make tracks, and so the great end is gained. Dangerous as the movement is, I rather prefer the pleasure of seeing a good fish break water, and flash his silver sides in the air, though the risk be a broken line. I would rather have a dozen somersaults than a prolonged sulk below, with that ominous trembling which so often ends in the gut being sawn off against a sharp stone. But our fish now hooked does neither. It runs up and down the pool, and continually returns to the spot where it met disaster. Finally it goes swiftly down stream, whither the angler has the opportunity of following it, and in twenty minutes the young man in attendance goes in knee deep and nets it, as it is on the point of steering once more into the stream—a fifteen-pounder, in immaculate condition.

Lucky for the angler that the finish was on that wise. Fifty yards down, the water was broken and rock-studded, and the nature of the bank fatal to any further pursuit on land. Salmon-fishing is full of such narrow escapes, and fish are not always taken with such ease. The exertion and tension of nerve undergone by the angler will nevertheless explain the possibility of a gentleman meaning what he says when he declares that, after the strike, and the first run or two, he has lost interest in the business. We have all heard of the angler who invariably hands his rod to the gillie, should the salmon play longer than ten minutes ; and of the worthy who, the fish escaping after a vigorous play of forty minutes, exclaimed, "Thank God, that's over."

Salmon, however, are taken by other means than the artificial fly. Quite legitimately in Tay and other Scotch lochs, and in the Irish lakes, the fish in the spring, beginning with February, are taken with the phantom, spoon, and other artificial baits, and by spinning with the natural bait from the boat. This is, in truth, the only remunerative fashion of fishing at this period in these waters, and there is not a whisper to be breathed against the custom. But there is something unpleasant in the notion of the King of Game-fishes being done to death by a nasty blackheaded worm. Sinking and drawing with shrimp, perhaps, seems less objectionable, and when the fly is useless, as it often is in the hands of the best of anglers, conscience will tolerate minnow and par-tail rather than an empty creel. I should not like to go so far as to affirm that worm fishers for salmon and trout were poachers, but if I ever brought myself to such a pass, I would not talk about it, and should consider myself entitled to rank with the person who shoots a pheasant sitting. The end may justify the means, but it is not to be gloried in.

In February the trout angler, also welcomes his opening day. In numbers he is in the proportion of a hundred to one as compared with him of whom we have been speaking. As yet it is not the custom to impose a licence upon trout fishing, and the tickets issued by the local associations are a wholesome check upon malpractices, and no hard tax upon the fisherman. He is probably not a gentleman of leisure, or independent means, and must snatch his sport between turns at the mill-wheel of daily occupation. Very keenly, therefore, he looks forward to the opening of the rivers, and has furbished up his casts, and overhauled his rod, taken apart and oiled his winch, and arranged his flies long before the joyous day. He may have taken a preliminary Sunday ramble up the stream of his affections to make a mental map of the campaign, and be assured that the familiar scours and stickles have not been altered by the winter floods. For it will only be a dweller in the vicinity who takes earliest advantage of the February fishing—the local enthusiast who is aware that the first comer will find the trout ramping hungry in the strong currents, and so stand a good chance of sport however adverse the weather may be.

In such a climate as ours it is of course altogether too soon to talk about spring in the short, bleak, wintry February days, but for the purposes of this book we must assume that the spring begins with the 1st of February, because on many streams the close season for trout finishes on that date. At that time there are no visible signs that the winter is past, and the angler who makes up his mind to go forth must be quite independent of those sentimental thoughts which are supposed to have so large a share in the fascinations of angling. The chances are very much, however, that at the beginning of February the rivers will be unfishable. Even if frost and snow are not abroad, the streams are likely at this time of the year to be charged with flood-water, and therefore out of the question for angling.

But it is a long-established custom in Devonshire, where Nature begins to throb and move earlier than in most other parts of the country, to take advantage of the earliest fishable day after the termination of the fence months. True, the trout are seldom in condition, and ought not to be taken until March, but this is not always the case, for I myself on a frosty day on the Ottery, during a little midday sunshine, have taken at Shrovetide, which then fell in the middle of February, a brace of half-pound trout which were in as good order as any fish I have ever seen. Of course I need not remind the reader that there is no rule without an exception, and this perhaps might have been the exception. At least I made it the ground of a practical decision, acted upon in response to a dubious expression on the face of the keeper, who evidently viewed my capture of two trout from the same milky-coloured stickle with displeasure. He spoke not, but his eye most assuredly was fastened upon the second fish as he took it out of the landing-net in the hope of finding signs and tokens whereby he might invite me to return it to the water. I saw his desire, and at once pronounced the fish to be in splendid condition, a verdict with which he was bound to coincide, though he did so not very graciously, as he slipped the fish through the hole in the cover of the creel.

On the whole, therefore, though it would be impossible to pass by the month of February, we may fairly assume that it is not a valuable month for the angler, except in so far that it gives him the opportunity of getting together his tackle, and wandering out by the river side to try a few preliminary casts; and I have often been surprised to find how many anglers on the opening day of the season, let the weather be what it may, have equipped themselves, and hied them to the river, although there was not the slightest chance of getting a fish. All this, if amusing, is typical of the enthusiasm of the angler in Great Britain, and probably everywhere else. He has been waiting for this day; he has been preparing his apparatus; he has been making up his mind that now he shall have amends for the inaction of the dreary winter days. His waterproof boots are in prime order; his creel is sweet and natty; his rod has an extra polish; there is no flaw in landing-net or handle; and altogether our early angler has a very spruce appearance, when, with his heart full of hope, he goes out for the first time in the year to look for a trout. His real season, nevertheless, is more likely to begin with March.

Of Devonshire I have previously said that it still holds a first place amongst the trout-fishing counties to which the ordinary angler has access. The trout, if small, are plentiful, and there is a beauty in the county itself, and a charm in the forwardness of vegetation that make Devon very popular among anglers. The streams of Dartmoor may be taken as typical of the kind of trout stream which may be more properly termed a brook. Dartmoor, in fact, like its fishing, is a thing of itself; a wonderfully interesting solitude both for the rambler and angler. When the March brown is in its prime—although that fly may not be the best for Devonshire, where the anglers pin their faith to Meavy red, and blue upright, and hackles of various kinds—is the time to make for Dartmoor. Starting from the quiet town of Tavistock, which lies in a hollow, with the bare Cornish hills on one side and the billowy moorland on the other, you travel up-hill to Princetown, passing on the way little streams across which a strong man might easily leap, and out of which many a dish of small trout will be taken. These silvery streamlets tumble down from ledge to ledge, coming from various directions, purling through rocky little glens crowned with mystic tors, and all bound eventually to the Channel. The trout on the heights of Dartmoor are so small that the angler for awhile is ashamed to take them—ashamed until he learns how delicious the fingerlings are as served up by the Devonshire cooks, more after the fashion of whitebait, than any member of the *Salmo* family. For a man sound of wind and limb, well shod, with a small basket at his back and a light fly rod in his hand, with no necessity for carrying a landing-net, or being burdened with wading stockings or boots, a day on Dartmoor, when the wind blows well from the west on a March or April day, is a real treat, provided he be content to make it, so far as the trout are concerned, a day of small things.

March is, upon general trout streams, the first month in which fly-fishing may be hankered after in real earnest. A tempestuous, rude month it may be, but the weather is generally for the greater portion hopeful; for though the cold strengthens with the lengthening of the days, and gales prevail, there are glimpses of sunshine, and intervals of warmth which betoken the reviving year. The flies dance into life under the grateful influence, and the trout are on the look out. Later in the year you will have to ring the changes upon your stock of flies, which is generally three times as large as it need be. In March you may ordinarily rely upon the ever useful March-brown, the Blue-dun, the Olive-dun, Red Spinner, and the Marlow buzz *alias* Coch-y-bondu. Even at Lady-day the aspect of the river-side and its surroundings is bare and wintry; but when you take a short cut through the plantation to avoid the dead water, and reach the long rippling piece that murmurs down from the bridge, you will trample upon primroses and violets, and the little celandine. And the birds seem to join in a special carol of welcome to the March angler, and wish him the good fortune which often falls to his lot.

In April do not discard the above-named flies, but add to them the Grannom, Yellow-dun, Hawthorn, and Sedge, and cleave to them so long as trout-fishing lasts. April has proved to me invariably the month of months for trout in England and Wales, and would, I can fain believe, have proved so in Scotland and Ireland had I been able to subject them to the same test. If trout have feelings, they must, like the observer of nature abroad in the fields at this season, feel that it is good to be alive. They come with such a will at your flies, fight so gamely to the very end, and look so handsome in their brilliant vesture, that you linger in admiration over them in the landing-net. One or two streams in private hands are reserved for May-day, but as a rule the British trout streams from John o' Groat's to Land's End, and from Lough Foyle to Bantry Bay, are in the prime of trout fishing in April.

Whether up-stream or down-stream fishing be the correct thing; whether gossamer casts are profitable in the long run; whether one, two or three flies should be used; whether the Alexandra fly is orthodox—these are amongst the topics the assembled fishermen discuss as they sit around on the spot to which the frugal luncheon has been brought, under shelter of the golden-blossomed gorse, their rods spiked hard by, and the flies streaming out before the breeze. If there are more than two present there is not likely to be unanimity upon any of these points.

It is well for the tackle makers that new notions—heresies in the eyes of anglers of the last generation—are so freely promulgated. I know some successful fishermen who habitually fish down-stream, and who use medium gut for their casts. In very rapid water, free from weeds (the Derbyshire rivers, and Welsh streams, for example,) a third fly may be added to the stretcher and dropper, but, on the whole, little good comes of more than two flies on the cast. In trout water where the fish do not rise well at the usual flies the Alexandra is as much in place as a spun minnow, but it spoils the fish for the artificial fly pure and simple. Upon all these matters the angler must form his own judgments from experience, and then I fancy he will take a delight, when wading, in casting straight up-stream with a short line; will always, otherwise, aim at casting across and allowing the flies to drift down without worrying them as they swim ; and when a quick current, or impediments ashore leave no alternative, will do the best within his power, down-stream, underhand, or by that curious pitch which the angler learns to make with effect when he has an obstacle at his back. When he has achieved the art of throwing a fly without frightening away the fish he has conquered the primary difficulty.

April brings an opening day for the Thames trout-fisher. The Thames trout, by careful preservation and the introduction of new stock, have not for many years given so good an account of themselves as during the season of 1883, and even after its close on the 15th September, a provokingly large quantity took a fancy to the baits of barbel-fishers, who returned them, as in duty bound, to the river. Trouting on the Thames is, however, indulged in by the few rather than the many. Only the most patient men follow it through evil and good report. It makes an abnormal draft upon human faith ; it is a somewhat sedentary occupation, as followed by modern masters. Now and then this notable fish is taken with an artificial fly, but fly-fishing is seldom practised by the regular Thames trout angler. You will find this worthy mostly perched above the head of one of the weirs, of which Boveney is a more than average sample, spinning a bleak in the streams and rough water under his feet, not, however, if he understand his business, leaving the bait to work its own restless will, and fruitlessly revolve on the top of the foam, but cleverly humouring it right and left, in eddies, down the current, and so making it dart and move that its action is calculated to deceive the very elect amongst Thames trout, the most knowing perhaps of any of the *Fario* family.

Spinning for Thames trout, whether from weir or boat, is work for none but accomplished artists, and there are upon the river a few renowned specialists who day by day, and week by week, pursue their sport with untiring devotion, though a fish or two per week throughout the season would be considered very excellent sport. The Thames trout, however, is a gallant battler when once he feels the little triangles in his palate. While the rush lasts he outdoes even the salmon in his fierce charges and desperate tactics, so that, if he be discovered but rarely, when he does make a grave error he is a foeman worthy of the best steel ever fashioned into a fish-hook.

The game goes on until the 15th September, but the bloom is taken off the sport in a couple of months from the opening day. Every weir is spun persistently, and every weir, perhaps, if it could reveal its secrets, would testify to fish that had broken away, been pricked, or otherwise put upon their guard. Thus the trout, already cunning, get exceedingly wary, and hard to catch. Once upon a time the Thames anglers never dreamt of looking for trout in other than weirpools and rough, swift water, but modern men have found out that in reaches of the river where their presence was never suspected, an occasional lusty patriarch, retired from the noise and perpetual motion of lasher and weir, has taken up a quiet haunt; and as, in his more lively foraging expeditions, he is certain, sooner or later, to let his whereabouts be known—since the Thames is not hid in a corner—the process of live-baiting is applied to him, and not infrequently with fatal results.

CHAPTER III.

SUMMER.

SUMMER angling brings out new and more miscellaneous forces than heretofore to promote designs upon our fresh-water fishes, and the English ladies are taking very kindly both to fly-fishing and general fishing. May they never be persuaded into pleading their sex as an excuse for establising unsportsmanlike practices against salmon and trout? Fly rods are made so daintily now, and casting a fly is really so easy, when once the knack is acquired of permitting the rod to do the major part of the work, that want of strength is no plea. And there is a still better argument. Not even the harp or the violin, nor the lawn-tennis racket, shows off the female figure to such positive advantage as the graceful manipulation of the fly-rod. In the summer evenings, therefore, when there is a saunter through the hay-field to the river and its forget-me-nots, listen not to the assurances of the youth (who knows better) that when ladies fish for the speckled beauties of the stream any bait may be used. He may be deprived of that coveted chance of impaling the worms for the fair fisherwoman, but his conscience will be at peace if he recommend and teach her the use of the fly.

The Mundella Act sets loose the fishing-punts on the 15th of June, when we may reasonably assume that summer smiles upon the land. On Thames, and such inland waters as come under the operations of the measure, the anglers swarm to renew their acquaintance with roach, dace, barbel, chub, perch, and (sad to add) with pike. Throughout the summer angling is made the occasion of happy water picnics. Hot bright days will mostly find all but the surface-feeding fish ensconced within the cool shady arbours of their subaqueous abodes, and morning and evening are the anglers' likeliest times for sport. The carp, however,—rarest of objects in the fisherman's basket—loves the blazing summer weather, and on intervening cloudy days may be hooked unawares. The long days are welcome to the angler on account of the spells of calm evening fishing afforded; and a traveller rushing through the kingdom by any of the main lines of railway will be able to observe how universally popular is the amusement. By river, lake, canal, pond, clay-pit, and ditch, coming within ken of his carriage window, he will behold its persevering followers.

In the pond out of which the horses come to slake their thirst after the day's team-work is over, the schoolboy, having got through, at scampering pace, to-morrow's lessons, is allowed to make his first essays in angling; and perhaps to the majority of us those juvenile snatches of fishing, with tackle of the most primitive kind, live longest in the memory, not only because of the singular passion for the sport which takes root in the boyish mind never to be eradicated, but because of the wonderful luck which proverbially falls to the neophyte's share. How often does it happen that the expert fisherman, with his delicate silk line and drawn gut links, with his carefully chosen baits, and working with all the wisdom of mature experience, has the mortification of seeing some untutored rustic walking away with a string of fish, while his basket remains untenanted! And in some of those out-of-the-way ponds in rural England—ponds that have held fish from time immemorial—there is rare sport to be obtained on summer evenings with the mud-loving tench and the undaunted perch, descendants, may be, of the same fish which the Puritan lads caught in the days before their father's farm was drenched with the blood of Cavalier and Roundhead. On warm muggy days when all creation seems to sweat, and there is thunder in the air, that singular fish, the tench, bites well, and the largest and most plentiful of them are to be found in the most ancient of park lakes and monastic ponds. The sport is not particularly exciting, but it requires to be conducted with great care on account of the shyness of the fish. Different is it with the pond perch, which is a great encouragement to the youthful angler by the reckless readiness with which it will, in its hungry moments, assist him in imbibing a lifelong taste for the pastime.

In the vicinity of large towns the angler sits by the water side breathing at least fresh air, and surrounded by sights calculated to make him forget the petty cares of life, or the sordid belongings of a lot of poverty. He is content with even the smallest result in the way of sport. That sport is not of an extensive kind, nor of a high class, but he enjoys it, and appreciates his little show of roach or dace, or barbel, as much as the man of means appreciates his trout or salmon.

Summer time is also the period when that very remarkable collection of fresh-water lakes known as the broads of East Anglia are laid under contribution by anglers and cruisers. These broads have a character of their own in the angling of Great Britain, teeming as they do with bream and other coarse fish. It is no uncommon thing in a cruise up the waters from Lowestoft and Yarmouth, or from Wroxham Bridge, which is the starting-point for the upper broads, to pass hundreds of boats, each filled with its earnest angling party.

There are in these waters roach and perch and pike, bream and rudd, in untold quantities, but the reed thickets surrounding them are so dense that the pike are not generally enticed out of them until the winter, when the other kinds have retired to the deeps. The bream are so numerous that they are reckoned by the stone rather than by the brace or dozen, and although they are not highly-esteemed for table purposes after they are caught, they furnish a good deal of fun in the catching. This operation is somewhat disagreeable to a fastidious person. The angler provides himself with a huge bucket containing a sloppy mixture of grains and meal, and he protects himself from stray *débris* by wearing a white apron. This compound is thrown broadcast into a particular pitch—it should be done overnight—and the bream collect in herds around it. The hook is baited with a worm or with gentles, and the fish, when they are fairly on the feed, bite without cessation until the store net, which the East Anglian angler keeps suspended over the side of the punt, is full of large broad-sided, bronze-coloured bream, averaging 3 or 4 lbs.

These broads are also a favourite hunting-ground of the rudd, a fish often confounded with the roach. It is confined to a comparatively few localities, and there is no mistaking its lovely golden jacket and carmine fins and irides. Though commonly angled for on the same principle as roach, it will rise very freely at a fly in hot weather. In the quiet evenings, after the sun is down, I have moored my rude boat to the reeds that border one of these meres, and whipped out two half-pound rudd at a time, as fast as I could introduce to the shoal my small black gnat or red palmer, with a gentle on the tip of the hook. You could see the whole shoal rising at the small insects that were humming in the summer air.

Here a man is out of the noise and turmoil of the world. For leagues the eye roams over the tranquil waters, or upon the flat peculiar country converted by the slow running rivers, abundant windmills, and far-reaching broads, into a very Dutch-like kind of scenery. Nothing breaks the silence but the plunge of big fish amongst the reeds, or the constant passage of water-fowl, for which the region is as celebrated as for its coarse fish. When the gentlemen of Norfolk kindly invited the foreign commissioners at the International Fisheries Exhibition to go and inspect this region, Mr. Wilmot of the Canadian Court, and Professor Brown Goode of the United States Commission, expressed an opinion that the waters were very suitable for the introduction of the black bass. This fish has already been acclimatised by the Marquis of Exeter, and from its game qualities, its freedom in rising at a fly, or taking a spinning bait, it would be a very welcome addition to our fresh-water fishes, and would take an intermediate position between the pike and the perch, and the members of the Salmonidæ family. And it would be easy to confine the black bass to waters where it would not destroy more valuable species. Whether the gentlemen who have formed themselves into a society to protect the fisheries of these broads will entertain such an idea, or whether they will act upon a more recent suggestion and attempt the introduction of salmon, remains to be seen. The broads, at any rate, cannot be omitted from a description of our angling waters; they are visited every summer by thousands of anglers from various parts of the country, and are well worth visiting.

According to the terms of the Mundella Act, as I have stated, the Thames fisherman has his opening day on the 15th June, although it is much too soon to angle for pike. The other fish, if not in fair condition, are rapidly arriving at that stage, and from this date the professional fisherman hopes to have his regular customers, and each favourite station of the Thames will have its periodical visits from anglers. The efforts of the Thames Angling Preservation Society have undoubtedly been crowned with success, for the stock of fish has been improving year by year, and, as a passing reference in the previous chapter shows, the angling of the present season has been in all parts satisfactory. The Thames anglers are somewhat of a school to themselves, and, moreover, a very numerous class. They have a variety of fishing at their disposal. Roach and dace are plentiful everywhere from Kew to the source. Barbel are taken at certain stations in bulk. Pike too and perch are equally distributed along the whole length of the beautiful river, and the fly-fisher has plenty of room for the exercise of his abilities with chub and dace.

Fly-fishing for chub answers best in the hot summer months—say July and August; and along the willow and alder lined reaches, at odd times payable sport is obtained. It is a great boon after all for the man in the big city pent to be able to get away from business, and by an afternoon train arrive at any portion of the Thames below Oxford in time to have three or four of the best hours' fly-fishing which the day affords. The chub is not fastidious in its choice of flies. So long as the lure is large and hairy; so long as it bears some passing resemblance to a caterpillar or beetle, or large-winged moth, the angler's chances of big fish are good. The chub, however, is an easily scared fish, and it is a primary essential that the whipper shall keep out of sight.

The breadth of such rivers as the Thames at Moulsford, or Ouse below St. Ives, and the out-of-the-way places in which the chub loves to lie, render the use of a boat imperative. In this the angler stations himself in the stern, his boatmen allowing the craft to drift slowly with the stream ten or twelve yards abreast of the over-hanging branches, under which he knows the fish are lying. Let the fly touch the leaves, and then make believe to tumble accidentally into the water. There will be a straight rush made by the chub (which is not at all insulted in the old-fashioned appellation of logger-headed); he will take your fly at a gulp under water without the ceremony of a rise; and the leathery formation of the mouth makes the chances of escape very poor for the fish. The chub has no character for pluck, since after one pretty strong run by way of protest, it ceases to fight, and may be hauled into the landing-net without much trouble or the employment of any art on the part of the angler. I have known gentlemen in the course of a few hours' fishing in this manner take their 20 and 30 lbs. of chub, ranging from 2 to 4 lbs. In the Upper Verniew in the month of April three years ago, at one stand, fishing for trout with a small March brown, I took 18 chub of about a pound each. If they had weighed not more than a pennyweight I would have killed them in any trout water.

Trout-fishing I have dealt with in one or two phases in the chapter on spring. It need scarcely, however, be explained that this fish is the fly-fisher's idol during the entire summer. But the carnival of trout anglers may be said to occur when the May-fly is up. This anxiously looked for event generally happens early in June, and while it lasts the sport is indeed fast and furious. On preserved club waters, like the Hungerford water of the Kennet, and on the choice preserves of Hampshire, and other parts of the West of England, the sportsmen turn out with one consent to take advantage of the seven devils of gluttony which seem to enter into the strong-minded trout.

It is a glorious time of the year in which to be abroad on such a quest. The honey-suckle is opening its buds in the leafy lanes, the satin blossoms of the bramble are put forth, the rich meadows are ready for the haymakers, the foliage of the woods is developed upon nearly all our English trees, the wild flowers are spangling field and hedgerow in their glory, and the cuckoo, making the most of the little time that is left for song, "Tells his name to all the hills."

But I should say that at no season of the year has the sentimental angler less time than now to indulge in rhapsodies, for when the green and grey drake are what is technically termed "up," sport will demand all his attention. Lucky he if it make him not a butcher. There was a deal of human nature in that eminent divine who, upon being asked by his friend the bishop when an important work upon which he was engaged would be finished, replied—"My lord, I shall work steadily at it when the fly-fishing season is over." Such a reference, we may be permitted to believe, could only have been prompted by an unusually exuberant "great rise" in the May-fly season.

And no one has in pithier words described the peculiarities of this festival than Charles Kingsley, who, in his 'Chalk Stream Studies,' says:—"For is not the green drake on? And while he reigns, all hours, meals, decencies, and respectabilities must yield to his caprice. See here he sits, or rather tens of thousands of him, one on each stalk of grass, green drake, yellow drake, brown drake, white drake, each with his gauzy wings folded over his back, waiting for some unknown change of temperature or something else, in the afternoon, to wake him from his sleep, and send him fluttering over the stream ; while overhead the black drake, who has changed his skin and reproduced his species, dances in the sunshine, empty, hard, and happy, like Festus Bailey's great black crow, who

> 'All his life sings ho ! ho ! ho !
> For no one will eat him he well doth know.'"

The peculiarities of May-fly fishing are so well known, that there would be no excuse for pausing longer upon the subject. Bungling indeed must be the angler who cannot during this space of ten or twelve days catch fish, and the barefacedness with which, under favourable circumstances, the trick is done, rather leads one to regret that on any English stream the custom still prevails of fishing for trout with a living instead of artificial May-fly. The angler who cannot score with one of the perfect imitations now turned out, ought not to have a second chance.

It is different in the celebrated lakes of West Meath, where the big fish are not readily taken by the artificial fly, and where it has been an immemorial custom to use the impaled live insect with the blow line. Upon these lakes, for which Mullingar, some forty miles from Dublin, might be made convenient headquarters, the green drake comes up in myriads. The brown trout which the waters contain are in takeable condition as early as March, and are to be enticed with some of the common artificial flies used in the spring months. The most knowing fishermen in the drake season use two hooks tied back to back, and two flies so arranged that the head of one shall lie next to the tail of the other. The surface of the lakes, amongst which I may mention Ennel, or Belvidere, Owel, and Lough Ree (through which the Shannon runs), is agitated all over with the rising of fish that are seldom less than two pounds, and that run even to the maximum size of six and seven pounds. The boat is rowed up against the wind, and allowed to drift back broadside on. The angler uplifts his moderately stiff rod, to which is attached the line of floss silk, very flimsy in appearance, but in reality strong enough for all necessary purposes. This the wind takes out, and the art is to allow the flies to dance upon the surface of the water as if a fancy-free insect were sailing along, tacking here and there with outspread wings, as is its pretty custom. It, however, requires a little experience to get into the way of striking the fish with a line which is naturally considerably bellied out at the time the bait is taken; but practice here, as in other things, soon makes perfect, and astonishing bags of trout are made.

This blow line fishing might in the summer be used with advantage to a greater extent than it is at present in English waters. In the Lea I have seen masterful baskets of roach, chub, and dace, acquired by this device; the hook attached to the blow-line in such cases, however, being very small, and the insect a house fly, or some other creature of no more formidable size and character. Roach will occasionally, I may mention in passing, take the artificial fly, especially when to it is appended the luscious gentle; but this only happens in the very hottest weather, when the fish are lazy on the shallows. But the blow-line invariably agitates, and often catches them.

On the disappearance of the May-fly the trout become demoralized. They have gorged to their heart's content, and probably a little more, for their voracity during the term (it is commemoration term with the angler) in which the fly is up is such that you often take the fish crammed with them, and with a little bunch of flies waiting at the threshold of the gullet for a favourable opportunity of being absorbed into the stomach. I have seen a May-fly crawl out of the half-opened mouth of a trout in my basket.

It is not to be wondered at that after this debauchery a certain supineness intervenes, and that the trout lie about in a depressed state of mind, such as should always follow immoderation of appetite. Upon some rivers, indeed, the pick of the trout fishing is over after the May-fly time, while in others, as in the Gloucestershire Coln, the really best fishing does not begin until the trout have recovered from their periodical feast. As the summer advances the trout fisher enters into another phase of his artistic sport, perhaps the most delicate of all. The rivers run low, the weeds form thickets and forests in the streams. The trout, much whipped over during the preceding three or four months, have become disagreeably artful, and if they are to be caught at all they must be caught by guile.

Guile in this particular instance takes the shape of what is termed fishing with a dry fly. Of late years the tackle-makers have arrived at the perfection of art in manufacturing what should be to the fish the most ravishing of artificial flies, whose upstanding wings materially assist the angler in this very artful angling operation. At the same time, I ask permission to believe that trout fishermen are apt to ride the dry fly notion to death. When once some of us get into the habit of using the dry fly, and wax proud of our ability, we become wedded to the method, and in season and out of season adhere to it. At times it is unquestionably absolutely necessary to use the dry fly, for the best of all reasons—the fish will look at no other. But I have frequently seen experienced anglers persevere with their floating fancies, yet do nothing, when other persons who were allowing their flies to sink and swim in the usual way down the stream were rewarded with trout.

It is always useful, nevertheless, to have your supply of dry flies at hand, and in case of non-success in the other method, to put them up. But, I repeat, too much is oftentimes made of the dry-fly theory. Perhaps this is because of a consciousness on the part of the angler that it requires the acme of skill to be successful with it. Perhaps, also, it may be partly accounted for by the said angler being used to waters where dry-fly fishing in the later months of the summer is a *sine quâ non.*

There are no more skilful trout anglers than those accustomed to the streams which flow tranquilly through the fat Hampshire meadows. The rivers contain beautiful fish, but they are extremely difficult to take, and the Hampshireman is quite justified in his boast that the angler who can kill in Itchen or Test need not be ashamed to exhibit his prowess anywhere. It requires a good deal of experience to learn how, after whipping the fly four or five times through the air, to secure the requisite dryness, to dispatch it across underneath the further bank, and make it alight so that it shall float some distance down the stream without being checked by the line.

The situation necessarily involves a certain slackness of line, and with the fine tackle that must be used, the extra skill, of which I have just spoken, must be extended to the striking, else a long farewell to fly and fish. There is no doubt that a large percentage of trout hooked in dry-fly fishing by defect at this crisis get away. I know of no more pleasant form of angling for trout on a fine summer's evening, when a mere zephyr skims over the water, when the swallows are hawking low upon it, and the voice of the corncrake is heard in the uplands, than to kneel warily amongst the flowering comfrey, meadow sweet, willow herb, and loosestrife, and mark a rising trout close under the rank sedges fringing yonder bank. The artificial sedge fly, with its artistic ribbing, though not made expressly to float, is capital for dry-fly fishing, and all things being favourable there is no more telling way of adding to the contents of your basket than by finishing up a day's fishing in laying siege to that fish till he capitulates.

Then in August the red and black ant come in, and all through the summer three specific flies should never be out of the angler's book, to wit the Wickham, Hoflands, and the Francis Francis Fancies. During the past season I was introduced by my friend Mr. Marston to a new fly, new at least to me, the wings of which are made of pike scales. It is manufactured by McNee of Pitlochrie, and I have found it answer, and seen it answer, when the trout allowed every other kind of fly to pass by unheeded. The theory is that the pike scale, when it becomes wet, has the unctuous appearance of a gelatinous wing, and it may be so. At any rate, on streams as opposite in their character as the Chatsworth Derwent, the Little Stour in Kent, and the Lambourne in Berkshire, I have reason to be thankful that this addition to our list of flies was made known to me. It is certainly worth a trial.

Loch fishing is a fashionable and essential item of the general summer programme, and on Loch Leven the club competitions for which the lake is celebrated are decided. It is truly astonishing that the trout in this lake show no signs of diminution, for although careful restocking is attended to, there is no more thoroughly thrashed water in Scotland; and amongst the gentlemen who make such pleasant parties in the boats you generally find one who has never handled rod before, and whose flies do *not* fall like the traditional thistledown upon the water. Yet the sport, if not what it was when an angler was disgusted if he came ashore at Kinross without his twenty or thirty pounds of fish, is maintained above an ordinary level. In the year before last, I can recall one day in May, when seventeen boats were on the lake—a full complement. The wind and water were favourable, and the boats finished in the evening with 212 trout, weighing 213 lbs. The Loch Leven trout always seem to average one pound; and as I have watched anglers from Edinburgh, Dundee, Glasgow, Stirling, Perth, Kirkcaldy, and Dunfermline, I have often thought that their tackle is unnecessarily coarse. No doubt they know their own business best. They get fine sport certainly.

Different from Leven are the lochs away in the unbeaten districts of the Highlands. There is the small lake swarming with yellow trout of three to the pound (game little fellows to angle for on a summer day), and there is the larger loch in which the pike keep down the small fish, so that the angler will get none under two pounds. The brown trout attain a heavy size—five, six, and seven pounds—in these waters, and, unlike the *ferox*, they will take a large fly with gusto. Spinning with a phantom minnow of medium size, when the natural bait cannot be procured, is useful for all these large trout, and for salmon. In the streams the summer warrants the use of Stewart's tackle, a most telling method, which one may almost describe as fly-fishing with worm. I have seen it applied by southerners in southern waters with surprising results in perch and chub fishing.

CHAPTER IV.

AUTUMN.

THERE is a charm in the English autumn to which the angler ought to be peculiarly sensible. The late coming salmon and sea-trout fishing, wind and weather permitting, is the best of the year, since it is not, in the natural order of things, interfered with by the turbulent floods which follow the melting of the snow, nor reduced by the netters, nor ruined by the low, bright waters of the summer weeks Autumn is more often reliable, I have noticed, as to weather than other seasons, though there was a miserable exception to the rule in 1882. When the elements are favourable, the water is in excellent condition for the Scotch, Irish, English and Welsh streams visited by the migratory salmon.

The days, which rapidly close in long before the swallows depart or the leaves fall, are all too short, however, for such out-of-door sports as angling, because the fish have now no inclination to move freely until the forenoon is well advanced. Against this drawback must be written the exquisite tints of the trees, and the bracing air, in which the more active exercises of angling may be conducted in comfort. For spinning or trolling, for wielding the big greenheart, the double-handed hickory, or the split cane single-hander, there are no better months than September and October; and as to landscape, I am one of those who love spring, revel in summer, but adore autumn, with its corn and wine and oil, its golden plenty emphasised by a framework of gentle decay.

The salmon fisher has seen the brown hills brighten with green, and blaze into the regal purple of the heather, and now the rowan tree hangs out its scarlet lamps, and the firs assume a deeper hue. The trout fisher in the bright May days was gladdened by the fragrant hawthorn, and noticed how strong the briony clasped the hedgerow. He saw the blossoms of the wild guelder rose shaken to earth by the lightest summer shower, and the true wild rose in full bearing. Their berries now gleam black and red, those of the guelder rose clustered like drops of blood, while its leaves are veined with every colour of the rainbow. The village children, who months back stood shyly by to watch the landing of the two-pounder that had taken the Red Spinner in the smooth stream above the ford, had sprigs of immature travellers' joy round their hats, and their hands were full of cowslip, ragged robbin, and lady smocks. Their faces are smeared with blackberry stain, and their pinafores turned into receptacles for hazel nuts, as they wonder why, on that late September evening, you cast your fly so many times through the air before allowing it to touch the water. The punt fisher moored in the Thames above Maidenhead, has, in Bisham, and incomparable Cliveden, a mixture of colours upon the densely wooded hillsides such as mortal hand could never compound.

The sea-trout fisher is in his glory in the autumn. That last run up of the fish is generally the briskest, and the sea-trout angler has therefore the privilege of leaving off for the season without the consciousness that it was convenient to make a virtue of necessity. So long as the *Salmo trutta* is in the river, you do not wear out your welcome. This fish gives super-excellent sport. Your equipment is heavier than that used for brown trout, and lighter than salmon gear. A well-balanced double-handed rod that will answer also for grilse is the weapon, and there is no need whatever for the coarse gut footline which in both Scotland and Ireland the native anglers deem essential. The gut must be of the purest quality, but medium size is ample. The difficulty here is to obtain flies that are tied upon gut to correspond, and this is a difficulty which causes annoyance to all classes of anglers. It is a forcible argument in favour of the new fashion of eyed flies for every description of fly fishing. The sea-trout is found in most salmon rivers, of course, and in the lakes, but his chief recommendation to me is that he runs up small streams, which but for him would never be visited by any of the silvery visitors.

There is in my mind's eye at the present a narrow river, if I may so term it, which has no name upon the map. Within a hundred yards of the sea I could leap across it in two places. You can reach its infant stage by tramping a couple of miles up the moor through a heathery bog, and follow it down through, at first, a series of rough, rocky leaps, next through a sequestered glen, and finally through a descending mile of turning and twisting. This streamlet, up to the heaped-up rocklets, is a succession of pools and streams, alternating with perfectly dull water. In the autumn the sea-trout swarm in every one of them, though they do not reach the maximum size. In the next river on the same coast, and not twenty miles distant, five-pound fish are not rare, but in my nameless stream you create a sensation at the village post-office—which is the Rialto of that Highland community—if you kill one of three pounds. Two pounds seems to be an average, and may I never meet with worse sport than a couple of dozen sea-trout in such condition and of such dimensions, fairly caught with the fly.

The sea-trout fights in a manner of his own. His first dashes are as fierce as those of the Thames trout, but (for his size) he keeps the game up longer, and has some special gift at leaping out of the water. It was not until I had caught a few sea-trout that I comprehended how it could be possible for a man, who had the instincts of a true sportsman, to treat with contempt all fresh-water fish but sea-going Salmonidæ. Numbers of Scotch anglers deem even brown trout unworthy of notice, and they are generally men who have been fortunate enough to be able to fish for sea-trout, and on privileged occasions a salmon, in their younger days. The sea-trout soon steals into your affections. He is so elegant in shape, so full of health and life, so active in his movements, so plucky in resisting the doom to which the angler (who loves him so much) consigns him—a justifiable doom, nevertheless, for the sea-trout is a fish that will not disgrace any table.

The Welsh sewin is nothing like so reliable as a sport-yielder as the *trutta,* if, indeed, what you are assured is a sewin should happen to be the bull-trout, as in the majority of instances it will prove to be. He is not a ravenous riser at the fly, though in this respect he is more charitable in his actions than the great lake trout of Ireland and Scotland. The Coquet is the British stream most frequented by *Salmo eriox,* and the lusty fish run to ten or twelve pounds, and sometimes to sixteen or eighteen pounds. You rarely bag them so large in the south Welsh streams, and in fly-fishing two and three pound fish are as much as you can expect. More than half of the fish called sewin by Welsh anglers are *Salmo trutta,* to whose healthy appetites flies never come amiss. But the smaller bull-trout come sometimes liberally to the fly-fisher of Wales, whose best flies are our old friend the March brown, locally known as the Cob, the Bittern, and the Coch-y-bondu, all tied large. You cast down and work your lines as with sea-trout and salmon.

The ancient legend by which we are assured that our forefathers believed that the grayling was introduced into this country by the monks, seems by modern authorities to be somewhat discredited. Let us hope this scepticism does not arise from a mean spirit of sectarian animosity, from a desire, in point of fact, to rob the reverend fathers of the credit that attaches to a work so undoubtedly meritorious.

Whether the fish be indigenous or not, after all, matters very little. We may be thankful that they abound. They are such a blessing to the angler, that I believe there would be little difficulty in raising a marble monument to the man who could be proved to have introduced the grayling into English waters, for the fish is, in truth, entitled to most affectionate regard. When trout-fishing is done with, grayling-fishing is within a month of its zenith, and right away through December, January, and February, in the middle hours of the day, when the sun shines, though the ground be hard with frost, and the snow glistens upon branch and bank (so long as there is no snow broth in the water), the grayling will rise steadily at the fly. The streams of Herefordshire I have already referred to as great in stores of grayling, and the Hampshire waters are almost as good; in the opinion, perhaps, of the Hampshire fishermen themselves, better. Yorkshire, again, has plenty of grayling streams, the chief of which is the Wharfe. Although the fishing within a mile either way of Bolton Abbey is scarcely worth a trial now, below the Duke's waters, and, again, a few miles above Bolton Abbey, the sport is good.

We will, for a moment, take the Bolton Abbey water as a general type of the river in which grayling will thrive. Towards the end of October the yellow and brown leaves are beginning to scatter before the blast, and their presence in the stream is sometimes almost as much a nuisance to the angler as the disgusting little midgelet, not inaptly called "the angler's curse," is in summer time to the trout fisher. The fall of the leaf and activity amongst grayling men are synonymous. At the wider end of our limit, we begin with a long stretch of shallow water rippling at the uniform depth of a foot over amber-coloured pebbles and gravels. Here you would naturally expect to take trout in the early part of the year; but you would waste your time in whipping for grayling. Wait until you pass through into the next field; there you will find that the river takes a sudden swerve to the right, flowing deep at the bottom of the woods opposite, and washing up at your feet, as you stand by the brink on your own side, from a shelf which gradually slopes to the deepest part. At the upper end of the curve, there is something in the nature of a fall, caused by large blocks of boulder, and in the very eye of the sharp stream formed by them, you may make certain of a rise. Also in the smooth gliding water, five or six feet deep, though it may be in the bend of the curve, you should, with red tag, or a tiny floating dun, or one of those queer little spiders in fashion in the district, pick out your pound grayling; while at the tail of the stream where it escapes in an oily fashion from the depth of the pool is another favourite haunt.

In Dovedale, again, is a noted grayling water, to which disciples of Walton and Cotton devote loyal pilgrimages.

The Derbyshire streams I must needs once mention, for it is a boon indeed to the English angler at large, that proprietors, like the Duke of Devonshire, allow the public, under reasonable regulations, to fish them. One of the cross-purposes so often experienced by the angler arises from these rivers, which contain both trout and grayling. How frequently it occurs in all grayling streams, that while you are fishing for trout in the summer, you hook grayling, whereas when the trout are black and foul, and you are trying diligently for grayling, the unseasonable fish will make gratuitous onslaughts upon your fly!

The grayling is not given to leaping out of the water, but he makes amends whenever you bring him to the surface, by floundering about in a position more dangerous in a tender-mouthed fish than leaping; so that unless you are careful, the grayling, by the free exercise of that large and beautifully tinted dorsal-fin, will contrive to escape at the very moment when you have made sure of him. There are waters in which you may fish for trout with medium-sized casts, but this will not do for grayling. The very finest tackle is required for them. As, however, they often lie deep, and make nothing of darting straight upwards three or four feet to take the fly that is floating down above them, the grayling fisher is not required to crouch upon all-fours, or kneel by the river side as in summer-trouting.

There is a dispute, which is not of much importance, amongst some grayling-anglers, as to what this dainty fish smells like. Some swear by thyme, from which the fish receives the name of *Salmo thymallus*, whilst others have a notion that cucumber would be nearer the mark; and there is a fish in Australasia which is as often called the cucumber fish as the Australian grayling.

An English grayling of about $1\frac{1}{2}$ lbs. weight is as handsome in his own peculiar style of beauty as the trout, for if he lack the crimson spots and golden burnishment, he has a fine admixture of blue and silver, while his shape is faultless.

There is another kind of fly-fishing to be followed during September and October, of which I for one am extremely fond, albeit it has a somewhat unpretentious object, being directed to nothing more important than the common dace. The dace is really one of our surface feeders. He may be found during the winter time in deep water, keeping company with the roach, and he congregates in force in deep mill-tails and weir-pools, where he will take the small red worm or the gentle with very much the boldness of the perch. In Autumn, however, the dace still lingers upon the shallows, and rises well at almost any small fly. Take two examples of dace-fishing in the autumn. The first was in the Thames, above Richmond Bridge. All the shallows, from Twickenham downwards, have a well deserved repute for fly-fishing for dace, and the Thames-side urchins, with willow-wands, lengths of whipcord, and anything in the shape of a fly which they can beg or borrow, make nice little strings of fish, running to about seven or eight inches in length. A sunshiny day, with a soft ripple, is the best for this sport, and one might pass away four or five hours in worse amusement than wading into the Thames opposite Ham Lane, and whipping down upon the shallows with the fancy black and red flies manufactured for the purpose, their speciality being tiny strips of wash-leather, in place of tail. There is a continual procession of pleasure-boats up this gay reach of the Thames, and the familiar features of Richmond Hill are an elevated background to the picture which the downward moving angler looks upon. It is useless fishing for dace in the Thames, except at particular times of the tide, and the regular plan is to begin when the tide is at half-ebb, and leave off when the flood makes. A working-man angler, who was standing a few yards above me, on the last occasion I indulged in this amusement, whipped out, with very indifferent tackle, his four dozen of fish, and I myself, had something over three dozen of the silvery little fellows in my basket.

A seven-inch, however, or even a nine-inch dace (and you will seldom get larger specimens while fly-fishing on the Thames shallows) is very indifferent game as compared with the really good-looking and gamesome fish of the same species which are to be had in the Colne and in the Lea. On the second occasion to which I have referred, I was taken by a gentleman to a choice club water on the Lea, between Hertford and Ware. A mill pool was pointed out to me as full of dace. The mill was silent, and there was no stream from the pool; but a light breeze tickled its surface, and the sun was shining in a cloudless sky. The sides of the mill pool were solid masonry, and the pool terminated in a somewhat sudden shelf. The stream thenceforward, for some hundred yards, was of the shallowest description. One does not often get the opportunity of fly-fishing from a seat, but I was in an indolent humour on this particular morning, and sat me down on the edge of the wall, with my feet dangling over the stream, some 10 yards below the tail of the pool. The fish, for an hour or so, were perfectly ravenous, and gave me much entertainment. There were very few dace under ½ lb., and fat lively white fellows of that kind upon a drawn-gut cast, and with the smallest trout-rod that is made, will treat you to no indifferent sport. Within a short space of time I contrived to get from the pool, or from the two-inch shallows down stream, nine and a half brace of specimen dace, which, with the addition of a few others contributed by my friend, made the total weight nearly 10 lbs.

We have glanced at the grand salmon rivers and the swift trout streams, and at the more sluggish rivers by which the general angler watches his travelling float, or keeps the tightened leger line well in hand. Lakes and ponds, amidst the "tall ancestral trees" of country domains, have not been forgotten. But autumn reminds me of yet another haunt of the English angler. It is the millpool, within the upper wall of which the waterwheel drippingly revolves, grinding the corn of the miller and his men. Not less dear to the angler than the poet and artist is the English mill. Above the mill head there is often a quiet reach, permanently tenanted by pike and perch.

From the pool miscellaneous bags are extracted. The live bait works on its own accord on the other side under the graceful willows, while the angler, with his ordinary rod, line, and float, angles promiscuously. Out of such a millpool I have seen, lying in one heap upon the grass behind some old woodwork upon which the angler sat, a representative sample of many British fresh-water fishes, and as they were caught on an October day, they were all, with one exception, in their healthiest hues and forms. The heap comprised a 7 lb. pike, four or five burly perch, a brown and a white bream, several roach and dace, one gudgeon, four minnows, and a small barbel. The exception indicated was an indiscreet trout, which had taken a gudgeon on the live-bait apparatus, and since the hook used was the gorge affair that is threddled under the skin of the side, the case was hopeless, and the kindly miller, on being appealed to, decided that the fish should not be returned to die a painful death.

The autumnal general-fishing of the rivers produces, as a rule, larger fish than are taken in the summer. The weeds soon begin to rot after Michaelmas, and most of the coarse fish betake themselves, without more ado, to their winter quarters in the deeps. The prettiest hour's roach fishing I ever saw was on a September evening, on returning from whipping a ford where the large dace were in the habit of congregating. Above one of those small noisy weirs which are laid across our lesser rivers, there meandered through the meadow some 200 yards of even current, still but deep. There were three rustic seats stationed upon the bank, for the convenience of the members of the club who rented the fishery. Upon one of these sat a veteran angler, who had had his share of the more energetic descriptions of sport for half a century, and who was now content with the tranquil amusement of roach fishing. He thoroughly understood the art, and would have deemed that the roach were insulted if angled for with other than a tight hair line and a long bamboo rod. His process was troublesome, but remunerative. At every swim he enveloped his paste bait with a thin wrapping of the bran composition with which he had been ground-baiting, and it was a liberal education to watch his fortunes. The float, shotted down to a quarter of an inch of the surface, to my eye indicated no bite, but invariably, when the end of the swim had been reached, within a foot or so, my good friend was somehow playing a fish, following it hither and thither under the point of his rod. The 20-foot bamboo was unshipped after the orthodox Lea style, reducing its length, and the angler netted his fish without a splash or alarming movement.

The essence of roach fishing, under these circumstances, is to be quiet, and so well did this successful angler comply with the requirement, that a pretty brown water-rat opposite went on diving for, and returning to land with, some kind of ribbon weed, and audibly munching it on the balcony of his sandy abode in the bank. In less than three-quarters of an hour I witnessed, by this clever tight-line fishing, the taking of ten roach, of which the largest was nearly a pound and a half, and the smallest three-quarters of a pound. I enjoyed the watching, I am sure, as much as the veteran enjoyed the catching. As an illustration of the precarious nature of roach fishing, it is incumbent upon me to add that the whole of the morning and afternoon, to that evening hour when the mellow sun was setting over the church spire and its adjacent rookery, had yielded only half-a-dozen small fish.

CHAPTER V.

WINTER.

WHEN the salmon, by legislative enactment, are hunted no more by net or by rod, but are allowed to perform their spawning operations in peace and security; when the trout are also left undisturbed, to increase and multiply, and get into condition by the time that spring returns again, there is still a good deal worth having left for the English angler. Fair-weather fishermen will put away their rods and console themselves during the short winter days, and long winter nights, by their firesides; but there will be in town and country a decided majority of enthusiastic English anglers, who will brave the frost, snow, rain, and fog, and never abandon, until compelled to do so, their raids upon the fish that are in season.

As in treating of the Salmonidæ I have placed the *Salmo salar* at the head of the list, so in a concluding chapter upon winter angling, I cannot do less than give prominence to the pike.

The humanitarian question of angling, I may confess, without apology, never troubles me, and there will be time enough to meet it and deal with it, or shirk it, when, should the Pigeon Shooting Bill become law, consequential attempts are made to interfere in other directions. During the debate in Parliament upon that remarkable measure, it may be remembered that references were made to the pastime of angling. Until actually forced to defend themselves, I should recommend anglers to hold their tongues upon the subject. It is very plausible to argue, as many do, that it is vouchsafed to fishes to enjoy a minimum of pain; and there are some who are so convinced of this great gift to the finny race, that they have at last apparently persuaded themselves that fish rather like the sensation of being hooked and played than otherwise. It may be so. With regard to the pike I do not, however, hesitate to declare that I have no bowels of mercy for him. Last year I read a singularly interesting book by a lady, who described her travels by fell and fiord in Iceland. The authoress was a confessed fly-fisherwoman, and she, as might be expected from one of the tender-hearted sex, seemed to be a little troubled in mind upon the question of cruelty. One argument of hers struck me as being so apposite, that I entered it in my note-book, and, in beginning this chapter, which is virtually one upon pike fishing, I will take the liberty to quote it:—

"Fish are outside our circle altogether, and we may have the further satisfaction of thinking that though they seem to live particularly careless, jolly lives, they all end in being eaten, either by us or by each other, unless they meet with great ill-luck, such as chemical waste in rivers, and are poisoned. Now, for every big fish we kill, and it is these we aim at, a number of merry little fishes have longer lives; so we anglers are really benevolent institutions from a purely fishy point of view. Real fish, too, as distinguished from whales and seals, have no attachment to each other—they are only rivals. Witness the fighting for bait in a shoal; witness the withered old carp wrestling with each other in ancient palace waters. Therefore, in catching a fish you make no home desolate, you bereave no fond creature of a friend. Cool, calm, and selfish, the fish goes on his glittering way like a regular man of the world; he misses nobody out of his water home, and, when he ends an easy life by an easy death, nobody misses him."

The character of the fresh-water shark is especially exemplified in the closing sentence of the extract, and the authoress might have gone further and described *Esox lucius* as a systematic and professional marauder. He respects not his own kith and kin ; he prowls up and down, seeking what he may devour; and he has no claim upon our consideration except as a furnisher of sport. There are few waters that are exclusively devoted to the breeding and preservation of pike, and, in the majority of rivers and lakes with which I am acquainted, where they are to be found, keeping down these creatures is a general good.

Spinning is in pike-fishing what the use of the artificial fly is with salmon, trout, and grayling; it is the most artistic branch of the sport. Pike fishers in one respect resemble their brethren of the salmon rod, for they are continually inventing new fancies, laying down new theories, trying new experiments, and dogmatising upon them all with a profundity of faith that in these sceptical days is most refreshing to witness. Artificial baits have been invented without end, and for each and all there is something to be said. I shall not venture to discuss them, but I may remark in passing, that artificial baits, from the oldest to the newest, are very useful to the pike angler. There are times when it is impossible to procure the natural food of the fish, and there are times, as every angler knows, when a spoon-bait or artificial dace or gudgeon, or one of those beautifully finished imitations of fish in brass, silver, and other less solid compositions, answer better than anything else. But, when the natural baits are to be obtained, let the angler give them a fair trial before he takes out his artificial bait-case. I will illustrate, to the best of my ability, the principal methods of pike-angling by casual recollections which it is pleasant for me to recall.

The first scene is a lake in one of those old English estates which have been in the possession of one family for generations. As I wait for the keeper to open the doors of the boat-house and bring out the little fishing-boat from which I am to operate, I can descry over the tree-tops the turrets of a castle of modern build, and behind me, peeping through the leafless branches of another plantation, I can see, beyond a group of noble cedars, the ivy-covered ruins of a building in which Sir Walter Raleigh spent a portion of his time, and which was made short work of by Cromwell, who placed his cannon upon the hill yonder, at the bottom of which is the deer fence. In the home park a choice herd of Jersey cattle are grazing, and as I put my pike fishing-tackle together, I notice the Squire, an octogenarian within a month or two, drive down the chestnut avenue with his workmanlike four-in-hand.

An angler here, who had the necessary permission, might fish all the year round. Beginning with January, there is not only this lake, with its coarse fish, but a grayling stream within three miles. When, in spring, the trout are in condition, there is a river within an hour's drive behind a fast-stepping dog-cart horse. Roach last until the "ides of March" are over, and they may be caught even in winter in shoals around the promontory on the lawn where the swans are fed. Tench of enormous size infest the waters, biting well in spring, and timing their domestic duties, as an old writer intended them to do, with the blossoming of wheat. The head of the extensive house of Cyprinidæ Brothers may be left out of consideration, for the fat, lazy rascal seldom comes from his hiding-place until the winter is over and gone; yet in the under-keeper's garden there is a rudely-stuffed specimen of a carp of 24 lbs., set up as a scare-crow. Perch may be taken up to the middle of March. By the time trout-fishing is over, which in the stream in question is virtually at the end of July, the coarse fish are ready again, and the grayling almost fit, in the stream into which they were introduced some years ago. There is finally an estuary not very far away where salmon peel are occasionally taken.

The centre, however, of all this fishing is the serpentine lake, out of which, last Christmas, the nephew of the old squire, in a short December afternoon, killed 80 lbs. weight of pike. It is with no ordinary hope, therefore, that I enter the boat and am pushed out upon the surface. Some men are born to be unlucky, and, in angling, I have often thought that I am one of them. There is not to-day a breath of wind to ruffle the surface, or scatter the light mist which still broods over the water. Although the thin blue smoke which floats over the trees from the castle chimneys shows that what little upper current of air there is comes from the bleak north-easterly quarter, which anglers never pray for, there may yet be a chance, for, if the wind be verily honest and constant, you need not, in pike-fishing, seriously trouble as to the point of the compass from which it blows. Wind of some sort, however, is a prime necessity in pike-fishing.

I had rigged up without loss of time my spinning apparatus. As the reader is probably aware, there are many spinning flights of different sizes, of different patterns, but they are all based upon the one supposition that by their means the bait is made to spin without an ugly motion, and as nearly as possible to resemble the swimming of a natural fish. I have tried all the flights that have been invented, and having listened carefully to all the arguments advanced in their favour, have at last decided in favour, first, of one which has no other name, to my knowledge, than "Storr's flight"; and the other, I believe, is called Wood's Chapman spinner. The latter has a lead weight moulded around a length of brass wire, which is sharpened at the end, and armed with a small hook. At the head of the weight are a couple of flanges to give the requisite spinning motion. The sharply-pointed leaded wire, with its little hook, is thrust into the interior of the fish until the flanges protrude on either side of the mouth. Two sets of flights then lie along the sides of the bait. The whole arrangement is of course kept from slipping out by the aforementioned small hook attached to the wire.

This bait spins beautifully, and it has the very desirable advantage of making but one splash when thrown into the water, because, the weight being within the bait, the usual lead attached to the trace, a foot or so from the bait, is dispensed with. The disadvantage of the Chapman spinner is that after being in action a short time the tender interior of the fish with which you are spinning yields to the constant pressure of the tiny hook, and there is a gradual withdrawal of the flanges from the mouth. Still it is an excellent bait, because you can at least make sure that it will always revolve steady and straight, while the disposition of the flights gives the pike very little chance when once he has closed his jaws upon it.

Storr's flight is a simple and convenient, yet at the same time effective, arrangement. It consists of one large triangle, two of the hooks standing out laterally. This is attached to a piece of gimp half an inch longer than the bait to be used. By means of a baiting-needle the gimp is passed through and out of the mouth, the large triangle jamming against the vent, and there remaining. It will be found convenient to have a small triangle attached to an inch and a quarter of gimp, slipping over, and flying loose above the shoulders of the bait. Sometimes a difficulty is found when the bait is other than dace or gudgeon, in getting the proper spinning motion; but you soon learn how to act.

It is always best in pike-fishing to use a trace of twisted gut. Our forefathers considered that anything would do for pike, but this is an exploded idea. The use of coarse gimp is now generally acknowledged to be a mistake, and the deterioration of the quality of gimp some little time ago led to a more general adoption of the twisted or double gut trace. Gimp, however, for the hooks, is essential in angling for a fish with such a formidable furnishing of teeth as the pike.

On a day like the one in which we are supposed to be fishing the Squire's lake, fine tackle is more than ever a necessity, for not only is there an absence of wind, but the water is unfortunately abnormally clear. The direful *anacharis* has, as usual, installed itself in the lake, and, but for the free use of an ingenious steam ploughing machine, would render pike fishing an impossibility, so densely has it taken possession. The first few casts produce nothing. In fact, to be truthful, I must confess that two hours pass before any sign of sport is forthcoming. This in a choice preserve known to be, as the saying goes, full of pike, is ominous, for the voracious nature of the fish is such that if he means taking he does not waste time in pondering over the how and wherefore. But fate relents towards the afternoon, and a pretty ripple dances over the more exposed portions of the lake. A long cast into one of the open spaces brings me the first fish. It moves, nevertheless, in a most mysterious way. Upon feeling the attack you of course strike sharply. Anglers are earnestly impressed with the duty in fishing for pike of striking hard, so as to plunge the barbs into the bony palate; and they are recommended, if in doubt, to strike a second time. There is little necessity for the advice. The rousing shake which a hungry pike gives to a spinning bait acts upon the angler as if he had received a violent blow in the face, and he will assuredly strike back again; in other words, he involuntarily gives his line a quick twitch. The pike then shakes his head angrily, as if he would worry the bait into pieces, and the arm of the angler again involuntarily responds to this by another sharp strike.

Our fish at present, however, seems to be indulging in a relay of rotatory movements that are incomprehensible, but they are partly explained when the captive is brought to the side of the boat; the line is wound six times round the body of the fish so tightly that in one of the circles it has cut into the belly. The boat is next slowly pulled about in the deeper water, where in winter time the fish lie; but the wind has dropped again, and the day seems to yield nothing heavier than seven or eight pounds, and there are only some eight or ten fish lying at the bottom of the half boat half punt. Allusion has been made to a little promontory jutting out from the lawn, at the end of which the food is thrown in for the swans; and although the water there is shallow, it is a reasonable supposition that the clustering of small fry, picking up grains of barley and what not, may have induced a cunning pike to sneak around in the rear. Just half-an-hour before dark, putting this theory to the proof, we get towards that quarter, and a fresh dace, bright as silver, falls into the water about a yard from the land. Apparently from the outer fringe of a mass of decayed weeds, and in not more than a foot depth of water, something arrow-like speeds straight away, churning up the water as it goes. There is no half-heartedness about the smack bang of the transaction.

The fish, as you may wager without seeing the result, has taken every one of the hooks into his safe keeping, and has only to be allowed to take his own course to be added to the spoil already accumulated. Given strong tackle, well tried before the day's angling begins, there is little excuse for the loss, by breaking away, of a well-hooked pike, however large it may be; barring such accidents as fouling with trees, or hanging the line up in some irretrievable position. And a sixteen-pound pike on a spinning flight does not give in all of a moment. Your pike never fights out the battle like some of the fish that have been spoken of in the course of these pages, but he puts out all his strength and speed when hooked only with snap tackle, and is by no means a contemptible antagonist. This fellow leaps out of the water after a thirty yards gallop, and plunges into a weed bank. But I winch up to him in the boat, dislodge him, and gaff him, to put the crowning weight to the sum total, which the keeper's man bears, staggering, away with me in a rush basket to the station.

The venerable practice of trolling with the dead gorge has latterly gone a good deal out of fashion, and it cannot be denied that its deadly nature is a fair argument against it when the preservation of the pike is in question. Let the fish be ever so small, after it has taken the murderous gorge into its gullet, its career is ended, and even pike must have sportsman's law, and the youngsters be returned to the water when possible. But I must plead guilty to a sneaking kindness for this form of pike-fishing, upon which, in the seventeenth century, old Robert Nobbes wrote a very quaint treatise. Trolling is the kind of artifice that suits a half-indolent man, or one who, through age or inclination, does not care to enter into the fatiguing labour which is involved in a day's spinning.

Trolling is an appropriately effective method of angling for pike in a river. The angler, with bag and gaff slung at his back, sallies forth on a winter day, crackling the frozen snow, perhaps, beneath his feet as he trudges to the river-side. His trolling bait may be dropped here and there into holes and eddies, the proceeding being just sufficient to keep his blood in active circulation, the exercise enough to bring all his muscles into play, and yet all being conducted with a dignified action that adds not a little to the enjoyment of the sport. There is also something particularly entertaining in the manner in which the movements of the pike are to be studied when trolling.

You have thrown your bait out ten, twelve, or fifteen yards, as the case may be; it sinks to the bottom, and by a series of gentle draws up and down and ever onwards, it is gradually worked towards you, the line meanwhile being neatly coiled on the ground at your left side, unless you have acquired the art of casting, Nottingham style, from the winch, which is the poetry of the process.

Something on the way seems to touch the bait. Is it a loose weed? It may be a submerged branch. Here, then, is the first sensation—to determine whether the slight check proceeds from a fish. At any rate, you have paused in action. Sometimes the angler is held in doubt for several seconds. The pike on grabbing the bait (across the middle) has a habit of keeping still, as if to gloat over the certainty of a meal which Providence has at last placed in his way. Before long, however, he will begin to move away, the line running meanwhile free through the rings. The art of trolling lies not a little in calculating the amount of freedom which it is necessary to allow the fish. The general rule is that the pike, having struck the bait, proceeds forthwith with the pleasing movement technically known as "a run." The theory is that, not to be disturbed or pounced upon by a big brother, he retires to his lodgings, which may be near or which may be a long distance off, to pouch at leisure.

On no account should the line be checked; and it is the safest plan to allow the fish to pouch at even inordinate leisure, if such be his inclination, and then move off on a second excursion. By this time it will be safe to tighten the line, striking being unnecessary with this particular process, and to bring the fish in. The two hooks are not in trolling affixed to the bony walls of the jaws, but in the soft linings of the gullet, and there is no shaking them off or breaking them. This is the general rule, but the experienced troller is aware that when the pike is a large one it often takes the bait, slews it round, and swallows it at a gulp, and then darts swiftly, and may be repentant, away. Some five or ten minutes are generally consumed in waiting for the moment when it is safe to bring to his senses a fish that has taken your trolling bait in the regular way, and this prolonged sensation of hope and doubt may be fairly set off against the more acute excitement of playing a fish struck with the spinning flights.

The live bait gorge is open to the same objections as are urged against the trolling hook, but it is a very convenient method of commanding broad water upon which there is no boat, and where your float should be despatched on a mission of not less than thirty yards, the line being kept up, while the bait is working, by three or four smaller floats unattached. This is the only justification for using it, there being no ground for the excuse pleaded by the troller, that he can work between weeds and cover water, impracticable for spinning. Jardine's snap-tackle has been now generally adopted, in preference to the saddle and other rigs familiar to pike fishermen for many years.

A final word as to useful winter occupation for the angler. When the low-lying lands are a yellow sea, and the heads of the trees in which you were wont to entangle your fly-cast in the summer, seem to be floating on a watery expanse; when the river has forgotten its bounds, and the landmarks are swept away, there is no angling, save in a few exceptional lakes which never become discoloured. At home, you will be tired, sooner or later, of gazing at those stuffed fish that day by day remind your admiring household of your genius. The fondling of your rods and books, and general impedimenta, palls after a while. But, from the thoroughly practical books which have been published, exhausting every phase of the subject of angling, there is always something to be learned: and in the lighter literature of the sport, which is part study of human nature, part communion with nature, animate and inanimate, other than human, and part rehearsal of angling experiences, we may, through the darkest night and most inclement day, be led to continue our recreation in the spirit, if not in the flesh.

INDIAN FISH AND FISHING

BY

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INTERNATIONAL FISHERIES EXHIBITION

CONTENTS.

INDIAN FISH AND FISHING.

ONE great purpose which many persons have anticipated from the International Fisheries Exhibition is a full investigation into the condition of fisheries in general; the causes which have conduced to their prosperity or deterioration, with the suggestion of rules for their future administration. At present British fish economists are divided into two schools, which may be thus defined :—

I. That Government should permit our marine fisheries to be untrammelled by legislative restrictions, everyone should be permitted to help himself to fish as he pleases under the belief that the stock in the sea is inexhaustible.

II. That Government regulations in the working of sea fisheries is advisable in order to prevent undue destruction of the spawn and young fish, on the supposition that our inshore fisheries, as well as those of some trawled forms, are being unduly depleted.

The following pages on the "Fisheries of India," mainly relate to the condition they were in a few years since, as ascertained by personal investigations. Some of the obstacles under which they laboured have been removed, while others, it is hoped, are shortly to be remedied ; but the result of the incidence of the salt-tax on marine fisheries, and the want of restrictions on fresh-water ones, are well demonstrated.

The length of the sea-board of India and Burmah has been computed at about 4611 English miles, throughout the whole of which extent the waters are more abundantly stocked with fish than are those around the British Isles; either due to the greater reproductive powers of the species, or more probably to the less amount of depredation committed by man. While predaceous fish-consuming animals, as porpoises, sharks, rays, skates and sea perches, are far more numerous in the tropics than in these more northern climes. But it is a remarkable fact that due to some cause these fisheries which should afford a plentiful supply of food along the sea-coast are practically nearly unworked, except near large centres of population, or where cheap salt can be procured wherewith to cure the captures. This food harvest, up to within the last few years, has been comparatively untouched even while famines were devastating the contiguous shores.

Maritime fisheries, irrespective of affording food, ought likewise to be serviceable, as producing isinglass, fish oils and manures, as well as necessitating the purchase of materials for boat-building, the manufacture of nets, hooks and lines, the carriage of produce, &c. The principal modes made use of for utilising fish for food along the sea-coasts of India and Burmah may be considered under the following heads: (1) Fresh fish, how far it can be conveyed inland? (2) Dried fish and its varieties. (3) Cured or salted fish, and how prepared?

How far can fresh fish be conveyed inland? In examining this question, if the employment of ice or salt is omitted, the distance sea fish can be carried inland, while fresh, depends upon several circumstances. The season is one important factor, as during the hot months putrefaction commences very rapidly, while some forms, especially the immature, the herrings, and the siluroids or scaleless fishes, decompose more quickly than others ; and the same result follows close packing, or want of protection from the full force of the sun's rays. Usually, fish are not landed until after sunrise, while those brought on shore of an evening are generally kept where they are until the next morning, coolies being averse to travelling after dark. On the other hand, facilities of carriage may exist, as railways, water communications passing inland, or arrangements made for this purpose. As a general rule, inland places having no special facilities for carriage do not receive uncured sea fish in a wholesome condition upwards of ten miles from the beach where they were landed. Should, however, the fish be first opened and cleaned, some salt rubbed in, and care taken in their conveyance (as warding off the sun's rays), they may be carried considerably further. But salt being very expensive is very seldom employed for this purpose, or else a very slight amount is used, and putrefaction has often set in prior to the fish being disposed of for human food. While ice is only prepared or stored at large centres of population, and at such localities a ready market exists for all the fisherman's captures.

What varieties of dried fish exist in India? In many places along the shores of British India, especially where the salt-tax is rigorously enforced, it is usual for the purpose of laying in a store for future supply or for inland trade, simply to dry fish in the sun. This can be done with smaller and thinner forms, as *Ambassis*, *Equula*, the Bombay duck (*Harpodon nehereus*), many of the herrings and small varieties or immature forms, but not so well with the larger fish ; however, even from these last, slices may be cut and sun-dried. In some localities small fish are first buried in the sea-sand, in order to obtain a little saline substance, and subsequently sun-dried. In damp weather such articles rapidly decompose, while in the hot months they are attacked by innumerable insects.

Lastly, how are fish salted? The processes employed are chiefly divisible into the two following:—(1) Those cured with monopoly salt, or salt which has paid the Government tax; and (2) those prepared with salt-earth, or spontaneous and untaxed salt. I propose first referring to salt and its cost, for wherever the fisherman or fish-curer can obtain this condiment at a cheap rate, there marine fisheries flourish; where it is dear, his occupation is destroyed, except for the purpose of supplying daily wants, and a small surplus for salting or sun-drying. This will be most easily explained by referring to a few districts in detail.

The amount of salted and dried fish exported by sea from Indian ports was as follows (the value is given in £, computing one rupee at two shillings):—

Five Years ending	From Sind. Value in £.	From South Canara. Value in £.	From Malabar. Value in £.	From Coromandel Coast. Value in £.
1857–58	8,472	No returns.	No returns.	No returns.
1862–63	13,064	,,	26,272	,,
1867–68	18,725	6,969	48,207	1,753
1872–73	22,944	14,921	90,849	4,513

The duty in Sind upon salt was 2*s*., or less, a maund of 82$\frac{2}{7}$ lb. avoirdupois, during the entire period comprised in the foregoing table.

The first great increase in salting fish in that province occurred in 1860–61, in which year the duty was raised in the contiguous Presidency of Bombay from 2*s*. to 2*s*. 6*d*. a maund. The next spurt of this trade, in Sind, was in 1864–65, when the salt-duty in Bombay was again raised from 2*s*. 6*d*. to 3*s*. a maund. Possibly the importations into that Presidency from Sind would subsequently have been even more considerable, but Government decided, in 1867, to admit all salt-fish from foreign ports, where no salt-duty exists, into British India free of duty, to the immense advantage of the Portuguese settlements and the Meckran coast, but completing the ruin of Indo-British fishermen and fish-curers, unless they were advantageously located.

In olden times, salt was allowed duty-free in British territory, for salting fish; but this enactment was repealed (year not ascertained), because the excise officers found that it assisted smuggling, and so necessitated keeping up a larger preventive staff than would otherwise be required.

The annual sales of Government or monopoly salt in the various districts on the Malabar coast of Madras, along with the value of the salted and dried fish exported by sea, are shown in the following table. The figures demonstrate that but very little, if indeed any, taxed salt was employed by the fish-curers; while in the native state of Cochin, the sale of salt in ten years, ending 1872–73, owing to augmented duty, was reduced by two-thirds, and it is a significant fact that it was during this very period the great increase in the amount of exported salt-fish began. In the contiguous British district of Chowghaut, although in the year 1872 £1067 8*s*. worth of salt-fish were exported, only £46 worth of monopoly salt was disposed of among the entire population.

The reason why the sale of taxed salt is not in proportion to the amount of salt-fish exported, appears capable of the following explanation. Due to a legal decision the people had become entitled to collect salt-earth in order to cure fish for their own consumption; but, there being no law restricting their disposing of any surplus they possessed, a large trade in selling salt-fish sprang up. This induced

Years.	South Canara.		Cannanore.		Tellicherry.		Travancore and Cochin.	
	Fish. Value in £.	Salt Sold. Maunds.	Fish. Value in £.	Salt Sold. Maunds.	Fish. Value in £.	Salt Sold. Maunds.	Fish. Value in £.	Salt Sold. Maunds.
1863–1864 ..	1,057	191,002	96	11,653	1,459	72,505	5,416	728,268
1864–1865 ..	3,036	168,279	219	7,932	1,504	57,516	6,052	643,897
1865–1866 ..	875	184,174	11	9,856	194	62,135	7,061	672,370
1866–1867 ..	1,124	151,113	12	9,728	1,825	57,381	7,337	497,988
1867–1868 ..	875	174,629	303	8,721	2,011	56,502	7,803	558,766
1868–1869 ..	114	176,465	520	9,045	4,319	63,340	7,130	573,639
1869–1870 ..	2,053	147,173	4,340	8,807	5,839	72,616	6,096	574,119
1870–1871 ..	3,927	136,967	1,470	7,932	5,309	57,624	5,833	593,389
1871–1872 ..	2,845	177,482	695	12,008	5,340	88,674	6,987	577,268
1872–1873 ..	5,980	135,839	951	6,985	8,429	77,332	?	?

an increased demand for fish; the fisherman's trade became well paid, and a very large amount of animal food found its way into the market which would otherwise have been lost. That this is most probably the correct explanation is shown by examining the condition of the fisheries on the eastern coast of the Madras Presidency at the same period. On this side of the Presidency the right to gather salt-earth was not recognised, but, observed one official, the practice of salting fish must be increasing, considering that the price of the fish, which formerly cost 2*s.*, has been reduced to 1*s.* 3*d.* or 1*s.* 6*d.* But it appears probable that this reduced value of the fish was due, not to the increased prosperity of the fishermen, who were evidently in a miserably poor state, but that the absence of salt wherewith to cure fish had diminished the demand for the article, and fishermen had to be content with a lessened price.*

In the Madras Presidency the salt-tax in 1859 stood at 2*s.* a maund, but has since been raised as follows:—1859–60, 2*s.* 9*d.*; 1860–61, 3*s.*; 1864–65, 3*s.* 4½*d.*; 1869–70, 4*s.*; 1875, 6*s.*; now 4*s.* The incidence of this tax resulted in a very small amount of salt-fish being prepared with monopoly or taxed salt for local consumption, and a little for export

* The Madras Revenue Board (May 14th, 1873) observed that the fishermen numbered throughout the Madras Presidency 394,735 persons; that the answers elicited by the questions put by Dr. Day, &c., have directed the attention of the Board to the subject of the influence of the salt-duties on the trade of fish-curing, and they see reason to think that a great practical hardship exists, which they would advocate immediate endeavours to alleviate. That this is being done will be shown by the following extract of a letter from one of the Members of the Revenue Board at Madras, who observed on November 8th, 1882, "The industry (of salting fish) is really commencing at last: 400 tons more were salted this year than last, and 80 more yards for curing are to be opened in a month or two." The amount cured in the Madras Presidency was 1734 tons in 1882.

to Ceylon ; but the amount of this condiment employed by fish-curers cannot be great, as it makes no perceptible figure in the quantity of salt disposed of. During the last few years the system of bonded enclosures, within which fish may be cured with free salt, has been tried at Madras, and it appears to be working so successfully, that it is hoped it will be found practicable to introduce it to all other parts of British India.

In Bengal, excised salt appeared never to have been employed for fish-curing, and the fisheries were in a neglected state; or, as observed by the collector of Balasore, "Fish sold in the markets are so stale that no European would touch it, and most of it is putrid. . . . The people in this district do not salt their fish, they dry it in the sun, and eat it when it is quite putrid. They like it in this way, and there is no reason why they should be interfered with." Salt was then (1870) subject to a duty of ten shillings for $82\frac{2}{7}$ lb. weight. Further to the eastward, in Burmah, the salt duty was one shilling for the same quantity, sun-dried fish a rarity, the fisherman's trade flourishing, while salted fish or crustacea, in the form of *nga pee,* invariably formed part of every meal among the indigenous population.

The amount of salt which must be employed in order to properly prepare a given quantity of fish is about as follows:—In Sind 20 lb. of monopoly salt is added to $82\frac{2}{7}$ lb. of fish ; on the western coast of Madras, as Tellicherry, 28 lb. of salt is used to $82\frac{2}{7}$ lb. of small fish, as mackerel, herrings, &c. It appears that, for the purposes of trade, one part of monopoly salt is necessary to about three parts of fish. However, at Gwadur, in Beloochistan, where this condiment is very cheap, a larger proportion of it was used than in either Sind or in India. Fish cured with salt-earth, or spontaneous but untaxed salt, require a much larger amount of this antiseptic than they do of monopoly salt, or nearly three (upwards of 2½) parts of salt earth to one part of fish. This cost of salt, it will be perceived, must have a direct bearing upon the usefulness of the fisheries; where it is cheapest (other things being equal) the fisherman's trade will be most developed. Along the coasts of Beloochistan, where there was no salt-tax (1873), large communities were entirely supported by fisheries, their captures being cured and exported for the Indian or Chinese markets. The same remark applied to the Portuguese settlements of Goa, Daumaun, and Diu, the salt used there costing about threepence per $82\frac{2}{7}$ lb. weight, whereas in the contiguous British territory it stood at the salt-pans at about four shillings. Hence the foreign fishermen were able to freely use this condiment; the cured article was preserved in a superior manner, more wholesome to the consumer, and able to be carried further inland.

The following return shows the amount of dried and salt fish (in maunds) despatched inland from Bombay and other stations on the Grand Trunk Peninsular Railway, for ten years ending 1881, and shows how the trade is developing:—

1872—21,837	Maunds.
1873—22,839	,,
1874—20,608	,,
1875—25,563	,,
1876—23,690	,,
1877—25,718	,,
1878—33,916	,,
1879—35,885	,,
1880—42,011	,,
1881—45,192	,,

A few years since, fisheries thrived along the Beloochistan coast and the Portuguese settlements, due to the excise on salt being not excessive or entirely absent. In the Bombay Presidency, the fisherman's market became restricted to the sales for immediate consumption, or else for sun-drying, or, as the Collector of Tanna observed, "Whether fish is dried as above, in preference to its being salted, is a question I have been unable to ascertain. It is very probable that it has been resorted to in the place of curing by salt, consequent on the excise duty levied on salt." Wherever salt-earth could be obtained free of duty, along the western coast of Madras, there the fisheries thrive, the fish-curer requiring a large supply of fish. Along the east coast of Madras, the collection of salt-earth was more or less prohibited, and the fisherman's trade, except near large towns, the reverse of flourishing. But in Bengal the fisheries are, or were, worst off, the only curing fish obtained being sun-drying. Lastly, in Burmah, where salt is cheap, the fisheries were thriving. Before concluding this portion of my subject, I would observe that it is not to be supposed that fish cured with salt-earth are of the best quality; on the contrary, it imparts a bitter and unpleasant flavour, and is believed to engender disease. But the poor cannot be particular respecting the taste or smell of their food—expense being usually the most important consideration. Salt-earth costs about ½*d.* a basket of 144 lb. weight, depending upon its quality; but, as I have remarked, it requires treble the amount to what is necessary if excised salt is used. But 82$\frac{1}{7}$ lb. of monopoly salt was taxed 3*s.* 7½*d.* at this time; now 4*s.*; whereas 246 lbs. of salt earth cost from ¾*d.* to 1*d.*, and this is evidently the reason of the latter being preferred by fish-curers for the purpose of preparing fish for the trade; for if monopoly salt, at its present rate, were used, the article, at least to the general public, would be beyond their means, and simply unpurchaseable. The reason why the plentiful harvest of fish in the sea remains ungathered is not due to the apathy of the fisherman, or the unwillingness of the general public to be consumers of fish, but is solely a result of the cost of salt, and that due to the Indian salt-tax, a condition of things which it is hoped is being slowly ameliorated.

Having thus briefly adverted to how the fisherman's and fish-curer's occupations are injured by the incidence of a heavy salt-tax, I pass on to the fishermen and their condition, as it was a few years since. Doubtless, should no sufficient market exist for the produce of their industry, some of these people must cease fishing, and engage in other pursuits ; while those who remain to make a livelihood, as did their forefathers, seek the cheapest way and easiest method by which such may be accomplished. A very little acquaintance with the habits of fish suffices to teach the fisherman that the smallest kinds and fry are taken with the greatest ease ; as, preferring the vicinity of the shore, and seeking their food in shallow waters, they are more readily captured in weirs, or with fixed engines and traps, than are the larger, more predaceous, and deep-sea forms. But by destroying or driving away the small fish, crustacea, and minute animal life, the food is being diminished which previously decoyed the larger and more predaceous forms in, thus scaring away what would otherwise be the natural supply. The fisherman's business is to supply personal requirements and family wants ; consequently, if he obtains as much of the finny tribes as he can find a market for or otherwise employ, no injury is inflicted by his proceeding. For, so long as salt is not available for the purpose of curing any surplus, meeting the small local demand for fresh fish is all that is really requisite.

The deep-sea fishermen—or rather, those who ply their occupation outside the shallow waters of the littoral zone—

as a rule do so by means of nets, stakes, or with hooks and lines. Deep-sea netting is not carried on to any great extent, partly because of the insufficiency of a market to render such remunerative, and likewise owing to the expense which would be necessary in obtaining the requisite nets, and the cost of building seaworthy boats. Fishermen are not to be classed among the richer classes, but have to borrow money, which is lent them at exorbitant rates of interest, wherewith to supply themselves with the requisites for their work. As an instance, in Sind a net suitable for sea-fishing would involve the outlay of £40 or £50, while it does not usually last more than a year. A boat costs about £100, and ought to be serviceable for several successive seasons. The money having been borrowed, the fisherman, who is the borrower, disposes of his captures at half the market rates to the money-lender, still this leaves a profit due to the existence of a good market for the fish-curer's trade.

Along the coasts of Sind large nets for sharks are employed in the comparatively deep sea; while off Malabar during the mackerel and sardine seasons, drift-nets, having a mesh suited to the size of the species it is desired to capture, are used for taking these two descriptions of fish, as well as for the seir fish (*Cybium*) and horse mackerel (*Caranx*), but not expressly for any other sorts. Also in the vicinity of large towns, or where a great demand exists, stake and other nets are somewhat largely employed. In some places fishing by hooks and lines is much pursued: not so in others. The modes of capture may be divided into two descriptions: *first*, the larger hooks used for sharks and other predaceous forms when they are connected by a chain to a strong cord; *secondly*, the smaller kinds of hooks used in catching sea perches, maigres, polynemi, and other eatable or valuable species. Occasionally artificial baits are also made use of. For embarking upon these last descriptions of fishing, a large capital is unnecessary, at least in such districts where catamarans or rafts are employed. When line fishing is carried on off coral reefs, as at the Andamans, large numbers of hooks are lost, due to the hooked fish dashing into or below the coral, when the lines become severed. In certain places, as at Kurrachee, for line fishing, moderately sized boats are employed, prawns being considered the most killing bait. In some boats captured fish are opened, cleaned and salted while at sea, and in others the whole of this process is carried out on shore. This is especially the case along the western coast of India, because the fisherman can obtain salt at Goa or other foreign settlements at $4\frac{1}{2}$*d.* to *6d.* a maund ($82\frac{2}{7}$ lb.), take it out to sea, capture and salt his fish there, and then run in and dispose of them at a British port.

The salt-water fisheries of India and Burmah are carried on by means of various contrivances from the most primitive to elaborate labyrinths ; also in many other ways in the deep sea. Without entering upon a detailed description of each, with the variations noted in the several districts, perhaps it may be better to briefly advert to the chief characteristics observed.

First, there are tidal fisheries, the most primitive type of which is when pounds are constructed, or tidal ponds made use of, where the fish which enter with the flood are left impounded on the ebb occurring ; from such a place they sometimes have to be removed by scoop, lave, cast, or other nets ; or a very rough stonework may be employed to bar the outlet to the fish, but through the interstices of which the water is able to escape. Bamboo, rattan, reed, or other screens constructed in various ways may also be used to preclude the escape of the imprisoned fish. Slightly in advance of these pounds, frequently constructed at the head of an estuary, are wicker-work labyrinths placed at right angles to the shore, or else acting like a pound in permitting the fish to enter with the flood, but precluding exit with the ebb.

Probably as the supply from pounds became insufficient, stake-nets were constructed where suitable currents exist, and these are now among the chief means of obtaining a supply of fish along some portions of the coasts of India. The stakes which are employed are usually made of the stem of some species of palm-tree or jungle wood, and up to as much as 100 feet in length. They are placed at right angles to the shore, and driven perpendicularly into the mud to a depth of twelve feet or more, and at a distance of about twenty-five feet apart, while to them nets, mostly constructed of hemp, and of a bag or funnel shape, are fixed. These bag-nets are up to great lengths, as forty yards, and are composed of meshes, diminishing from two inches between knot and knot, to half an inch at the apex. Into these nets the fish are carried by the tide or currents which exist even far out to sea, while fishermen are waiting to secure the captures. Trammels are also employed.

Another mode of sea-fishing is by means of a stationary dip-net; this in Malabar is worked from a frame-work situated upon the river-bank, where the tide ebbs and flows; an addition to this is used in China, where the dip-net is worked from a boat or a platform. Slightly in advance of these fixed nets are purse-nets, fixed in bamboo frames and capable of being dragged up narrow pieces of water, or lave-nets set in triangular frames, and which can be worked by a single man up shallows, or a row of fishermen can employ them along suitable places on the coast. Next we find the cast-net, which can be carried from one spot to another, as requirements dictate; occasionally several are joined together, thus constructing a drag-net. There are simple nets with floats, which are either without sinkers or with them; some employed near the shore have a bamboo at either end. There are purse-nets and bag-nets, some with, others without, pockets; some for drifting, others for being dragged or fixed; as well as special nets for various purposes, some of which have more complicated arrangements, while the size of the mesh is constructed in accordance with that of the fish it is intended to capture.

One of the most primitive forms of implement for the capture of fish, and which is extensively employed in the East, is cone or bell-shaped, made of pieces of split bamboo or rattan, the lower end of this cone being open, while at its upper end is a small orifice through which the fisherman can pass his hand and remove the captures. In many places rows of fishermen, each armed with one of these primitive implements, work a tideway, and often with good results, especially among grey mullet and small fish; or the upper end of this cone may be closed, forming a handle, while a rope-handle is affixed to the larger extremity, and it is thus employed as a scoop. A similar cone, but closed at its narrow end, and having a second one inserted into the larger extremity, when laid flat constitutes a trap which can be used in weirs or elsewhere. From these have sprung a most varied assortment of wicker traps, many resembling in structure rat-traps; some are baited, others simply inserted in tideways for the purpose of taking fish or crustacea. An enumeration of all forms would be endless. Triangular lave-nets used by a single fisherman are also constructed of split bamboo as well as of net.

In some places on the Andaman Islands, the fishermen to this day can obtain fish by diving, the use of spears, or shooting with bows and arrows; these latter having the shaft in two pieces attached together by a piece of string. The upper end of the shaft is made of reed which will float in the water, and as soon as the game is struck, the arrow separates into two parts (these being connected by string), and the fisherman obtains possession of the floating portion, and thus secures his prey. Hooks and lines are used in many places, and also artificial bait of the most primitive description in imitation of flying fishes (Plate IV., Fig. 3), and which is towed at the stern of boats when it is desired to take seir and other large fishes. In many parts crustacea are scarcely fished for, except as bait for line fishermen; in other localities, as Cochin, Madras, Calcutta, and Burmah, they are extensively captured. In taking crabs, an iron hook is inserted into the cavities of rocks where they exist, and by it they are removed.

The sea fishermen belong to the servile class or Sudras, according to the ancient legislators of Hindustan, and in most parts of the coasts of India still maintain that they were, in times now past, divided into two distinct classes—(1) those who captured fish in the deep sea, or beyond their own depth; and (2) others who fished from the shore and in the backwaters and creeks. But that now, owing to the depressed condition of the fishing trade, the deep-sea fishermen (except where salt is cheap or a good market exists) have taken to the less expensive occupation of plying their work in-shore, and earning a portion at least of their living by engaging in other pursuits. In several parts of India, more especially in the Madras Presidency, they have customs of a patriarchal nature, but which are more strictly observed on the Coromandel than on the western coast. In Sind the fishermen termed Mohanees are a

Mussalman tribe, composed of immigrants from Arabia, or the descendants of Hindus possibly converted by their conquerors to Islam. The divisions are each under their own chief, who is hereditary, and his business is to settle caste disputes and other trifling matters, also to conduct the religious ceremonies connected with marriages and deaths. In Bombay, as in the Deccan and Carnatic, they claim to be a sub-division of the Mahrattas; while in the Madras Presidency, headmen to the fishing castes exist; in some localities they are hereditary, in others elective; or, should there be no headmen, matters are laid before certain wealthy individuals of their own caste, whose decision is final. In places where the fishermen are native Christians, the priest is frequently appealed to in order to settle such disputes as arise.

In olden times the fishing castes were commanded by their own chiefs, who appear to have been constantly ready to engage in military expeditions. The Samorin, in 1513, sent a deputation to Portugal, and his ambassador, who turned Christian, was knighted, under the name of "John of the Cross," by John III. On his return to Malabar, he was banished from the Samorin's court, as a renegade from the faith of his fathers. In 1532 he joined the fishermen, by whom he appears to have been installed as their chief, as he headed a deputation of eighty-five of them to Cochin, soliciting the assistance of the Portuguese against the Mahomedans. The whole of the embassy are said to have become converts to the truths of Christianity, so a Portuguese fleet was sent to their relief, and 20,000 are reputed to have immediately consented to be baptized. Ten years subsequently, Xavier instituted a church for these people.

It appears probable that the present organisation of the fishing classes is the remains of some ancient system, for on no other supposition can the existence of individuals holding such extensive sway be accounted for. The village or patriarchal system of an elective headman to such of his caste as inhabit each street and hamlet, is what is seen elsewhere among other classes; so likewise is the hereditary headman over several villages. But among the fishermen there exist priestly chiefs, two of whom in the Madras Presidency are to be found on the Eastern coast, one being at Madras and the other at Cuddalore, the territory of the former stretching up the Coromandel coast, while that of the latter reaches towards Cape Comorin. A third is found in South Canara, where he exercises spiritual control over a large district, and it is by no means improbable that others may exist. These chiefs, whose offices are hereditary, claim or receive fees and fines from those of their caste living within their jurisdiction, and they are the final referees in all cases of caste or family disputes.

The next grade is also hereditary. These mere petty chiefs or headmen only hold sway each over a few villages; their duties are the same, and some of their fees seem to have to be transmitted to their superior. On one of these headmen dying without heirs, a new one is elected by the people of the caste. Lastly, the fishermen have the elective headman, who is chosen by the residents of a single hamlet; his duties are to decide disputes, to be present at marriages and religious ceremonies, often to fix the work, and assist in certain Government duties; his emoluments appear to be very trifling.

Passing on to the condition of the fishermen (as it was a few years since) in Sind, they have to pay a tax of 10*s*. a ton yearly on their fishing boats, while the rate at which they borrow money for the purpose of procuring boats and nets I have already alluded to. Here these people are well off. At Guzerat, in Bombay, the fishermen are poor, and the precarious living they make often induces them to accept service as sailors, labourers, or anything that ensures them a steady competence. Although following out the condition of the fishermen in various districts must have rather a sameness, it will be necessary to do so in order to clearly see whether these people are really in a prosperous or in a poverty-stricken condition; whether, in short, it is the case that they are in the utmost misery, not due to their own laziness, but as a result of British legislation imposing prohibitory duties on salt. In the Junjura district, the fishermen supply themselves with boats and nets; six or ten club together to obtain a boat and net, dividing the produce; here they have decreased in numbers, at least, up to the year 1873 when my inquiries terminated. At Broach they are also said to have diminished. The same report comes from Kaira. In Rutnagiri the practice of salting fish has decreased during the last fifteen years, in consequence of the increase in the price of salt, but the fishermen are said to have increased. If, however, the practice of curing fish has decreased, while the number of fishermen has augmented, such must be due to a greater demand for fresh fish, or else the fishermen, from increased numbers, must be worse off than they previously were, or be engaged in other occupations as boatmen. However, the official from Kanara gives a similar reply. The Commissioner observed that at present no larger number of men are engaged on fisheries than are required to provide sufficient for local consumption. The practice of curing fish has to a great extent diminished, owing partly to the falling off in the amount usually captured, and also the duty charged on salt in British territory.

In the Madras Presidency, we are informed that, in the

Tinnevelly Collectorate, the fishermen, as a rule, were a very miserable lot of people, and excessively poor. The way in which they work is by a system of advances made by traders, a few of whom reside in each fishing village, and supply all the requisites for fishing, as well as the boats, taking one-third of the captures as their share. In the Nellore district, although no one claims exclusive rights to the sea fisheries, the inhabitants of the different villages are exceedingly tenacious in order to prevent fishermen from other localities plying their occupation within what they believe to be their limits; this, however, is by no means restricted to this district, but is common throughout most portions of the sea-coast of India. In the South Canara district, where the use of spontaneous salt is, or rather was, not prohibited, the number of sea fishermen is stated to have increased of late years. This augmentation has been computed as high as 15 per cent. The same symptom of prosperity was reported all down the Malabar coast. At Ponany there is an annual increase in the number of fishermen. At Cannanore the owners of boats and nets supply them to these people, as well as advance certain sums of money. The money-lenders sell the captures, half the proceeds going to either party; if, however, the take is insignificant, the boat and net owners surrender their share to the fishermen. A like plan obtains at Tellicherry, where the fishermen have framed rules for their own guidance, one of which is the right of the first discoverer, among a lot fishing together, to a school of fish: he is allowed to capture them without hindrance from the others, even though at the time when the fish were discovered he was not prepared to launch his net. Passing out of the districts where the free collection of salt-earth is permitted, another change for the worse in the condition of the fishermen is reported. In Madura it is said that, on the whole, the sea fishermen have increased, but that the aboriginal fishing castes have decreased, owing to emigration or their becoming sailors. At Ootipadaram the native official estimates the daily earnings at threepence, taking all the year round, and excluding costs, and at Munjery at from three-halfpence to ninepence, while at Tenkarei their earnings are computed at from threepence to one shilling a day. In the Tanjore Collectorate, they are reported to have decreased in some places, but remained stationary in one locality. A little better report comes from Madras, but there the fishermen are also employed as boatmen, which is very profitable, while the vicinity of large stations affords a ready sale for fresh fish. Without tracing out the condition of these people in each district on the coast, it will be sufficient to say that they are poor and miserable, but not so badly off as in the Bengal maritime districts, where they appear to be quite poverty-stricken, unless near large towns. Passing on to Burmah with its cheap salt, we find the sea fishermen well off.

If we survey the reports from all the sea districts of India, we find the fishermen well off in Sind, while, unless in the vicinity of large towns, they are miserably off in the Bombay Presidency. Along the western coast of Madras, with its untaxed salt-earth, these people prosper; but once round Cape Comorin, where the collection of spontaneous salt becomes a penal offence, they become, as observes the Collector of Tinnevelly, a very miserable lot of people, and such is the same account all up the Coromandel coast, except where there are large towns. With poverty we find them reported to be decreasing in numbers, due to cholera or other diseases, emigration, or accepting service as Lascars in coasting vessels. These are a people who in olden times were among the most prosperous of the inhabitants along the coasts of India; who, when the Portuguese first landed, were able to bring large armies into the field; whose occupation is now but too little considered by some of our Indian officials—as an European civilian remarked, that sympathy ought not to be wasted on fishermen, for they are an independent, careless, and drunken set of men. This gentleman appears to have placed upon official record what are probably the feelings of many who are unacquainted with the state of this trade, for by careless and independent is probably meant idle, which idleness is due, first, as I have already explained, to the incidence of the salt-tax; and, secondly, that when salt is unobtainable, did they exert themselves, the market would become overstocked.

The result of the investigations I conducted in India led me to conclude that wherever a good local demand existed for fish, the fishermen were in a prosperous condition. Wherever salt was dear, the fish-curers' trade was restricted or destroyed, and as a result the fishermen were in a depressed state. That fish salted with taxed or monopoly salt is a luxury for the rich, the sick, and for export: that such as is prepared with salt-earth keeps badly, and predisposes to disease. That in many localities where the salt-laws were rigidly enforced, the poor had to consume their fish putrid, or simply immerse it in sea-water, and then dry it in the sun. In short, it was patent to most that the depressed condition of the fishermen and fish-curers' trades was to be found in the incidence of the salt-tax, and that those who deprecate any interference with the poor fishermen, on the ground of their miserable state of destitution, must be unaware of their real condition. One cannot suppose such advisers to be oblivious of the distresses of those among whom they reside, or would desire to feed the poor on putrid fish, on the consideration that the realisation of the salt-revenue is of much greater importance than the lives, health, and comfort of their fellow-creatures. Assisting fishermen with money, boats, and nets would be insufficient to place the sea-fishermen and fish-curers' trade in a healthy state, while if it is in a healthy condition such advances are unnecessary. Expensive salt is beyond the reach of the majority of the fish-curers, it is ruinous to their trade, and in the ruin of the fish-curer the fishermen must eventually participate. It is to be hoped that the endeavours now being made to re-introduce prosperity among this numerous class will be productive of the greatest benefits, not only to themselves, but by augmenting the food for the general public.

Fresh-water fisheries differ in many respects from marine ones; while, wherever any quantity of fresh water exists in the East, there we are almost certain to find fish; and this from a sea level to nearly the summit of the highest mountains. Consequently, fishing is had recourse to, in various manners, in rivers, irrigation canals, lakes, tanks, ditches, inundated fields, and swamps. The importance of such fisheries is not solely in a ratio as regards their productiveness, but also in accordance with the character of the adjacent people as to whether they are or are not fish consumers; while the sparsity or the reverse of the population has also to be taken into account.

Should no regulations be in force for the protection of inland fisheries, and other circumstances be equal, that district which is most densely populated by man will be least so by fish. Individuals can more readily live by fishing than by agriculture, as the trouble of capturing the finny tribes is considerably less than that of tilling the soil. But unregulated capture is simply catching food without a thought respecting future supply. Fish have been endowed with certain means of increase and protection—the number of their eggs may be enormous, and sufficient to counterbalance natural waste. The operations of man, however, are in excess of natural waste, consequently such a destructive agency requires to be kept in some check. In India certain forms of fish keep guard over their eggs, and likewise over their fry, in order to afford them protection from their enemies.

When man increases, watery wastes (wherein the fish had been protected by grass, reeds, bushes, and the roots of trees) become drained and cultivated ; predaceous man increases his means of destruction ; an augmented population, possibly assisted by the unscrupulous manufacturer or miner, pollute the previously wholesome water, and a diminution of the finny tribe becomes apparent to the investigator.

With an increasing fish-eating population, an increased supply of fish is a self-evident necessity, and this must be provided for by augmented captures or dearer prices, the latter acting as a check on the poor, by more or less placing it out of their reach. This latter result may, consequently, eventuate in gradually diminishing the physical strength of the people by decreasing their food, a proceeding which will scarcely bear examination. It is clear that a greater supply must be met from one or two sources, either from fisheries which previously have been insufficiently worked, or by overworking such as exist, by means of capturing, for present use, those which ought to be left for a future season. Even if the extent of the water is so great, and the contiguous inhabitants so few, that this result need not be anticipated for several generations, still, populations under good systems of government have a natural tendency to increase. Means of carriage generally improve with time, and should neither regulation nor care of the fisheries be attempted, disastrous results must eventually be arrived at, unless the finny tribes by means of artificial propagation are kept up to the required numbers. Fish appear to have but few friends and many enemies, and investigations as to their condition but too frequently end in giving increased licence to their captors. We see interested parties and philanthropists (so-called) exclaiming against the hardship to the poor in not allowing every available fish to be secured. The majority of our law-makers are content to allow the fish to shift for themselves, and to leave the fishermen to be controlled simply by their own consciences. To-day's market it is hoped will be supplied, sufficient for this season it is believed may be obtained, so to-morrow's wants are left to be met as they can, until the time arrives when depletion of fisheries becomes obvious, when, if the fault cannot be laid upon meteorological or other conditions, something has to be attempted.

The fishermen of the fresh waters of India and Burmah are divisible into two main classes—first, such as follow this calling as their sole means of livelihood; and, secondly, such as engage in it only occasionally, and as a subsidiary occupation. Who, then, are these Indian fishermen? Here, even within the limits of a single, or at least of a few generations, great innovations have crept in, for in the time of native rule, fishing was in the hands of distinct castes, but now it is only here and there that one comes across some remnants of these people, living in small communities, and frequently in the greatest poverty. At Combaconum, in Madras, there is a tradition that the fishing castes resident there were originally brought from Conjaveram as palanqueen-bearers; while, at Broach, in Bombay, two sub-divisions of these people are named in accordance with the villages from which they originally migrated.

In native States, fish have obtained great consideration, more so perhaps in ancient than in our own times. Thus in Mysore, in the time of Hyder Ali, very stringent fishery laws existed; whereas, at the present day, about two-thirds of the population of some divisions of the country occasionally add fishing to their other occupations, nearly every villager possessing a fish-net or trap, to be employed as occasion or opportunity arises. Now fisheries are open to all; a fisherman's calling is no longer a profitable one, mainly due to the fisheries being depopulated. When whole districts were let to contractors, they were not so short-sighted as to permit an indiscriminate destruction; but now everybody does as he likes, when he likes, where he likes, and how he likes. Thus it has come to pass that among the animal productions of India, fresh-water fish meet with the least sympathy, and the greatest persecution, many forms having to struggle for bare existence in rivers which periodically diminish to small streams, or even become a mere succession of pools, or in tanks from which the water totally disappears. They have their enemies in the egg stage, in their youth, and during their maturity; but among these man is their gretest foe, as anyone who desires a fish diet captures these creatures whenever and wherever he gets the chance, irrespective of season, age, and size. In certain districts they simply appear to exist solely because man and vermin have been unable to destroy them.

Fisheries may be let to a contractor, and if their extent is large he takes partners or sublets portions; sometimes he employs servants, who are paid partly in money, or food, clothing, and lodging, and partly in a share of the captures. In some districts the fisheries, or a portion of them, are declared free, but a licence fee is charged to the fishermen. Or the general public is permitted to take fish for home consumption, but not for sale. Lastly, no regulations at all may exist, due to the general poverty of the fisheries, peculiar difficulties in their capture, or the general impecuniosity of the inhabitants.

When the public have, more or less, depleted fisheries, the fishermen become poorer and poorer, unless they turn to other sources of obtaining money; at first, no doubt pleased at the remission of rents, and the removal of all restrictions upon fishing, they employ redoubled energy, and thus augment their immediate profits. But soon the general public find that nothing precluded their fishing in any way they please; the markets become glutted, and the price may fall from the want of purchasers. But after two or three years fish become scarcer; fishing is no longer remunerative; removing the rents from fisheries and throwing them open to the public will not decrease the price of fish. The rates ruling in India are comparative to what obtains for meat and other articles of animal food. Fishermen, living on free fisheries, do not dispose of their captures below market rate any more than farmers who possess rent-free farms sell the produce at less than their neighbours, while perhaps one of the widest spread fallacies of the present day is, that permitting fisheries to be free of rent and unrestricted by regulations, is beneficial to the fishing population. If the fisherman benefits, the purchaser does not, and their misapplied energy eventuates in nothing but small fish remaining. The young have to be raised from ova of such as are merely one or two seasons old, while the younger the parent the smaller the eggs, and this is probably one mode in which races of fish deteriorate.

The rivers which have Alpine sources, as such which descend from the Himalayas, have, exclusive of springs, two most abundant sources of replenishment. During the hot months this is derived from melted ice and snow, while during the monsoons the rains assist; we may then have the hill rivers forming torrents, rising rapidly, and as rapidly subsiding, while they possess no contiguous tanks into which the fish can retire. These animals are often peculiar, or endowed with means of existence differing from such as live wholly or mostly in the waters of the plains. Many of the fish are provided with adhesive suckers, situated behind the lower jaw, or placed on the chest, which enable them to fix themselves against rocks, and so prevent their being washed away by the stream.

Through the cold months, and generally until the setting-in of the south-west monsoon in June, rivers are at their lowest, some at this period (especially in hilly regions) being merely a succession of pools, united by a more or less insignificant stream, in which limited localities the fish take refuge, and may be easily secured by fishermen.

Among the artificial causes affecting fisheries in many districts are the irrigation works, which are formed by throwing a weir or bund across a river, and diverting a large amount of its water down a main irrigation canal. These weirs are usually built as stone walls across the entire breadth of rivers, and consequently impede both the upward and downward passage of fish that are endeavouring to migrate, while should they be sufficiently high, they entirely stop them. Where large under-sluices are present, fish can pass up such when open; but up the long narrow ones, as constructed in Madras, the strength of the current renders this impossible. The under-sluices are here closed, except where there is an excess of water, as during the monsoon months; and as the weirs have no fish-passes, not only is ascent towards the breeding-grounds intercepted, but fishermen take the opportunity of capturing the fishes which are detained here. Standing on those weirs, one can see the fish jumping against the obstruction, which they vainly hope to surmount; some strike against the piers of the bridge, others fall into the cascade which descends over its summit; but to them the wall is an impassable obstacle.

The irrigation canals may be said to be streams obtained by diverting a large amount of water from a river into a new channel, and this, of course, would be taken from above the weir; consequently, all fish descending the river become diverted into the irrigation canal. If these canals are constructed for navigation as well as for irrigation, the fish can pass along them; but if due to falls, they are unsuited to navigation, then the fish can descend them, but are unable to re-ascend. They thus become vast fish traps, wherein all the finny inhabitants are destroyed whenever the canals are run dry in order to examine their condition in order to see what annual repairs are necessary. Passing off on either side of these canals are lateral irrigation channels, which are employed to directly water the crops, and at each successive replenishment of these, another shoal of fish passes to inevitable destruction. Unprovided with gratings at their entrance, and only kept filled on alternate weeks, all the fish which enter invariably perish. The same destructive process exists throughout India wherever irrigation is carried on.

As the yearly rains cause inundations of the country by the overflowing of the rivers and tanks, fish move about in order to find suitable localities for breeding in, and the small streams and their outlets resemble the net-work of irrigation channels. Many species ascend them to spawn, but find, at every turn, appliances invented by man ready for their destruction. Persons may be watching to intercept them, engines or traps may be fixed in their course; or, should any breeding fish succeed in effecting their ascent, means are taken to ensnare them on their return, whilst the fry are destroyed in enormous quantities—a proceeding which has been declared not to be waste because they are eaten.

Then there are tanks, some of which are, others are not, in connection with running water. Should they entirely dry up during the hot months, only such fish as bury themselves in the mud will survive to the next rainy season. As a rule, the owner of a tank, if it is employed also for fish-culture, leaves one portion (the deepest) in order to retain sufficient water to keep the finny residents alive, while, during the hottest weather, boughs of trees or tatties are placed over this locality to mitigate the heat.

The fishes which inhabit the fresh waters of India, Burmah, and Ceylon, may be divided into (1) those which enter from the sea for breeding or predaceous purposes; and (2) such as, more or less, pass their lives without descending to the salt water.

An exhaustive account into the strictly fresh-water forms would doubtless be interesting scientifically, but hardly so to the fisherman or general reader; consequently I shall restrict myself to observing that the fisheries alluded to contain about 369 species, appertaining to eighty-seven genera. Of the spiny-rayed, or *Acanthopterygian* order, we have nineteen genera, the members of which are most numerous in the maritime districts and deltas of large rivers, while their numbers decrease as we proceed further inland. Few are of much economic importance, if we except the common goby, spine-eels (*Mastacembelidæ*), the snake-headed walking fishes (*Ophiocephalidæ*), and the labyrinthiform climbing-perch and its allies. Among these forms, the semi-amphibious walking fishes deserve especial notice, owing to their great economic importance. When pollutions or poisonous substances find access to rivers, or mud is carried down in such quantities as to choke the gills of most forms, these Ophiocephalidæ are almost unaffected, for breathing atmospheric air direct, the presence or absence of fluviatile contamination is not of such material consequence to their existence. They are able to live until the poison has passed down-stream and the waters are again purified. Of the sheat-fish, or scaleless siluroids, we have twenty-six genera; the mouths of these forms are provided with sensitive feelers, which, serving as organs of touch, assist them while seeking their prey in turbid waters. All that are of sufficient size are esteemed as food, although, owing to their propensity for consuming unsavory substances, their wholesomeness appears, at times, to be questionable. The next three genera, gar-pike (*Belone*), Cyprinodon, and Haplochilus, are of but little value, but the thirty-five genera of carps and loaches are of the greatest possible consequence, affording a large amount of food to the population of the country. The remaining four genera, consisting of the curiously flattened *Notopterus*, and three forms of eels, are of but little mercantile importance.

The various modes in which the reproduction of these fishes is carried on is a most necessary investigation, and in briefly considering such, we must inquire into what migrations they undertake for this purpose? Whether the parents are monogamous, polygamous, or are annuals dying after the reproductive process has been accomplished? The time of year when spawning occurs? Whether such is or is not deleterious to the parent? The size of the eggs, their colour; whether they float or sink; are deposited in running or stagnant waters? If they are covered or left uncovered in their nests? If the male carries them about or protects them? Can their germination be retarded by artificial means or natural causes, as by the action of cold or their immersion in mud?

That anadromous forms, as the salmon or shad of Europe or the hilsa (*Clupea palasah*) of India, pass from the sea to the fresh waters to deposit their eggs in localities most suitable for their reception, is well known. If we examine into the migration of Indian fishes for breeding purposes in fresh waters, we find such takes place under three conditions, viz.:—(1) anadromous forms from the sea to the fresh waters, as already adverted to; (2) such species as may be considered pertaining to the mountains, or else deposit their ova in the rivers of the hills; (3) such as are restricted to the plains, but which likewise undertake certain changes of locality at these periods. Of the migratory hill fishes, the various forms of large barbels, *Barbus*, termed *Mahaseers*, furnish good examples. In the Himalayas they ascend the main rivers, but turn into the side streams to breed; while on the less elevated Neilgherry mountains in the Madras Presidency, the same phenomenon occurs, but with this difference, that they deposit their ova in the main streams because such are small, and perhaps due to their never being replenished with snow-water. Occasionally the fish are too large to ascend these mountain rivers, when they would appear to breed at the bases of the hills; whether it is from the offspring of such that this genus has extended through the plains it is not my purpose to inquire in this place. When the rivers commence being in flood, adults are able to ascend to feeding grounds which were previously inaccessible to them. Having spawned, they keep dropping gently down stream, during which time the amount of water is diminishing; thus the ova, when hatched, are completely cut off from the locality where their parents reside, precluding the possibility of their devouring them. The fry, consequently, have the heads of the rivers to themselves in perfect security, and each torrent becomes transformed into a small stream intersected by pools, where they can remain until the next rains enable them to descend to the larger rivers. Of the migratory fishes of the plains, we may observe many forms of carp, and this is more particularly perceptible where impassable weirs exist across the rivers; here they may be perceived attempting to jump over the obstruction, and so common is this phenomenon that the natives of India hang baskets, cloths, even native cots turned upside down, or anything equally suitable, over the sides of the piers, and into this the fish fall.

In Asiatic waters we have monogamous and polygamous forms of fish and other phenomena as to breeding, which deserve attention. The walking, or snake-headed fishes, *Ophiocephalidæ*, of India, and other amphibious genera, are perhaps the best known of monogamous fishes; some of them reside in ponds, others prefer rivers, where they take up their residence in deserted holes, which they find in the banks. The pond species delight in lying at the grassy margins, where the water is not deep enough to cover them; and here they are able to respire atmospheric air direct. The striped walking-fish constructs a nest with its tail among the vegetation, and bites off the ends of the water weeds; here the ova are deposited, the male keeping guard; but should he be killed or captured, the vacant post is filled by his partner. The hissar, *Callichthys*, of South America, is likewise monogamous, constructing a nest which it also defends. The majority of fishes unquestionably are polygamous, as has been repeatedly observed, and perhaps as distinctly among the salmon as any other form in a wild state, and likewise in sticklebacks resident in aquaria; while, doubtless, fishes which migrate in shoals for breeding purposes, as the mackerel, herrings, or some forms of carp, are all polygamous.

The time of year at which spawning is effected varies in accordance with the locality and the family of fish. This again appears to be further susceptible of modifications in accordance with the temperature of the water, and many other local causes, while there are some fishes which only breed once a year, others more frequently. I must here premise that some fishes do not appear to feed during the season of depositing their spawn, as the salmon, the shad, and the siluroid *Ariinæ*. In India an anadromous shad termed "Pulla" in the Indus, "Ulum" by the Tamils, "Sable-fish" by the Madrassees, "Palasah" by the Telingis, "Hilsa" or "ilisha" in Bengal, "Nga-tha-louk" by the Burmese, breeds in rivers as already described. In Sind they ascend the Indus in February to spawn, descending in September. In the Cauvery, in Madras, they pass up when the first burst of the June monsoon fills the river, and continue doing so for the succeeding four months. In the Kistna, which has a far greater velocity, but, similarly to the Cauvery, is filled in June, they defer their ascent until September, but it is not until the end of the month, or commencement of October, when the waters are subsiding, and their velocity decreasing, that the majority arrive; whereas in the neighbouring river, the Godavery, in which the current is less rapid, these fishes ascend earlier to spawn, being most numerous from July to September. In the Hooghly they continue ascending throughout the June monsoon, and many are found still in roe in September. The main bodies of these fish ascend the large rivers of India and

Burmah generally when the June monsoon commences, but not always at the same period, such apparently at times being dependent upon the rapidity of the current and other causes. That it is not solely due to the presence of rain-water flooding the river is evident, because those of the Indus and Irrawaddi are mainly caused by melting snows at this period, and likewise in the latter river these fishes push on to Upper Burmah, to which country the monsoon scarcely extends, but where the inundations are due to snow floods. Probably the cause of the majority of fishes at these various periods ascending the different rivers to spawn may be due to their having been bred there, while inherited instinct causes them to select the most suitable times, when the shallows are covered with water, and ascent is rendered practicable.

It is evident that members of the same family, genus, or even species, may spawn at very different periods, due to local or climatic causes. There are also fishes which deposit their ova twice yearly, if not more frequently; these are generally fresh-water forms, and not rare, especially in tropical countries; as an example, we have the walking-fishes.

Whether spawning exercises any deleterious effect upon the parent fishes, two replies may be given, as in some cases it renders their flesh unwholesome, while in others it does not cause their character as to food to be much altered. The shad in the East are excellent eating up to the period when they have deposited their eggs, subsequent to which they become thin, flabby, and positively unwholesome. Fresh-water fishes that deposit a smaller number of eggs, or perhaps do so more gradually, or twice at least during the year, do not invariably appear to be so deleteriously affected by breeding.

The size of the eggs, their colour, and whether deposited in fresh waters or in the sea, are all questions requiring attention. The forms which produce the greatest number of eggs are often those which live in large communities and spawn once a year. In an Indian shad I found 1,023,645 eggs. But other fishes have likewise numerous eggs. I observed 410,500 in a barbel (*Barbus sarana*) ; on the other hand, some have large eggs, as a few of the sheat fishes, and a genus of carps (*Barilius*). In such as spawn at least twice a year, and likewise protect their young, the number of eggs is less than what generally obtains in other genera ; thus in a walking-fish (*Ophiocephalus*), I found 4700.

Respecting the colour of fish eggs, they are very diversified ; in some fresh-water siluroids they are of a light pea-green, as in the scorpion fish, *Saccobranchus fossilis.* Regarding the localities where fish deposit their eggs, these are exceedingly various, as might be anticipated, owing to some sinking in the water, while others float. The gar-fish (*Belone*), and the flying-fish (*Exocœtus*), have filaments springing from their eggs for the purpose of attachment to contiguous objects ; others are covered with a glutinous secretion. In fresh waters eggs may remain at the bottom, either covered or uncovered.

Among the marine siluroids (*Ariinæ*), in some forms the male carries about the large eggs in his mouth until hatched ; or it may be that he only removes them from one spot to another to avoid some impending danger. However this may be, I have netted many along the sea-coast with from 10 to 20 eggs in their mouths, and in one example was a young fry just hatched. In none of these large males was there a trace of any food in their stomachs.

Bloch, at the end of the last century, made many experiments as to the feasibility of fish being artificially hatched, and also whether it could be possible to convey the ova in safety for any considerable distance. He proposed placing the eggs of pond-fish in mud, similar to that existing in the locality from whence the eggs were procured, and he believed that when the mass had dried, they could be thus removed without injury, from one pond to another. His proposal was based upon the theory that frequently on dried-up ponds being refilled with water, young fish appear, and which could only be due to the eggs having been present in the mud, but with their germination suspended. In India, as ponds dry up, some of the fish contained therein descend into the mud, where they æstivate until the next year's rains set in. As these commence, and the mud liquefies, fish are perceived diverging in all directions, up every watercourse, no matter how small, or how lately it may have been dry, while in a few days fry are distributed everywhere. Where the eggs come from which have produced these fry is a very interesting subject for investigation. Have they remained inside the mother fish, and did she deposit them as soon as the rains set her free? I cannot accept this theory, because I have witnessed fish removed alive from the mud, but they had no ova; and secondly, because the fry are so soon hatched after the setting in of the rains, while none of these fish are ovi-viviparous. It seems more reasonable to suppose that the fertilised eggs are embedded in the mud, and, as soon as the rains occur, they become hatched out, and this would give us reason for attempting to ascertain whether ova of pond fishes imbedded in mud could be successfully transported long distances.

We know that germination of fish eggs can be retarded by cold. In fact, by the use of ice, those of trout and salmon have been safely conveyed to Tasmania and elsewhere, and from America and Canada to Europe.

From the information collected between 1869 and 1873, it appeared that the fisheries in our Indian Empire in olden times were royalties, mostly let out to contractors, who alone in their respective districts possessed the right to sell fish, while they, as a rule, permitted the people, on payment, to capture sufficient for their households. It was, in fact, a licence on payment, resumable at will. Remains of this custom still exist in Lahore, while the leasing of fisheries is even now in force in many portions of India. Along the Himalayas, in the Kangra and other districts, the petty rajahs adopted a different method. To some persons they gave licences to supply the fish markets, of which they virtually made them monopolists, while others obtained licences for fishing with small nets for home consumption, but not for sale. In Burmah, under native rule, a similar plan was carried out. There were no free fisheries; but inhabitants had the privilege—or perhaps right—to fish for home consumption on the payment of a fixed annual sum to the contractor for the district in which they resided. It is believed, under native rule, the erection of fishing weirs was permitted in several of the streams in the Himalayas, but not to the extent that they are at the present day. In some districts landowners even now raise an income from the fisheries, claiming a third of the captures or a certain amount of money. Some of cur officials consider that, as Government has permitted indiscriminate fishing, the exercise of long practice has converted such into a communal right.

As British rule has gradually superseded that of the native princes, so the modes in which fisheries were leased has become widely different, and in permanently settled estates, unless a stipulation to the contrary exists, they go with the land. In some localities it has been decided that the adjacent villagers or people possess certain communal rights with respect to them, due, it seems most probable, to a misapprehension. Although it may have been proved that the landowner never received more than one-third of the produce, this does not demonstrate that the other two-thirds were public property, but that such expressed the share accruing to the fisherman in return for his labour in capturing the fish. It is the rule in India and Burmah to remunerate by the proceeds—sometimes the working fisherman has to dispose of his share to the contractor or lessee at a given rate; more rarely the fish are sold, and he receives a proportion of the returns, or he may be paid in kind. In the manual of the Madura district, it is remarked that a letter of 1713 states that the fishery of a single tank produced occasionally as much as 2000 crowns; and that sums so realised were invariably applied to the execution of repairs. In some localities the British Government leased fisheries, or imposed a tax on the implements of fishing, or a capitation tax upon the fishermen, but without interfering with the manner in which the fisheries were conducted. By degrees the tax on fishing implements was taken off, but the fishermen still became poorer, and in 1849, at least in Madras, many leased fisheries were thrown open to the public, resulting, as they were not regulated, in unlimited licence, and thus an intended boon eventuated in their depopulation. In Burmah, the practice of employing fixed engines in irrigated fields and watercourses very largely increased when the native *régime* became abolished, as did also the custom of throwing weirs across creeks and minor streams.

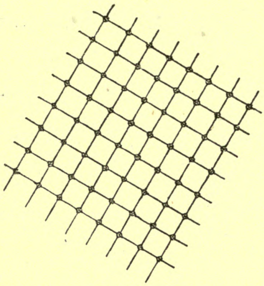
Free fisheries have been permitted, due to several causes, such as the difficulty in making them sufficiently remunerative to bear taxation or the incidence of rent; this may be owing to the rapidity of the current, the paucity of fish as in some hill streams and depopulated rivers, the depths of tanks, the presence of foreign substances in them, or the poverty of the general population. How general and indiscriminate fishing ruins fisheries, without any commensurate benefit accruing to the public, I have already stated. In these deteriorated but public fisheries, as soon as the monsoon has set in, and the fry are commencing to move about, women and children are daily engaged in searching for them in every sheltered spot where they have retired for security, as, not being able to face strong currents, or live in deep waters, they naturally resort to the grassy but inundated borders of rivers and tanks. Every device that can be thought of is now called into use; nets which will not permit a mosquito to pass are employed; even the use of cloths may be frequently observed. Neither are the agricultural population idle. They construct traps of wicker-work, baskets, and nets; these traps permit nothing but water to pass, and a fish once inside is unable to return, as they resemble some of our commoner kinds of rat-traps. So soon as fish for the purpose of breeding commence passing up the small watercourses at the sides of rivers and streams, these implements of capture come into use; breeding fish are taken, and the few which surmount the obstructions find the traps reversed, so that, although they have ascended in safety, it is by no means improbable that their return to the river will yet be cut off. In Burmah a large triangular-shaped basket is employed in places where trapping is difficult, and a pair of buffaloes having been harnessed to it, such is dragged through the localities inhabited by the fry. Even when there are no restrictions, fishermen often find it advantageous to ply their occupation in concert. Sometimes large bodies of villagers proceed at certain seasons of the year to rivers which can be easily bunded, having done which, they kill every fish they are able.

In investigating what is the minimum size of the meshes of the nets in general use in India and Burmah (excluding Sind), where no regulations exist declaring what such should be, I received the following replies from ninety-one native officials, who refer to such in inches :—

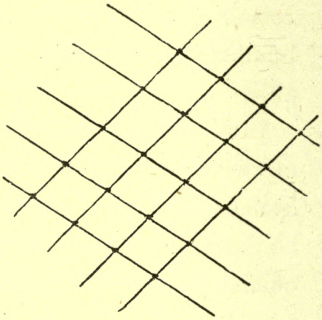
Native officials.	Size in inches between knot and knot of meshes.
5	1 inch.
5	Below 1 inch.
18	$\frac{1}{2}$ inch.
5	$\frac{1}{3}$ "
24	$\frac{1}{4}$ "
1	$\frac{1}{5}$ "
5	$\frac{1}{6}$ "
18	$\frac{1}{8}$ "
4	$\frac{1}{10}$ "
2	$\frac{1}{12}$ "
3	$\frac{1}{16}$ "
1	$\frac{1}{32}$ "

And out of seventy more returns, fifty-three officials compared the size of the mesh to a grain of wheat, mothi, mucca, gram, dholl, lamp-oil seed, barley, tamarind seed, a small pea, a peppercorn, a large needle, a bodkin, quill, coarse muslin, " will ensnare a gnat," or " hardly anything will pass." The remaining seventeen described the smallest size as follows :—Size of finger or thumb, five ; of half ring-finger, two ; as big as a broomstick, one ; size of half rupee, one ; of a four-anna bit, one ; of a quarter of an anna, one ; of a two-anna bit, five ; of a pie, one.

The size of the mesh must to a certain extent be made to suit the water to be fished and the fishes to be captured ; thus very small meshes are unsuited for rapids. The figures



No. 1.



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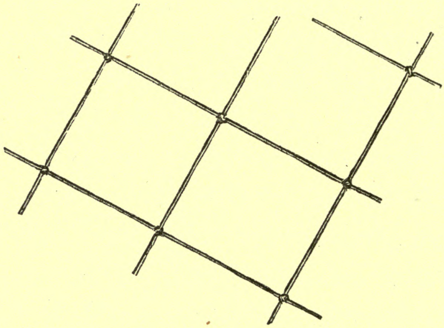
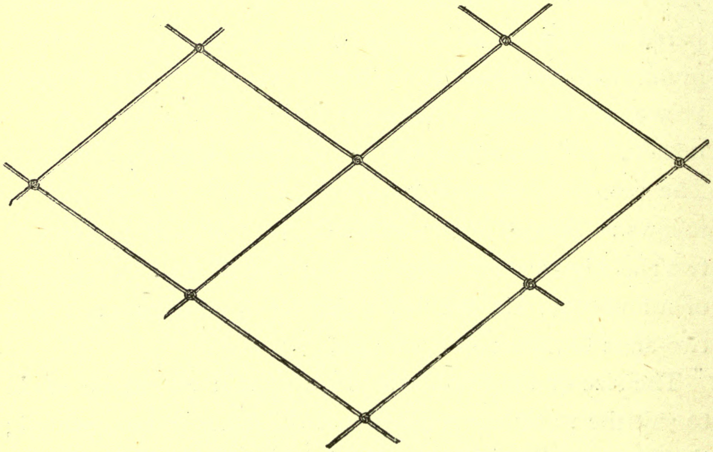


No. 3.



No. 4.

here given show (1) the size of the mesh in a drag-net employed during the rains in Orissa. As the water subsides and the fishermen are able to wade up to their waists, the size of the mesh is increased (No. 2); and as the waters begin to clear, No. 3 comes into use; and in the cold months No. 4. Young fry commence moving about at the first freshes.

The fixed engines employed in India and Burmah (see Plate I.) are mainly divisible into two forms—(1) those manufactured of cotton, hemp, aloe fibre, coir, or some such material; and (2) others constructed of split bamboo, rattan, reed, grass, or some more or less inelastic substance. Those which are manufactured of elastic substances include all stake-nets, but when the meshes are of a fair size, they are a legitimate means, when properly employed, for the capture of fish, but are occasionally to be deprecated, especially when used solely to take such as are breeding. But in some of these implements the size of the mesh is so minute that no fish are able to pass. There it stands, immovably fixed across an entire waterway, capturing everything, the water being literally strained through it. In one instance, in the Punjab, a whole drove of mahaseer were observed to be captured by natives fixing a net across a river, and then dragging another down to it, thus occasioning wholesale destruction, and ruining the rod-fishing for the succeeding season. This plan is a very common procedure throughout India, as is also constructing earthen dams across streams, leaving a channel or opening through their centre, where a purse-net is fixed, and arrests every descending fish. The largest numbers are taken towards the end of the rainy season, for as the waters fall, countless lakes and pools of all sizes are formed on the low lands in the vicinity of rivers. These, which during the floods were lateral extensions of the stream, now become lakes, having one or more narrow outlets into the river; across each opening nets are stretched, or a weir of grass constructed, and every fish which has wandered up becomes a certain prey to the fishermen.

Fixed engines constructed of non-elastic substances are still more destructive to fish than are such as are made of net, and which are more liable to be injured. Their forms are exceedingly numerous, their sizes infinite, while the interstices, between the substances of which the weirs or traps are composed, appear everywhere much the same, whether examined in the ghâts of Canara, the Yomas of Pegu, the Himalayas, or on the plains of India or Burmah. Still, local influences must occasion certain modifications, while some are solely employed for taking large fish, others for fry, and a few are employed for both. In hilly districts, as the monsoon floods subside, and the impetuosity of the mountain torrents has decreased, they can be erected without being liable to be washed away. Up the hill streams (as I have already observed), some of the most valuable of the carps ascend to breed, but now there are but few that are not weired, and the parent fishes have the greatest difficulty in reaching their spawning grounds. Some, however, surmount the obstacles which oppose their ascent, a few deposit their spawn; this completed, the rains are now passing off, the force of the current lessening; and these parent fish commence descending, trying to regain their low country rivers. I omit in this place how spearing, snatching, or snagging, netting, and angling are carried on, only referring to how fixed engines are employed. Weirs are now erected every few miles, through which the waters of the hill streams are literally strained, while each is fitted with a cruive or fishing-trap. The probabilities are that the great majority of the mahaseer which reach the rivers of the plains are the last year's fry that have fortunately escaped destruction during the dry months, and with the first floods have obtained a free passage, due to the standing weirs having been swept away. Wicker traps are likewise constructed across convenient rapids; here few fish can pass without entering, while these are examined twice daily. Or should there be no rapids, such are artificially formed by laying large stones in a V shape across a stream, while at the apex of this a trap is fixed. Or a mountain stream is conducted down a slope over a large concave basket, so that all descending fish are pitched into it, and speedily suffocated by the rushing water or other falling fish, which act like a succession of blows, preventing their ever rising again. Hill streams in some places, as in the Doon, are frequently diverted for the purpose of taking the fish. From March to the commencement of the rains, streams are dammed and turned. In these mountain districts the torrents, where they burst from the hills, form three or four beds, all of which are full during the rains, but subsequently only one. One year one of these beds will be used, another year another bed, and so on. The poachers select a spot where the stream and an old bed are in close proximity: both have good pools in their course. They fix their nets across the stream about a mile, or even more, below the selected spot, first nets with large, and subsequently those with small meshes. These nets are kept to the bottom by means of heavy stones. When the nets are ready they dam up the stream and open a water-way into the old bed. The force of the water soon cuts a deep channel for itself, and thus the late bed of the river is left dry except in the deep holes, while all fish attempting to come down stream are stopped by the net. Large fish are carried off, the fry are left to die as the pools dry up. This process is repeated lower down the stream, and after a month or so they begin again at the top of the hillside as before.

In addition to the larger weirs and traps, there are minor sorts most extensively employed, especially in the plains—some to capture breeding fish ascending up the smaller watercourses during the rain to deposit their spawn, others to arrest them and their fry attempting to descend the stream as the flood waters recede; and there is not a district, except perhaps in Sind, where this mode of capture is not carried on. And some officials now speak of the use of these contrivances as communal and prescriptive rights, and hold that their prohibition would be an interference with private property.

Moveable fishing implements are of two varieties, (1) those manufactured of cotton, hemp, aloe-fibre, coir, or of some such material, and (2) others made of split bamboo, rattan, reed, grass, or other more or less inelastic substances. Large drag-nets (see Plates III. and IV.), having fairly-sized meshes, are used mostly during the dry months, and employed for the purpose of obtaining fish from pools in rivers into which they have retired awaiting the next year's floods. But the moveable nets which occasion the most damage are those with small meshes, and principally employed for taking the fry of the fish as they are first moving about; they may be cast-nets with fine meshes, wall-nets dragged up some small watercourses, purse-nets similarly used, and even sheets may be thus employed. In some places several cast-nets are joined together, to stop up all passage of fish along a stream, while others are employed above this obstacle; or several fishermen surround a pool, each armed with a cast-net, and these they throw altogether, giving the fish but little chance of escaping. In Sind the fishermen float down the Indus, in certain suitable localities, upon a gourd or hollow earthen pot, while the net is let down beneath them ; as a hilsa fish (*Clupea ilisha*) ascends up the muddy and rapid stream, it strikes against the dependent net, which is made to contract like a purse by means of a string that the fisherman holds in his hand.

Irrespective of the modes already detailed as in common use for capturing fresh-water fish in India and Burmah, there are a number of what may be termed minor plans likewise in force (see Plate IV.). Sheets have already been remarked upon as employed for taking the fry which have ascended small watercourses, or are found in shallow water, while they may also be used as dip-nets, being sunk in an appropriate place, and raised by strings attached to the four corners, as soon as the little fish have been enticed above. Or on the sheets bushes may be placed ; here the fry seek shelter from the rays of the sun, and the whole concern is lifted bodily up. A little grain or bread is likewise found useful as a bait. Two pieces of rattan may be employed, crossing one another in the middle, where they are tied together: the ends are then bent downwards in the form of two arches. Here a net is attached, and this the fisherman presses down upon the fish, which are then removed by the hand. In some places they may absolutely be so frightened as to permit themselves being readily taken ; thus ropes to which at intervals are attached bones, leaves, stalks of kurbi or jowaree, or pieces of solar (pith) or small bundles of grass, are stretched across a stream ; two persons, one at either end, constantly jerk this rope, causing the fish to dart away towards nets that are fixed to entrap them. Snares of the most varied descriptions are almost universally employed ; but in some localities angling may be said to be almost unknown, especially in Orissa, or districts where wholesale poaching is preferred as easier and more successful. One method of using hooks is perhaps as cruel as could well be devised. A number are securely fixed to a line at regular intervals of about three inches for employment in a narrow pass in a hill stream. When used, the rope is sunk from eighteen inches to two feet below the surface, and held by a man on either bank; others drive the fish towards this armed cord, and as they pass over it, the line is jerked for the purpose of hooking it. In some places dexterity has been arrived at by constant practice, and many fish are thus captured. The desire is to hook the game by its under surface; but, as might be supposed, although in some cases the hooks penetrate sufficiently deep to obtain a secure hold, such is by no means invariably the case. The struggles of the wounded creature frequently are sufficient to allow it to break away, often with a portion of its intestines trailing behind it. If its gill-covers have been injured, respiration may be wholly or partially impeded: crippled, it wanders away to sicken and die in an emaciated state: while, should it be captured before death has stopped its sufferings, it is useless as food, unless to the lower animals. Baited hooks are in some places fastened to lines, which are tied to bamboos fixed in the beds of rivers, or to bushes or posts at their edges, and so managed that when a fish is hooked the line runs out. Or a somewhat similar plan is to have a cord stretched across a river, floated by gourds; to this the short lines which have the baited hooks are attached, but so that they are not long enough to reach the bottom; these are visited every few hours. In some districts night-lines are baited with frogs. Spearing fish by torchlight is extensively practised in the Punjab and in the Presidency of Bombay; or they may be speared during the daytime in the cold months of the year, when they are not very active. Two persons usually engage in this occupation; the one punts the boat along as noiselessly as possible, while the fisherman stands at the prow, silently pointing to the direction to be adopted, and uses his spear when he gets a chance. Shooting fish with guns is carried on in Oude, and occasionally elsewhere. This is more especially employed for the snake-headed walking-fishes (*Ophiocephalidæ*), which are frequently seen floating on the surface of the water, as if asleep. They may be approached very closely, but the game usually sinks when killed, and has to be dived for, or otherwise obtained. Crossbows are also employed for a similar purpose in Malabar. In Mysore—observed the native officials of the Nagar division—fish are taken by nets, traps, hooks, cloths, by the hand, by baskets of different shapes, by damming and draining off the water, by shooting, by striking them with clubs, with swords, or with choppers, by weirs, and by various descriptions of fixed engines; in short, by poaching practices of every kind, as well as by fishing with rods and lines, and poisoning pools of water by milk bush, tobacco-leaves, Indian hemp, and many poisonous kinds of jungle fruits. This is generally carried on during the dry seasons of the year, when the pools in the rivers are still, and hardly any current exists. It is very easy to collect the poisons, throw them into a pool, and await the fish floating intoxicated to the surface. These fish are sold in the markets. Even fishes' eggs do not escape the general hunt to which the persecuted finny tribes are subjected in these days, the ova being collected and made into cakes, which are considered a delicacy.

The boats employed for fishing purposes (see Plate II.) are too numerous and varied to permit of description in this place. The dug-out, or boat of a solid tree, is common. The coracle is also known; while the fast-sailing fishing-boats of the Konkan, termed Muchvas (an excellent model of which is in the Fish Exhibition), are evidently improvements on the dug-outs of the Maldives. One curious boat from Chittagong, but which is also employed throughout Burmah and the East, is fitted up with a bamboo platform on one side, behind which a bamboo, having palm-leaves attached, projects into the water. Thus fish are scared, and spring on to the platform, which is partly submerged, and on into the boat, while a net fixed on the opposite gunwale precludes their clearing the boat.

There are certain vermin in the East which are destructive to fish, some when in the immature, others when in their matured state. Commencing with the crocodiles, two distinct genera have representatives in the waters of India. The true fish-eating crocodile (*Gavialis gangeticus*), with its long and slender snout, attains upwards of twenty feet in length, and is a resident throughout the main courses and affluents of the Indus, Ganges, Brahmapootra, and Mahanuddi rivers, but absent from Burmah, and most of those in Bombay and Madras. This species is usually timid of man, excepting when he invades the locality where it has deposited its eggs. Their diet appears to mainly consist of fish, turtles, and tortoises. In 1868, I found it was one of the sights of Cuttack to watch these enormous reptiles feeding in the river below the irrigation weir which impedes the upward ascent of breeding fish. The long brown snout of the crocodile would be seen rising to the surface of the water, holding a fish crosswise between its jaws; next, the finny prey was flung upwards, when, descending head foremost, it fell conveniently into the captor's comparatively small mouth.

Crocodiles, similarly to predaceous fishes, generally swallow the finny tribes head first, because, if they are of the spiny-rayed forms, their spines are thus pushed backwards, lie flat, and do not injure the creature which is swallowing them. Were they taken in tail first, this would erect the spines, and wound every animal which should endeavour to swallow them. Doubtless some forms, while in transit, wriggle themselves round, and get fixed in the gullet of their captors, as the father-lasher of our coasts. These reptiles are very prolific. Thus the overseer in charge of the Narrage weir in Orissa, in the year 1869, came across a brood, and within three hours shot sixty-nine. When at this place I obtained a young one that had become entangled by its teeth in a fishing net, and asked the fishermen if they ever destroyed them. Astonishment was depicted on their faces, and they protested against the supposition that they had ever been guilty of such a mean action. Their argument was that both classes belonged to the fish-destroying races, therefore on the principle that hawks do not pick out hawks' eyes, they consider it would be wrong to cause their deaths. As to the destruction they occasioned, they admitted it, but also observed that they would do as much if they were able. It must not therefore be hoped that fishermen will assist in clearing rivers of these monsters; neither will the native sportsman throw away a single charge of powder and ball on such unremunerative game, which he could not sell, and would be unable to eat.

The common crocodile, *Crocodilus palustris* and *C. porosus*, are found in most parts of India and Burmah. These reptiles, although often termed man-eaters or snub-nosed crocodiles, assist in depopulating the waters of fish, and it has appeared to me that it is mostly when they find an insufficiency in the finny supply and carrion that they turn their attention to man and the larger mammals. Every traveller in the East must have seen these logs of wood, as they appear to be, lying for hours at the sides of rivers or on rocks above the surface of the stream, and which sink so noiselessly into the current as almost to make one believe one's eyes had been deceptive, for how could anything so large have so quietly disappeared. In 1868, when at Cuttack, the crocodiles' appetites were not appeased by the fish they obtained, so they commenced consuming human beings, horses, and cows, varying their diet with an occasional goat or sheep. Doubtless, in large rivers, as the Ganges, these reptiles have their redeeming qualities, being the natural scavengers and consumers of carrion. Human beings are now no longer permitted to piously place their dying relatives by the side of the sacred stream, fill their mouths with mud, and leave them to be carried away by the waters or adjacent crocodiles; neither are corpses interred in the current of that holy river. If fish are insufficient, and the crocodiles are not to be destroyed, from whence are these reptiles to obtain their subsistence? The common law of self-preservation will induce them to feed on the cattle of the neighbouring country, or on such human beings as unwarily approach too near to the waters in which they reside. This is no fancy sketch, but I will merely adduce two instances that came under my notice in 1868. At Cullara exists a hole or pool in the Nuna River to which these monsters resort during the dry season, and a short time prior to my visit, they had succeeded in carrying off five adult human beings, while near the Baropa weir two women and one horse were taken by crocodiles in a single month.

Otters are likewise very destructive, especially in the hilly districts, and when they have exhausted the fish, they turn their attention to the frogs. In fact, the large frogs (*Rana tigrina*) are evidently considered great delicacies by these animals, for when kept domesticated they even seem to prefer them to fish. In some rivers, as the Ganges and Indus, the porpoise (*Platanista*) is a large fish consumer.

When mentioning animals which compete with man in destroying fishes, there are some families that must not be omitted, although I only propose casually to allude to them. Birds which eat fish are exceedingly numerous, not only in the true swimming and wading forms, but even the Indian pee-wit may be observed in the dry months taking its share of the smaller examples of the finny tribe that are more or less exposed to view in the drying-up pools. Snakes luxuriate in irrigation canals, and revel in luxury at the bases of the larger weirs. In that across the Coleroon, when the water was low, I was plainly able to see these reptiles lying in wait for the fishes attempting to ascend. I should suppose I never saw less than twenty any evening I examined this weir on its down-stream face. Tortoises and turtles are fish-consumers, while most fishes prey upon their weaker neighbours or their eggs. Near Ganjam, a native official informed me how he had ventured out one night to see how murrul—the walking-fishes—were captured. The fisherman was provided with a long flexible bamboo as a rod, and as a bait used a live frog. Hardly had the frog splashed into the water, when a moderately-sized murrul seized and swallowed it. Desirous of observing what would next occur, the fish was left on the hook, as a bait for anything else. Before long, a large water-snake was seen swimming towards it, and soon had the fish enclosed in its capacious jaws, and in this fashion all three were pulled together out of the water. Frogs appear to relish fish-eggs, and to be by no means averse to occasionally devouring the fry.

Considerable discussion occurred respecting the condition of the fresh-water fisheries in India, some high officials suggesting that a falling-off in the quantity is no reason for legislative interference, unless it could be demonstrated that a danger existed of annihilation. The Viceroy summed up the question in the following suggestive sentences :—"Is the present plan of non-interference likely to ensure to future generations the fullest possible supply of this food staple? Is it even such as to ensure their inheriting a supply equal to that which now exists? The Governor-General in Council apprehends that both these questions must be answered in the negative, and that not only is there no prospect, as matters now stand, of an increased supply hereafter, but that, owing to the absence of precautionary measures and reasonable restrictions, the existing supply is diminishing."

Were poisoning of the fresh-water forms to be prohibited, the sale of fry be rendered illegal, and traps and nets placed under control, an immense increase in the amount of the fresh-water fish would be a certain result. Here I must refer to an experiment which has been made in India for the purpose of protecting fisheries. If no destructive waste was existing prior to the commencement of protective measures, no augmentation of the fish would have become apparent; if, however, very beneficial results have ensued, there does not appear any reason why such should not be extended elsewhere. In South Canara, Mr. H. S. Thomas observed that it may be doubted whether poisoning rivers or the wholesale destruction of fry is most injurious to fisheries; while prohibiting the finer and closely-woven bamboo cruives has been that the most ignorant, and therefore the most obstinate opponents, have been convinced by the testimony of their own senses, and have exclaimed, to use their own words, "truly the river is everywhere bubbling with fry;" and, what is still more to the point, their practice has not belied their words, for they have taken to fishing on grounds that were before considered profitless. Two years' discouragement of poisoning, and one year's discouragement of fine cruives, has worked such a change that it has been demonstrated, beyond cavil even of the ignorant and of the most interestedly opposing, that marked advantage can be reaped from the adoption of these two simple measures alone.

What rules have been instituted in order to mitigate the condition of the fisheries I have been unable to ascertain. An Act (VII. of 1875), however, has been passed for Burmah, for the protection of the fisheries; while Mr. Buckland, Member of the Revenue Board in Calcutta, remarked (November, 1879) that the following figures show the progress which is being gradually made at Goalundo, at the confluence of the Ganges, and Burhampootra, where hilsa fish abound:—Fish cured 1875, 1,362 maunds; 1876, 4,835; 1877, 10,800; 1878,* 14,000. He concludes that "there is, therefore, some reason to hope that Dr. Day's proposal may bring some good fruit after a while." While at page 448 I have referred to some results obtained in Madras.

I now propose considering what proportion of the people of India and Burmah use fish as food, or, rather, can do so without infringing caste prejudices?

In the Punjab, comparatively few of the inhabitants are prohibited by their religion from consuming fish, but

* This shows an increase of 1,043,215 lbs. of fish in a year in one locality, where in the first of the four years nearly 112,073 lbs. only were prepared.

there are many Hindus who reject it, as well as the rural population of some districts. But of those residing in towns, and in hilly ranges, it appears that, if the Brahmans are excepted, the consumption of fish is only limited by the paucity of the supply and the cost of the article. In Sind, fish is generally eaten by the population of the province, whether Mussalman or Hindu (unless a Brahman). In the North-West Provinces, containing about 28,000,000 of population, out of twenty returns received from native officials, seventeen give more than half of the people as not forbidden by religious scruples from eating fish. In Oudh, the majority of the people appear to eat fish, but the supply is unequal to the demand. In the Bombay Presidency, the majority of the inhabitants of the inland districts are consumers of fish when they can procure it. In Haiderabad, Mysore, and Coorg, more than half the population are fish consumers; in South Canara, 89 per cent.; in Madras the majority, the exceptions being Brahmans, goldsmiths, high-caste Sudras, the followers of Siva, Jains, &c. In Orissa, more than half the people; in Bengal proper, from 90 to 95 per cent.; in Assam and Chittagong, almost the entire population; and in Burmah, in the form of *nga pee*, its use is universal.

As Buddhists, the Burmans profess a religious horror at taking the lives of lower animals, but being immoderately fond of fish diet, they console their consciences (while indulging in it) with the idea that the deaths of those animals used by them as food must be laid to the account of the fishermen, and cannot in any way be attributed to the consumers' fault. The walls of their temples have pictures of the terrible tortures the fishermen will have to endure in a future state of existence. In some of these interesting representations are large fires being stirred up by devils, while other evil spirits are dragging more fishermen in nets towards the burning fiery furnace, helping on some by striking fish spears into them from behind, and hauling them forward by hooks and lines fixed to their mouths towards the place of punishment.

But it may be asked are these Poongees' (priests) practices in accord with their teachings? By no means, as the following example will show. At Yahdown, on the banks of a branch of the Irrawaddi, a fisherman (Een Thoogyee), built a *Kyoung*, or monastery, as his great hope was to be termed a *Kyoung taga*, or founder of a monastery, a highly-prized title amongst the Burmese. Poongees came, and Poongees went away, but they did not care to remain, and partake for any lengthened period of the hospitalities of their host and disciple. At last one old priest appeared, who seemed to consider the quarters as desirable. To him, in great trepidation, the owner put the following question, "Why, my father, do not the Poongees approve of my monastery, for none but yourself have remained over the going down of two suns?" "Because, my son," replied the holy man, "do you not break the law by depriving the fish of life?" "True," he answered, "but were I not to do so, how could I supply your table with fish, or how could I live were I to give up my employment?" The only reply he could obtain was, "Better to fast while keeping the law, than to feast whilst breaking it!"

With sorrow the disciple took the priest at his word, and for three days refrained from fishing, giving his preceptor merely vegetables for his diet. On the fourth morning, when the same fare appeared, the Poongee observed, "My son, when you fish the river, does your net extend all across, permitting no fish to escape; or is a portion of the river free for those which select to pass to one side?" "Not all across, but only one-third of the way," he answered. "Well, then, my son," said the priest, "I have been seriously considering the subject, and have arrived at the conclusion that, if you leave room for the fish to ascend or descend the stream, and they will not avail themselves of it, but rush headlong into your net, the fault is theirs and not yours. Even Gaudama blessed the hunter who met him when he was hungry, and supplied him with venison. This was accounted as a meritorious act, although he must have killed a deer to obtain it. So go, my son, and procure me some fish, for I am hungry." From that day the priest consumed his fish in quietness, and refrained from inquiring from whence it had been procured.

Investigating how the local markets were supplied with fish up to 1873, the replies from native officials gave the following results. In the Punjab one in ten markets was sufficiently supplied, in the North-West Provinces one in three, in Oudh one in four. In Bombay the amount was stated to be insufficient in all, and the same reports came from Haiderabad, Mysore, and Coorg. In Madras, near the sea, the quantity of fish was sufficient, but only in one in ten of the inland markets. In short, merely one-tenth of the bazaars were reported as fully supplied with fish, and of these one-fifth obtained them from the sea-coast.

Fisheries, to a greater or less extent, exist in the Indian Ocean, as well as up to the mouths of the larger rivers, in backwaters and estuaries; while parallel to certain places, especially along the coasts of the Madras Presidency, vast mud-banks are present in the sea, having such a thin consistence that many kinds of fish are able to obtain abundance of food there as well as a suitable locality in which to deposit their ova. The most casual observer cannot fail to perceive how numerous are the varieties and vast the number of the finny tribes in the seas of India, but from some cause—whether due to the legislative enactments and local obstructions, or native apathy and impecuniosity—the harvest has, up to within the last few years, been comparatively untouched; an enormous amount of food still remains uncaptured, while famines are devastating the contiguous shores.

FRANCIS DAY.

EXPLANATION OF PLATE I.

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1. *Dollika.*—A trap made of split bamboos, used in shallow water It is plunged suddenly into the water. From the Godavery.

2. *Honcha.*—A fishing scoop. From Nuddea.

3. *Malai.*—A fishing trap set in stone weirs, with the large end down stream.

4. *Ghonee.*—A trap with a double screen of finely split bamboos. From Bengal.

4*a*. Section of above.

5. *Khora.*—A trap used in irrigated fields, for catching fry in channels where there is no current. From Bengal.

6. *Aineh.*—Is set in streams frequented by small fish. From Bengal.

7. *Dhaur.*—A Λ-shaped trap, with a loose screen of pointed bamboos. From Bengal.

8. *Hoochna.*—Trap for catching fry.

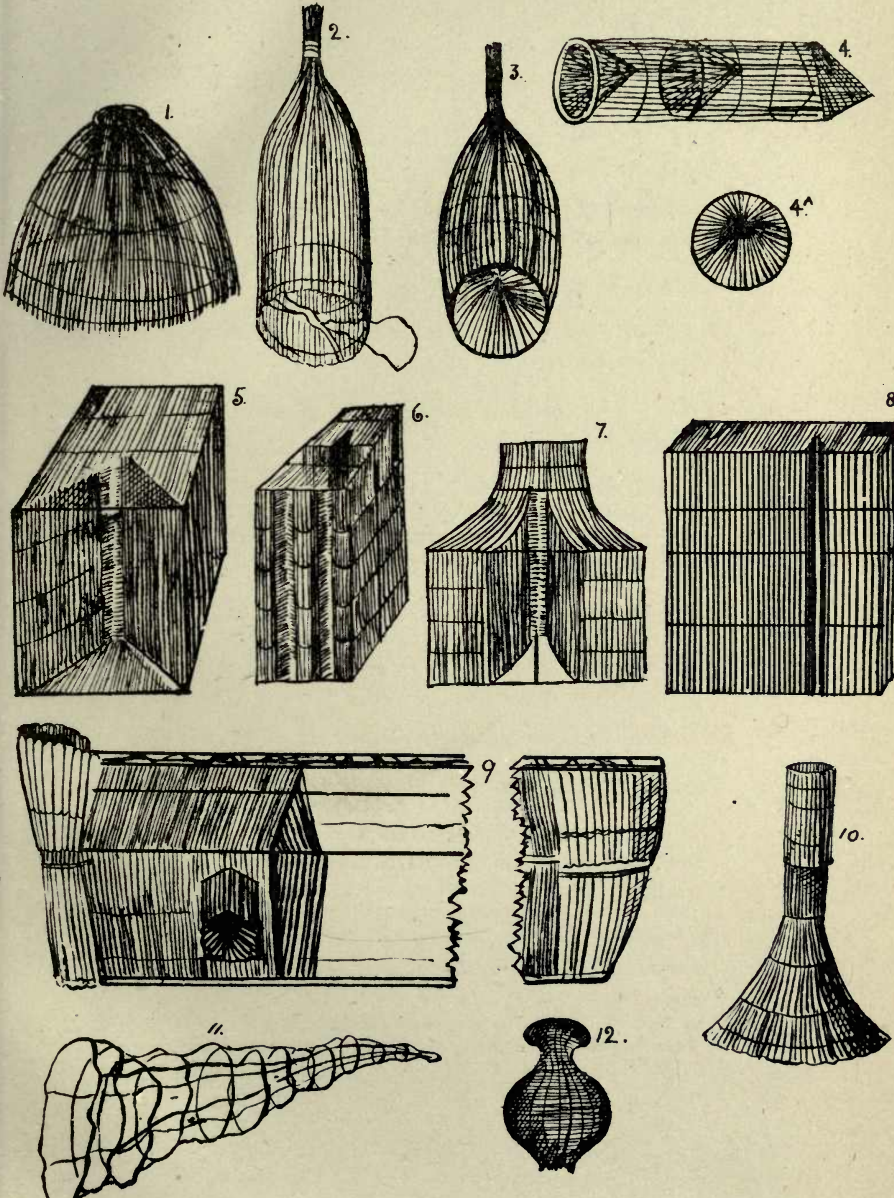
9. *Dhowree.*—A trap used in shallow streams. From Cuttack.

10. *Doob.*—Small trumpet-shaped trap, with narrow orifice, let into a short cylinder. The cylinder is taken off in order to remove the fish.

11. *Koramenalu Vuchii.*—A trap of net-work placed amongst rushes in tanks for murrul (*Ophiocephalus marulius*). From Godavery.

12. A vase-shaped basket, with small opening, for carrying fish.

PLATE. I



EXPLANATION OF PLATE II.

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13. Fishing-boat, fitted with a bamboo platform projecting into the water on one side, and with a net placed obliquely on the other. The fish are frightened on to the bamboos, and in leaping into the boat are prevented from clearing the other side by the net.

14. *Parachal.*—A coracle, or flat-bottomed boat, used in rocky torrents in the Bowani river, Coimbatore.

15. Bombay fishing-boat (Muchwa), built of Malabar teak.

16. Canoe dug-out, or *donga*, made of the stem of *Borassus flabelliformis* or *tār* palm; the soft portion of the palm-stem is excavated, and the broadly expanding base forms the prow.

17. Head of paddle belonging to the Muchwa.

18. Anchor made of wood, and weighted with stone or brick.

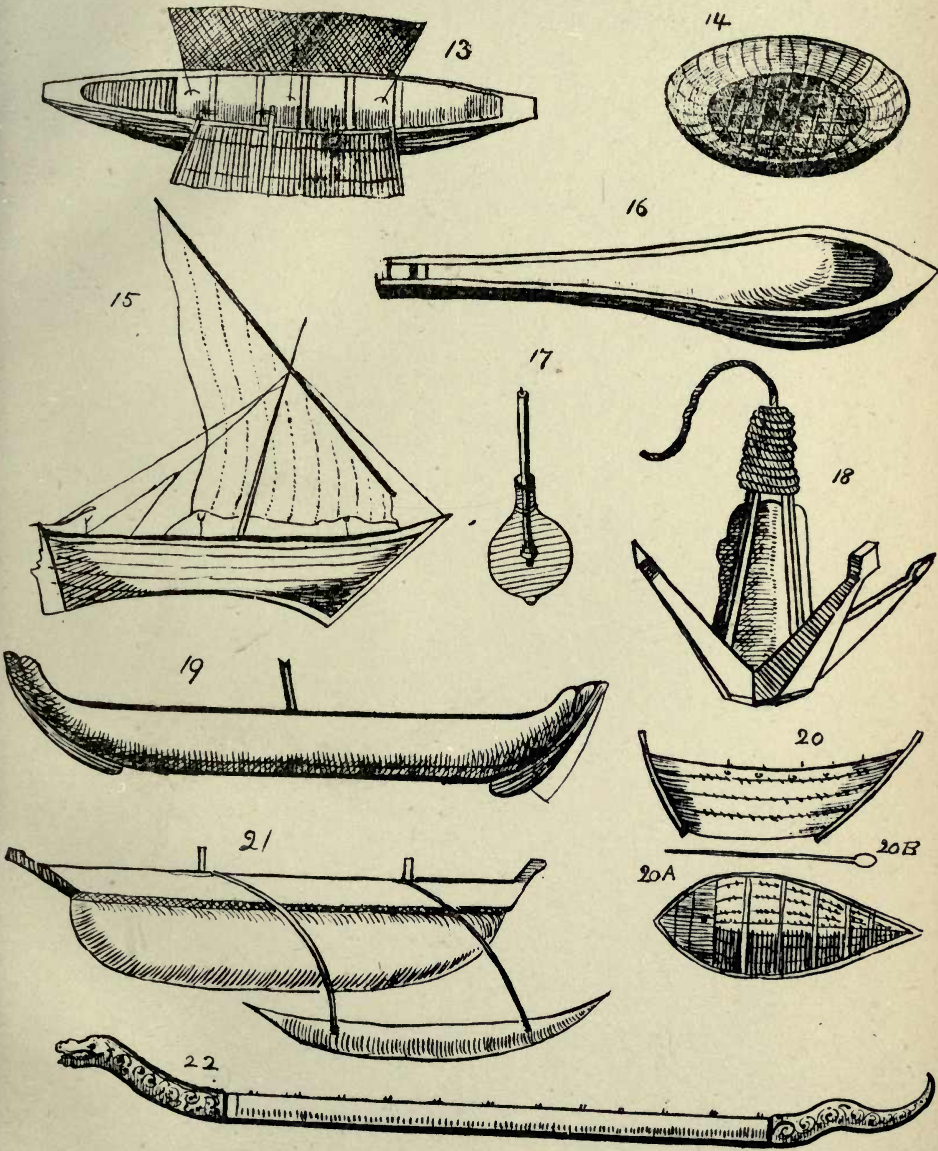
19. Bombay fishing-boat (Tony), made of Malabar teak.

20., 20*a*., 20*b*. Madras Masulah boat: the planks are sewn together.

21. Fishing-vessel from Tuticorin.

22. Burmese snake-boat, for passengers.

PLATE. 2



EXPLANATION OF PLATE III.

23. }
24. } Casting-nets.

25. A landing-net from Moorshedabad.

26. *Choba.*—A plunge-net, used chiefly in shallow water to capture fish which lay half-concealed in the mud. From Poona.

27. A shrimping-net. From Poona.

28. *Yethuvala.*—A hand-net. From the Godavery.

29. *Akhu.*—A scoop-like net for catching small fish. From the Konkan.

30. Stake-net—can be raised or lowered according to the depth of the stream.

31. *Palona jal.*—The base forms a scraper to which the net is permanently attached, and which has sockets for the receipt of the side bamboos. From Cuttack.

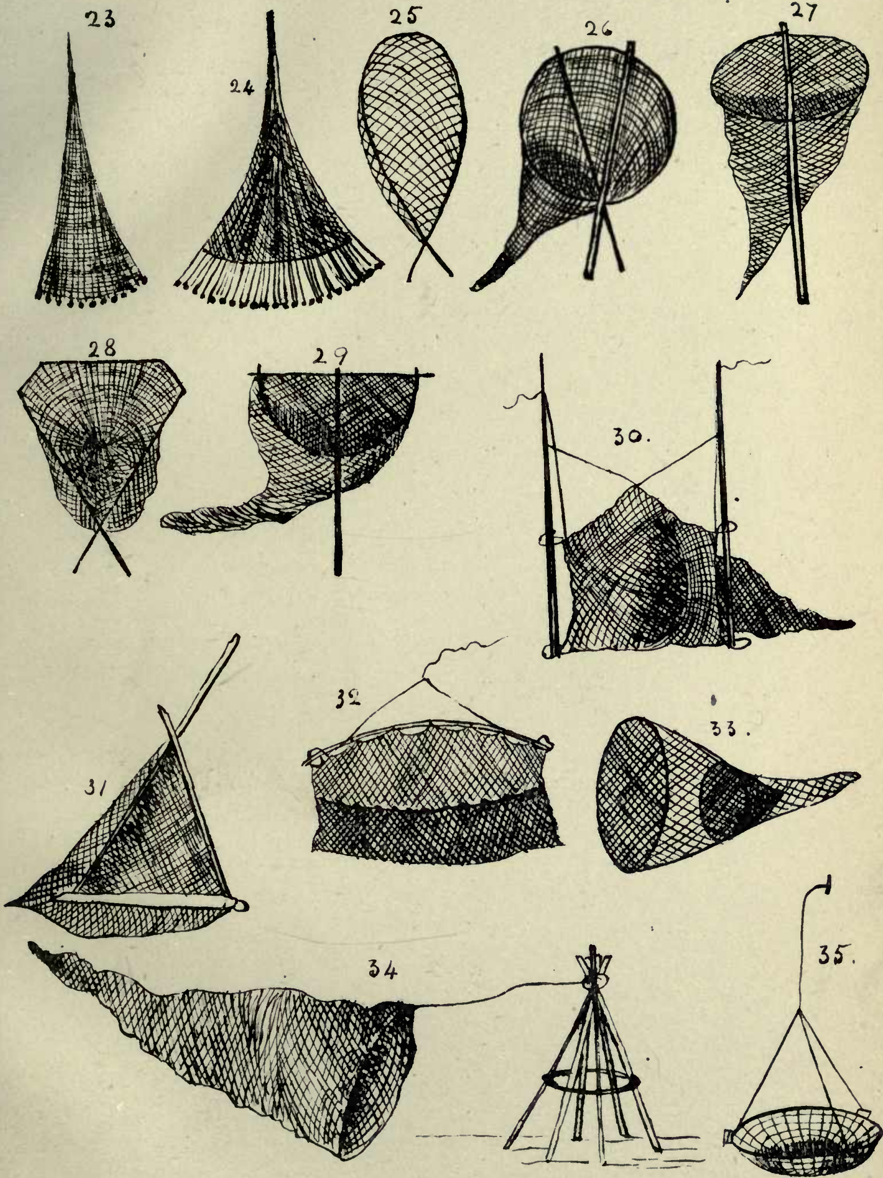
32. *Mai jal.*—A drag-net, attached to a bow-like bamboo, having a weight fastened to each end and a cord fastened to the middle. It is dragged along the bottom like a dredge.

33. *Chach jal.*—A hoop supporting a bag-like net 3 ft. in length, with a *septum* about 11 inches from mouth leading into the lower portion of the net. From Chittagong.

34. *Poluha jal.*—A conical net, used by means of a framework of six bamboos tied together at the apex, and kept in position by a hoop. The fisherman climbs on to this framework, and if in shallow water stands on the hoop, he then loosens the cord by which the net is fastened to the bamboos, and the net falls to the bottom. A feeler (which may be the rudder of his boat) to ascertain whether any fish are under the net, and if he finds one the spear is used.

35. A dip-net, with weights.

PLATE. 3



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EXPLANATON OF PLATE IV.

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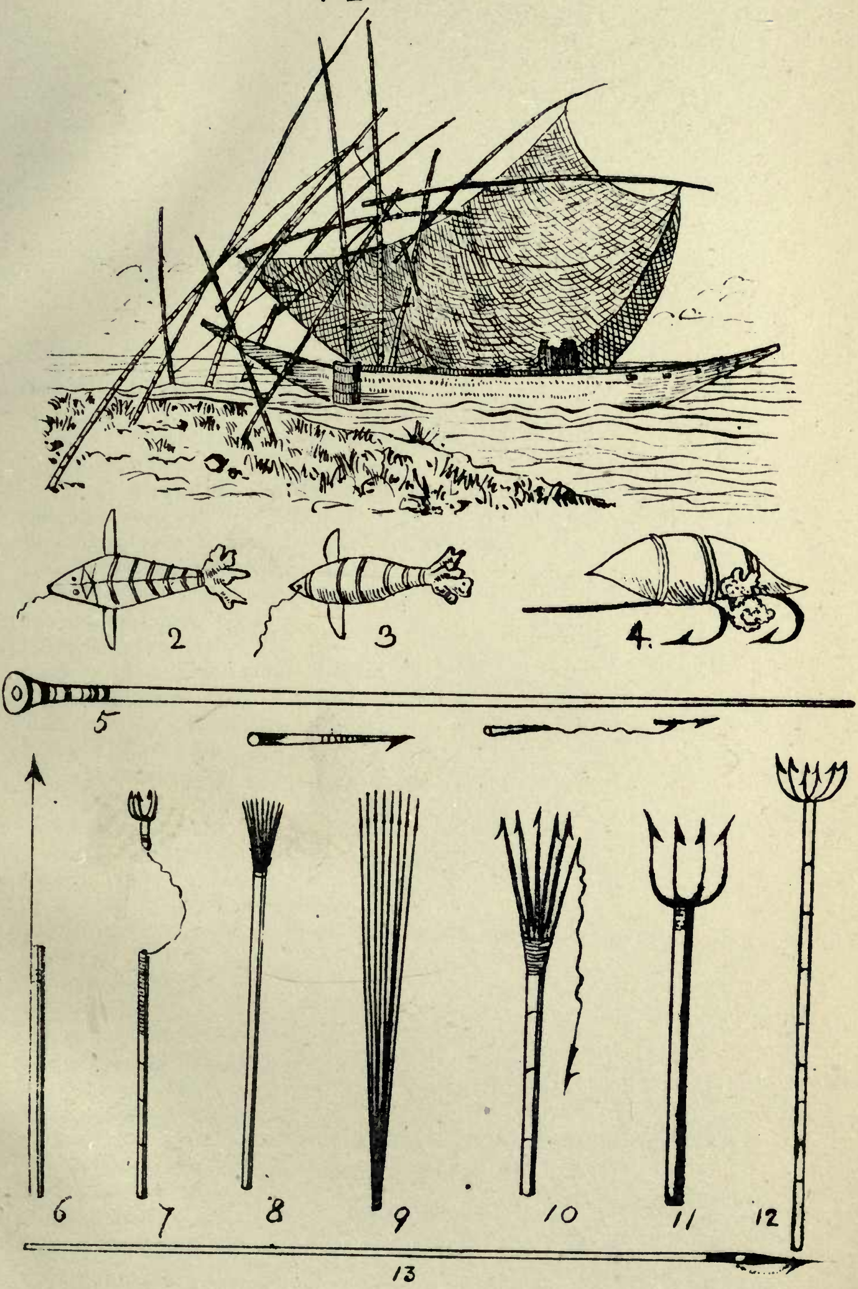
36. *Kharo jal.*—A large dip-net worked by means of a complicated arrangement of bamboos and a boat. To raise or cover the net, which is supported by a bamboo fixed to the side of the boat, a man steps backwards or forwards on the lower of the two bamboos which join the tripod of bamboos on the shore to the upright bamboos on either side of the boat. With one hand he holds on to the upper bamboo, and with the other raises or dips the net by means of a string attached to the bamboo which is fixed into the side of the boat.

37. Artificial bait in use among the Divi Islanders.

38. Malabar puffing tube, with darts used for killing fish.

39-46. Various kinds of spears used for killing fish, turtles, or tortoises.

PLATE. 4



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