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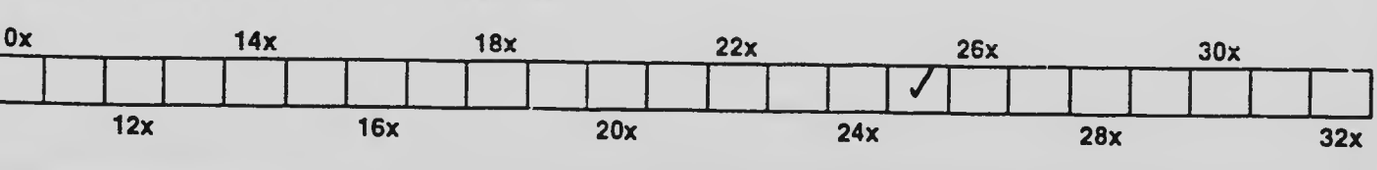

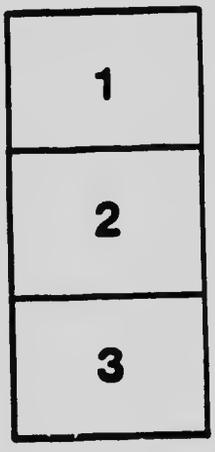

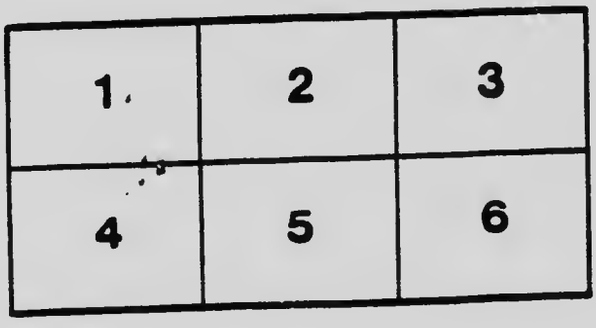

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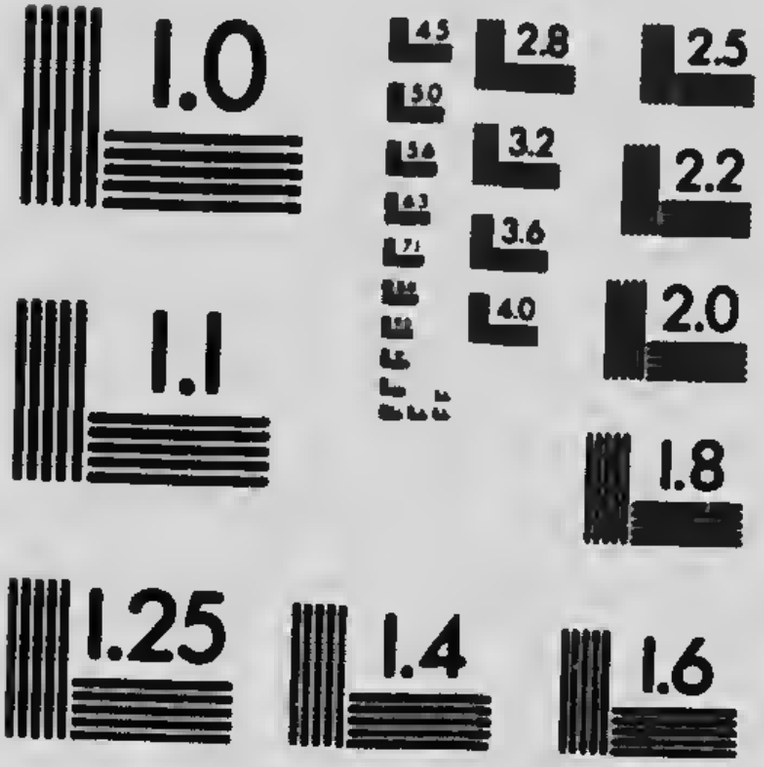

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SPECIAL

APPENDED REPORTS

BY

PROFESSOR E. E. PRINCE

Dominion Commissioner of Fisheries

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1. PLANTING YOUNG FRY: ITS COMPARATIVE ADVANTAGES.
2. THE VERNACULAR NAMES OF FISHES.
3. ACCLIMATIZATION OF FISH, FRESH-WATER AND MARINE.

1900

OTTAWA
GOVERNMENT PRINTING BUREAU
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I.

PLANTING YOUNG FRY: ITS COMPARATIVE ADVANTAGES.

BY PROFESSOR EDWARD E. PRINCE, DOMINION COMMISSIONER OF FISHERIES, OTTAWA.

It was my intention, in the present report, to treat exhaustively the much discussed question of the planting of yearling or 'fingerling' fish, as compared with the planting of newly-hatched fry. The latter method of stocking waters is that mainly carried out in the system of artificial fish-culture conducted by the Department of Marine and Fisheries. The controversy, respecting the merits of the two systems, has been actively carried on for more than a quarter of a century, and fish-culturists are still divided into two schools, the partisans of one school being as emphatic and zealous in their own special advocacy, as the partisans of the other. The adoption of one system does not imply the total disparagement of the other, and there is certainly much to be said for the rearing of the fry of fishes, in our hatcheries, until they are robust and independent; until, in other words, they are able to look after themselves. In order to do justice to the two methods: the 'young fry' method, and the 'fingerling' or 'yearling' method, the various points raised require to be dealt with exhaustively and I therefore propose to treat in a future report the whole subject with some thoroughness, in order that the practical aspects of the matter may be fully set forth, as theoretical considerations, have, it must be confessed, hitherto figured very largely in this important discussion. My present purpose is simply to state, in the meantime, the principal points which may be urged in favour of the system carried out in Canada. I shall do so as concisely and as clearly as I can, reserving for the present those more technical and complex features which can be understood by the embryologist, but are of less moment to the practical man, to whom the more salient points appear, of course, to have the greatest weight. It is necessary to point out that by the terms fry, young fry, or newly-hatched fry, is meant the true larval condition, before the features of the embryonic stages are lost. When a young fish emerges from the egg, at the close of the incubation process, it bears no resemblance in most cases, to the parent fish. It is, as a rule, not at all like a fish: but resembles a small worm with a protruding bag of yolk attached to the under side. I have often heard people declare, on seeing newly-hatched fish in a jar or tank, that they looked like wriggling insects. A minute scientific examination shows that the young fish larva is not only in external form and features, but also in internal structure and anatomical arrangement quite different from a fish, indeed is almost as unlike as the caterpillar is unlike the butterfly. At first the newly-hatched larval fish feeds only on its store of yolk, but as soon as this is exhausted, it begins to change its shape, the mouth, which at first is not used at all, becomes actively movable and numerous minute teeth protrude from the surface of the jaws. Indeed, in the young shad, for instance, teeth develop long before the food-yolk is used up. The late Professor Ryder called attention to this precocious appearance of teeth in the infant shad. Of his previously published statement 'that the yolk sack disappeared on the fourth to the fifth day after the young fish had left the egg,' he said (Bullet. U.S. Fish. Commis., 1881, p. 241): 'Although this statement is in a broad sense true, I find upon more accurate investigation that there is a small amount of yolk retained in the yolk-sack for a much longer time. It appears in fact that there are really two periods of absorption of the yolk which may be very sharply distinguished from each other. The first extends from the time of hatching to the end of the fourth or fifth day, according to temperature,

during which most of the yolk is absorbed.....The second period of the absorption of the yolk extends in the shad over about twice that of the first, or about ten days.... The function of the yolk-sack, during the first period, appears to be to build up the structure of the growing embryo ; during the second, not so much to build it up as to sustain it in vigorous health until it can capture food to swallow and digest, so that it may no longer be dependent upon the store of food inherited from its parent. Minute conical teeth appear on the lower jaws and in the pharynx of the young shad, about the second or third day after hatching... I have never observed food in the alimentary canal until ten or twelve days after the young fish had left the egg. At about the beginning of the second week considerable may be seen in the living specimens. But the intestine is often not yet very densely packed with food even at this period. At the age of three weeks an abundance of food is found in the intestine.' A young fish a month old, or even three weeks old in some species, begins to assume the fish-like form, the fins losing their embryonic or larval form, and the external and internal structure of the growing creature changes to a more mature condition. Between the earliest or immature larval stage and the more mature stage, when the form of the adult begins to be recognizable, there is often a peculiar post-larval stage, characterized in some marine species by the most extraordinary transient developments, which often give the young fish a most grotesque appearance.

Broadly speaking, then, there is a larval and a post-larval condition, the latter insensibly passing into the still small, but externally mature condition called by fish-culturists the fingerling stage. The latter is often called the yearling stage, although the fish may not be a year old. Indeed the rate of growth in any particular batch of fishes varies very much. Frank Buckland drew attention to this in his little work entitled 'Fish Hatching' (London, 1863), and quotes an authority as saying that of three specimens of young salmon taken from the Stormontfield ponds in Scotland, on April 1, 1863, all of the same age, one was 6½ inches long and weighed 646 grains ; another was 3⅝ inches long and weighed 135 grains ; and the third was 2½ inches long, and weighed 23 grains. The last had the dark parr-bands along the sides, the second had indications of small scales, and in the largest the scales were large, silvery and in an advanced stage of growth. As Buckland remarked, young fish whether kept in hatchery tanks, reared in large ponds or turned into streams, vary very much in growth ; some individuals growing more rapidly and attaining a greater size than others. In a study which I made at the Marine Biological Station of Canada of three batches of Pacific salmon fry this year, I found a similar though not quite so marked a difference in growth. The specimens in each series (five or six dozen fish in each series) were presumably about the same age, and in one series they varied from 42 millimeters (1$\frac{11}{16}$in.) to 31 millimetres (1$\frac{1}{4}$in.) in length. In another batch (belonging to the brood of another year) they varied from 65 millimetres (2$\frac{3}{8}$in.) to 38 millimetres (1$\frac{6}{13}$in.) and in another year's series they varied from 47 millimetres (1$\frac{7}{8}$in.,) to 34 millimetres (1$\frac{3}{8}$in.) The well-known authority on angling, Mr. Stoddard states, that the nature of the food greatly influences growth : 'Trout were placed in three separate tanks, one of which was supplied daily with worms, another with live minnows, and the third with those small dark coloured water-flies which are to be found moving about on the surface under banks and sheltered places. The trout fed with worms grew slowly, and had a lean appearance ; those nourished on minnows, which, it was observed, they darted at with great voracity, became much larger ; while such as were fattened upon flies only, attained in a short time prodigious dimensions, weighing twice as much as both the others together, although the quantity of food swallowed was in nowise so great.' Under natural conditions, however, where the food available for all the individuals in a brood of young is practically the same, the difference in size must be mainly due to inherent variability, dependent upon very obscure causes. Such variation in growth, which is so noticeable within the limits of one species considered separately, is no less marked when we compare several different species together. One kind or species attains a known average size at a certain stage in the growth of the young. Thus a newly hatched salmon measures a little more than half an inch in length ; at the fourth week the larva has doubled its length, and in the third month it attains two inches, while in the fourth month it is no less than two and a half to nearly four inches long,

and a month later as much as five inches in length. Brook trout in the fourth month are usually two inches from tip to tip, three inches when nine or ten months old, and five inches when a year old. Lake trout (*Salvelinus namaycush*) are six inches long at the end of twelve months, and black bass are four to six inches. The growth of very few marine larval fishes has been observed, but it is interesting to note that in a batch of young wolf-fish (*Anarrhichas lupus*), a fish reaching a length of five or six feet, the larval forms were a fraction over a quarter of an inch long on hatching out, in the fourteenth week (3½ months) they were not more than half an inch in length, this slow growth being probably due to confinement in tanks.

Marine fish being as a rule of very minute size and delicate in organization when hatched probably reach the same length as fresh water species in a much more extended period of time. The observed variation, which is frequently so very great in young fishes of precisely the same age, is of moment in connection with this question of young fry *versus* fingerlings. Certain fishes moreover exhibit a cannibalistic habit at a very early stage. Black bass when very young, devour each other, even when little over an inch in length, so that it is necessary to take special steps to prevent this. I have on a previous occasion (Rep. Canadian Lobster Commission, 1898) pointed out, in the case of the lobster, that amongst young lobster fry 'cannibalism is frequent, and the method adopted of attacking each other is very striking, as the young lobster barely a few weeks old invariably selects the most vulnerable point, viz., the opening behind the head-shield. The stronger larva springs upon the back of the weaker and savagely bites him at the point named.' Frank Buckland describes the voracity of fingerling salmon and trout and said 'they will certainly eat the young grayling when they can catch them, for they are very active: they also eat young perch. I have placed perch spawn in their tanks, and as the perch, which are exceedingly minute, hatch out, they are caught up and devoured in an instant.'

Whatever arguments may be urged for or against the prevailing system of planting newly hatched fry, it can hardy be doubted by any fair-minded critic that the attempt to stock depleted waters with countless millions of young fish, as is done in Canada, must have some beneficial results. There is certainly much evidence in favour of the view that benefit has resulted. Would better results follow the adoption of the system of planting advanced fry or fingerlings? There are certain points urged against planting very young fry which merit some attention. Nothing, it is said, can be more helpless and defenceless than young fish immediately on hatching out. They must be at the mercy of numberless enemies. This objection has this defect that as a matter of fact most of the fry are some days, or at any rate some hours old when deposited in the open waters The planting is postponed until at large quantity have liberated themselves from the egg, some time is occupied in removing them from the tanks, carting them to the railway or conveying them by wagon to the more or less distant localities to be stocked. In other words the youngest fry are always 12 to 48 or 72 hours old and are not 'newly born' young fish when placed in lakes or rivers. Two or three weeks elapse before all are planted, and the fry are thus getting older as each batch is sent off day after day during the distribution. Hence the majority of artificially hatched fry are really much older, and must be more sturdy and robust, than the delicate young fish exposed on the natural spawning beds. The further objection that artificially hatched fry are suddenly transferred from warmer water in the hatchery tanks to the colder water of the lake or stream outside is also baseless. The ample supply of water pouring through the hatchery troughs has been found to be, as a rule, many degrees colder than the water to be stocked. Ice is always used in keeping the water cold when transporting the young fish in large tanks. Records have been kept showing that the water in the hatcheries is more equable and cool at the distributing time than in the waters outside. The helpless fry, it has also been urged, being hatched under unnatural conditions are untaught to seek shelter, and must be devoured by watchful enemies. It should be remembered that the eggs are taken from wild parent fish. The fry hatched from these cannot fail to inherit, by the inflexible law of heredity, the instincts of their parents. They act, as indeed they cannot avoid acting, precisely as the young of wild fish do. Hence, when the fry have been carefully watched at the time of planting, they

have been noticed to act with great alertness and intelligence, and at once dart off to the nearest available shelter.

The objections usually urged, apply indeed with greater force to young fish kept for a long period under artificial conditions, and reared to the fingerling or yearling stage. Such young fish must become accustomed to the safe and protected conditions provided for them in the tanks or rearing ponds. In such ponds the usual enemies are absent, the water as a rule is warmer, and food is supplied to them, of kinds and at times wholly unlike those which obtain in the case of naturally hatched fish. 'If the fry are kept until they are of fair size,' wrote the late Francis Francis, one of the best authorities on fish-culture, 'fed regularly every day, never seeing an enemy of any kind, what will become of them when they are turned into deep water amongst foes, without the preliminary and probationary life on the comparatively safe shallows, being all unaccustomed to seek their own food, or see enemies? They are far more likely to fall victims then, and less likely to thrive on their own exertions, unless it is proposed to keep them until they are beyond the size taken by pike and large trout.' I cannot do better than quote the opinion of Mr. Francis on a further point, as it fully coincides with the view which I have already published, and to which I still adhere. 'I have heard people urge, that if the young fish are turned at an early age into the river, they will fall a prey to predaceous fish. It is possible that a small percentage of them may, but the remainder will easily learn to know their enemies and avoid them; besides, in putting them into the river, the most shallow places at the sides, and the most sheltered spots should be selected, and the fish should be distributed in small numbers in such places as predaceous fish are the least likely to come and look for them. Added to this, the remainder will thrive so much better in the wider area of the river, and will grow so much faster that this will counterbalance any slight loss.' Experiments have been carried with a view of comparing the rate of growth of fry in confined waters, and those liberated in a stream or creek and it has been shown that the fry which were planted soon after hatching and which subsisted on natural food under natural conditions grew much more rapidly than those under artificial conditions.

I am aware that some experiments in the Detroit river, carried on in 1895, under the Michigan Fish Commission, point to the opposite conclusion, for of a quantity of whitefish *(Coregonus)* fry confined in boxes in the river able to subsist on natural food, only three survived from April 20 to July 23, by which time they were nearly two inches in length, but the boxes were twice tampered with, and the results were thus deprived of their chief value, though it was noticed that a batch of several hundred kept in the hatchery, fared much better. 'These had grown rapidly, much faster in fact than those in the river,' the report states, 'and they were in fine condition... ..when moved (at about the age of ten months) they were three or four inches in length, in good condition, but small for their age.' No reliable conclusion can be drawn from this experiment, which is precisely the reverse of that communicated to Frank Buckland. (See Fish Hatching. 1863, p. 160.) 'Amongst the advantages of early turning into the river must be reckoned that of rapid growth. Some of those (wrote a correspondent to Mr. Buckland) which you and I turned in were, after only nine days, found to be three or four times l. . . an those of the same age left behind in the troughs.' An assistant in this e. . ment observed some of the young fish on the shallows, and stated that one of these liberated fish would weigh down four of the fish confined in the hatchery tanks. This is indeed what might be anticipated. Most animals are more vigorous, healthy and of more rapid natural growth than when confined under artificial conditions. 'The old idea (wrote the late Sir J. G. Maitland) was to turn out fish big enough..... to take care of themselves.' But it is not a question of size, but of food, habit and training. Yearlings will live, it is claimed, where young fry would perish; but planting of fish should always be in favourable localities only.

The main considerations, which weigh in favour of the planting of newly hatched fry may be summarized as follows:

1.—The fry being placed in their natural surroundings, food, temperature, and other conditions must be more favorable than in the cramped conditions of a hatchery or a rearing pond.

2.—The fry endowed with their natural instincts inherited from the parent fish, exercise those instincts at the earliest moment, and do not become accustomed to an artificial environment.

3.—It enables a vast quantity of young fish to be handled, whereas, an infinitely smaller quantity alone can be dealt with if the labour, expense and difficulty of feeding, rearing and caring for are to be faced.

4.—Fry are most vigorous and alert soon after hatching, but when kept confined and their stock of food yolk becomes exhausted, they are less vigorous, swim less freely, and require great care in management.

5.—When fish are planted at the young fry age, the public receive the greatest return and most widespread benefit. This would not be possible were a restricted quantity of young fish merely available for planting. It allows of the maximum of output at the minimum of cost.

6.—Lastly the planting of young fry has been successful, in spite of losses when planting, and undoubted losses (from predaceous enemies) after planting. It is incredible that 50 or 80 or 200 millions of fry of various fishes can be planted in Canadian waters, as they have been planted for over a quarter of a century, and have no effect whatever. The popular opinion, the opinion of practical men, the strong conviction of fishermen especially is that the beneficial results are patent and undeniable.

It has been shown that most of the stock objections urged are not merely based on gross misconceptions, they are the reverse of the facts The eggs in our hatcheries are, at any rate, safely shielded from numberless enemies and hurtful influences. When the fry hatch as Mr. Seymour Bower pertinently asked (in a paper in the Mich., Fish Commiss. Rep., 1896,) 'the question of how much longer they should be held, without any attempt at feeding, becomes an important one. Whitefish fry, as such, are never more vigorous than at the time of hatching: they are free swimmers, and begin to take food within a very few days. It would seem, therefore, that the sooner they are set free in their native habitat, to mingle with nature's fry the better. There is nothing to be gained by holding them and there is great risk in carrying them beyond the time when nourishment other than that supplied by the food sack is essential to normal development.' It is indeed impossible to supply food, at all corresponding to the natural food in quantity, or in its nature, to fry retained until the post-larval condition; and the resulting fish may be stunted, or at any rate will bear evidence in the adult stage of the unnatural conditions under which they were reared. They will reveal what Frank Buckland called the 'semi-tame' condition all through life.

II.

THE VERNACULAR NAMES OF FISHES.

By Professor E. E. Prince, Dominion Commissioner of Fisheries, Ottawa.

The editor of a well-known organ of the angling fraternity was compelled, a few years ago, to admit, 'the utter impossibility of ever clarifying the muddle caused by anglers clinging so persistently to local nomenclature in the identification and classification of fishes.' Anglers are not, however, by any means the worst offenders, and one of the main sources of confusion and uncertainty in this matter is the inveterate habit, prevalent amongst fishermen and those who handle fish commercially, of giving special names, often without rhyme or reason, to the kinds of fish which they send into the market. With regard to kinds which are uncommon, or of no value for commercial purposes, no name is too absurd to select, and the fishery expert and naturalist while frequently experiencing difficulty in determining precisely what fish may be meant, when a fisherman or dealer uses a special name for a common commercial species, finds the difficulty infinitely increased when some rare or uncommon fish is referred to. It is, as a rule, impossible to know what is meant when a fisherman speaks of a 'Sunfish,' or a 'Dog-fish,' or a 'Minnow,' for each of these terms is habitually used for half a dozen creatures wholly different and unlike. To add to the bewilderment, scientific experts have in recent years decided to throw aside generic and specific names, which from long use and familiarity have become universally accepted and recognized, and have substituted for them, in a great many cases, obscure and even uncouth and forbidding names, which, unlike the names so long adopted, are neither descriptive nor euphonious. This exchange of well known scientific names on which even amateur naturalists were wont with some certainty to rely, has been adopted in obedience to a principle of priority, consistent and defensible no doubt from an antiquarian point of view, but wholly confusing and misleading from the standpoint of utility and convenience. The once uniform and reliable scientific names, which were a safe refuge under the bewildering variations of local nomenclature, have been thrown into hopeless and inextricable confusion. Thus the familiar *Gadus aeglifinus*, the common haddock, has become *Melanogrammus aeglifinus*: the large tunny is *Albacora thynnus* instead of *Thynnus vulgaris:* and its close relative the bonito is *Gymnosarda pelamis*, instead of *Pelamys sarda.*

It is no matter of surprise that the early settlers in this western continent, anxious for old association's sake to keep in use names familiar to them in the old land, should have applied such names, borne by very different creatures, to fishes, birds and animals new to them in this country and bearing some more or less distant resemblance to the originals. Thus it is easy to understand that the name 'robin' was applied to a bird which resembles in hardly a single feature the original *Erithacus rubecula*, or robin redbreast of England. The large aggressive loudvoiced nervous thrush 'every motion decided and alert,' the American robin *(Merula migratoria,)* is the reverse of the small delicately-formed, retiring bird with throat and breast of a deep orange red colour, whose song is of a sweet, low, plaintive character, and whose habit is to haunt the dwellings of men only in the winter time, for the English robin, unlike ours, is non-migratory. Our robin is a typical, somewhat noisy, thrush—the original robin a retiring, tender-voiced warbler, indeed the *Sylviinae* as a whole differ in every feature from the thrush family the *Turdinae* to which our North American robin belongs. It was no doubt for precisely similar reasons, largely old association, that the name speckled-trout or brook-trout, was applied to that most widely distributed and highly esteemed fish

Salvelinus fontinalis. In the report of the Pennsylvania State Commissioners of Fisheries (1895, p. 221,) reference is made to this instance of mis-naming, and the following remarks put the matter so appropriately that I quote the paragraph verbatim :— As recently determined the beautiful brook-trout of our waters is not a true salmon but a charr, a circumstance which need not cause the angler or the lover of this attractive fish any sorrow, since all the members of this group of salmonoids are noted not only for their beauty and grace but their game qualities. No truer words were ever spoken than those uttered by an eminent ichthyologist when he declared that 'no higher praise can be given to a salmonoid than to call it a charr.' It came by the name of trout through the Pilgrim fathers who, when they first saw it in New England, mistook it for the same fish they knew in their own Devonshire streams. Had they come from the north of England or from Scotland and been more observing, the error in all likelihood would have never been made. But brook trout or speckled trout or charr, or whatever name may be applied to the fish, it needs no description. There are few anglers who are not well acquainted with this most beautiful and graceful of fishes. It is more eagerly sought for and by the majority of fresh water sportsmen in the east prized more than any other member of the finny tribe, while epicures regard its flesh as unsurpassed for delicacy and richness of flavour. Unquestionably, the pure cold water and the usually picturesque character of the streams in which the brook trout live has something to do with making this fish a general favourite among sportsmen.

Amongst many evils, which result from a lack of uniformity in the use of popular names, are the errors which inevitably appear in statistical records and comparative tables. Unless the precise application of any particular name frequently used indifferently for several fishes, be first ascertained, the information afforded by official reports may be most misleading. Familiar names like trout, salmon, smelt, herring, and pike, are used with utter carelessness, and so grossly misapplied that it is difficult to understand how any intelligent community can continue, year after year, to keep in circulation names so utterly inappropriate to many of the fishes upon which they have been imposed.

As an example of the erratic use of popular names even in official publications, I may instance the case of a very valuable, and sumptuously illustrated report of a Game and Fish Association on this continent, in which I find that the pike-perch, doré, or wall-eyed pike, is repeatedly called 'Susquehanna Salmon.' It is so called in the table of spawning seasons given in the book ; but in the text, only a few lines lower down on the same page, the fish is referred to as the wall-eyed pike, whereas in the body of the report the same fish is several times mentioned as the pike-perch. This last named term is the most appropriate and most descriptive, and has been in common use for a century or two at least in European countries. This instance will illustrate the confused state of mind—not to say of nomenclature, which leads to the use of three almost contradictory terms for one fish in the pages of the same report.

Similarly the weakfish or squeteague (*Cynoscion regalis*) in the southern states is called 'trout'. Indeed all the various species are thus erroneously named, as Professor Jordan says :—'All .... are absurdly called "trout" in the southern States—a name also applied in the same regions to the black bass.' .

The misnomers, innocently applied for old association's sake, are responsible for much confusion ; but this has been enormously increased by the less defensible and erratic method, adopted by men who have applied names which, through ignorance, they imagine to be rightly applied. Numerous examples of this occur amongst fishes, but perhaps the most glaring instance is the case familiar to the hunter of the magnificent stag of the western hills and plains—the *Cervus canadensis* which was called elk by men who no doubt imagined, in pure ignorance, that it bore some resemblance by reason of its size, and other features, to the elk of Europe. The European elk is really almost identical with the moose of North America. The late Professor Spencer Baird once wrote : 'It is somewhat unfortunate that the European name of this animal, the elk, should be applied here in America to an entirely different animal or deer. Much confusion has been produced in this way, and it becomes necessary to ascertain the nationality of an author before it is possible to know exactly what the word elk is intended to convey.' Nor is the name wapiti, generally supposed to be the Indian name for the great Canada stag, more accurate, for Mr. J. B. Tyrrell has recorded that the Indian

name for this fine mammal is 'waskasew.' Errors in nomenclature hardly less glaring are not uncommon in the naming of fishes, indeed they are far too frequent.

There are indeed, speaking in general terms, at least seven ways in which the names of fishes, as of birds and other animals, have been chosen and applied on this continent. First, we may note the adoption of Indian or Indo-French names—names which the early settlers continued to apply to animals because they were already in use. As a rule, these early names always more or less accurately describe features in the forms on which they were bestowed. Thus the name maskinongé, commonly, but very erroneously spelt muskellunge or mascalonge in the United States, is really an Indian name, the Chippewa name for pike being 'Kenosha' and the prefix Mis or Mas means large or great, so that Maskenosha or Maskinoge (corrupted into Maskinonge) is really a large deformed pike. So also the word ouananiche, sometimes spelt wananishe, or winninish, is really the old Montagnais Indian name, the Montagnais Indians being the Algonkin tribes who dwelt in the wild mountainous Saguenay country, as did also the Naskapis or Labrador Indians. In some learned and exhaustive articles upon the original name for the 'land-locked salmon' of Quebec Mr. E. T. D. Chambers has pointed out that the usual signification 'little salmon' (*iche* or *ishe* being a Montagnais diminutive termination) is not correct, *ouen-a*, pronounced 'when-na' is an interrogative, while *ounans* or *unans* is an eddying pool below a fall or rapid; and from either terms may have originated the word 'ouananiche,' which may thus mean 'the little what-is-it fish' or the 'little below-the-rapids pool fish,' both of which names may be paralleled by many examples in Indian nomenclature. Thus the large Mackenzie river food-fish, combining features of the pike family and the whitefish, so puzzled the early French explorers that they called it the 'dont-know-what-fish,' or the 'undetermined fish' tho inconnu[2]—a name which the fish permanently bears. The word Touladi—a variety of the great lake trout is practically the old Indian name, whereas "lunge" the name in some parts of eastern Canada for the same fish, is no doubt a French term having reference to the length of the body in this species as compared with the brook trout or the whitefish. The name for the small but valuable salmonoid, the blue-back salmon of the Fraser and other British Columbia rivers. viz, the Sockeye, is really that of the Indians inhabiting the lower part of the Fraser River—the word being Saw-quai or Suck-kia, a name which is replaced by the term Ta-lo higher up the course of the river.

It may be pointed out that in the United States the fish is usually known as the red-fish, more perhaps on account of the brilliant red colour assumed by the male when on the spawning grounds, than the deep red flesh, which is very characteristic of this species and gives it its special value on the markets.

On the other hand such names as gaspereau for the migratory alewife, called 'kiak' in Nova Scotia, is clearly a French-Acadian name, and it may be that togue, as certainly longe or lunge applied as already stated to varieties of the great lake trout in New Brunswick and the province of Quebec, are French, unless the word togue be Indian. Dr. Perley says, however, that the word togue is used by the lumbermen, while "the Indians designate it by a name equivalent to fresh-water cod.'

Second, we may note that of the names applied on grounds of old association, perhaps the most patent is that of the adoption of the name brook-trout, or speckled trout, for a fish which is not in a strict scientific sense a true trout at all; but, as already pointed out, is really a charr, and closely allied to species of charr found somewhat locally in lakes in Great Britain and certain European countries. The fish which occurs in certain Scottish, Welsh and Cumberland lakes in the British Isles, and is most closely related to our brook trout, is not called a trout at all, but is known as a charr. The genuine brook trout, the *Salmo fario* is a true *Salmo*, and not to be confused with any member of the genus *Salvelinus*, or charrs. In size and in many features our *Salvelinus fontinalis* or brook trout, recalls the trout of the old world, and the earliest English, Scottish and Irish settlers liked to think that the streams in the new land, like those in the old, were trout streams. 'When the New England States were first peopled from Britain,' said the late Dr. Francis Day, "this fish was called a "trout" for but few of the early emigrants could have had an opportunity of observing a "charr," and they gave it the name that most

nearly reminded them of a form which existed in the mother country.' Thus they habitually spoke of the Canadian charr as the brook trout or speckled trout. This was done deliberately and with the knowledge that this trout, like fish in the lakes and streams of North America, was not the same as the trout of English rivers and Scottish burns. Dr. Jordan has on many occasions pointed out with singular clearness the main points in which the American brook trout or charr differs from the original brook trout of Europe. Referring to the almost unavoidable blunder of the white settlers on this continent, he says:—'Finding no real trout with black spots and large scales in the rivers, and having forgotten the name of "charr," they gave to this fish the name of trout, or speckled trout, or brook trout, and in spite of the fact that in reality it is not a trout but a charr, the name of brook trout is likely to adhere for ever to the *Salvelinus fontinalis*. Real trout there are none on our Atlantic Coast, and salmon trout is likewise wanting, but the name salmon trout is often given to brook trout, or charr, which has run out into the sea; and it is also often given to another charr, a very large, coarse species, in which the red spots have faded out to a cream colour, which is found in all the lakes from Alaska to Maine, across the northern half of our continent. This is the great lake trout (*Salvelinus namaycush*), and except for its large size and comparative coarseness, it would never be mistaken either for trout or salmon. The name salmon trout is wholly inapplicable to it.'

In a very clear and luminous way this eminent authority thus compares the species to which the names 'trout,' 'salmon,' and 'charr,' were originally applied. He further says:—'In order to get a better idea of the proper application of the various vernacular names that are used in America, it is necessary to go back to Europe, the source from which these names have been drawn. First, we have a large fish, common in the salt waters of northern Europe, spending most of its life near the shores in regions where the water is cold and clear, and ascending the rivers in the spring when the high water comes down from the mountains, going through the rapids with great force, leaping cataracts, and finally casting its spawn on the gravelly bed of a small stream. This was known to the Latin writers as *Salmo*, the word coming from *salio*, which means "to leap," and in the different languages which are derived from the Latin having as its names some form of the word "salmon." The scientific name of this fish is *Salmo salar*. Very similar to the salmon in all technical respects, like it having black spots over the surface of the body and rather large silvery scales, is a smaller fish which rarely descends to the sea, and makes its home in the rivers and lakes throughout northern and central Europe. This fish was known by the name of *Fario* to the old Latin writers, the most important of whom, in this regard, was Ausonius, who wrote feelingly and poetically of the fishes of the River Moselle. From the Latin word "fario" comes the German name "forelle." This fish is the trout of all English writers, the trout of Izaak Walton, and the scientific name is *Salmo fario*.' Professor Jordan also very lucidly refers to the species on this continent, which received the European names, saying:—In the lakes of Greenland and the eastern part of British America, the European charr (*Salvelinus alpinus*) is as abundant as it is in Europe—a fact which has been only lately made manifest, and even yet there is some question whether some of these which are found in the lakes in New Hampshire have not some time or other been brought over and planted there from Europe.

In the lakes of Maine, and on the north, there is still another charr, smaller and finer than the European one, the Blue-back trout of the Rangley Lakes, known as *Salvelinus oquassa*.

Thus, instead of one of the salmon, salmon trout, trout, and charr, of Europe, we have in the Eastern States the same salmon, the same charr, and three other charrs, but neither the trout nor the salmon trout.

In coming to the Pacific coast, the settlers of California brought the names with them from the East, but found none of the fishes to which they had been accustomed. Salmon they found, similar in habits and in value as food, but many of them larger, finer, and vastly more abundant than any of the salmon of Europe. California salmon differ from all the rest of the salmon family, in the fact that the number of rays in the anal fin is from fourteen to twenty, while in all the salmon and trout on the other side of the Atlantic this fin contains no more than nine or ten rays. The Pacific coast

salmon have also an increased number of branchiostegals, an increased number of gill rakers, and a much larger number of pyloric cæca, or glands, about the stomach. They are, therefore, in strictness, not salmon at all, but something more intensely salmon than the salmon of Europe itself really is. They have therefore been placed in another genus known as *Oncorhynchus*. For the lack of any other common name they are always spoken of and will always be canned, as long as the canning industry lasts, under the name of Salmon. The Chinook name, *Quinnat*, was early applied to them, and if we feel the need of some other name to distinguish them from real salmon we may call the Pacific coast salmon Quinnat, or Quinnat salmon. These species all live in the ocean, ascend the rivers in the spring and summer, spawn in fresh water in the fall, the young, as soon as they are able to swim, floating tail foremost down the river and growing rapidly as soon as they reach the ocean and the peculiar ocean food. There are five species of these Quinnats, varying in size, colour, &c., and differing especially in the quality of the flesh : but all of the same genus.

Besides the salmon, the settlers of California found in the brooks an abundance of what they called trout. These are *black-spotted*, silverscaled, and in every way *closely resemble* the trout of Europe, and are wholly unlike the charr, or so-called trout of the Eastern States. The name trout by rights belongs to these fishes, and they are placed in the genus *Salmo*. *A charr* is also found in Pacific waters, but as the name 'charr' had been wholly forgotten by our ancestors, they could only call this, like the others, a trout.

A third mode of naming and one which has led to some confusion is that of the innocent application of names, which appear to the ordinary mind appropriate, but are in reality not suitable and not correct. Thus the term lake-herring is usually given by fishermen and dealers to fishes (of several species) which are really whitefishes, and not herring at all. The so-called herring of the great lakes—as also the 'long-jaw' (*Coregonus hoyi*) and the 'blue fin' (*C. nigripinnis*), all belong to the same group as the true whitefish, indeed the term lesser whitefishes should be applied to these species, which have all the characters of true salmonoids, and not one feature, except size and silvery brightness, to entitle them to be called clupeoids or herrings. In other words the term herring is in the highest degree erroneous and misleading. A similar case is that of the so-called shad in many inland waters of Canada. The process is, however, the reverse of that just referred to. The shad is a true clupeoid—a typical member of the herring family, though larger than the familiar *Clupea harengus* and reaching a weight of no less than four to six pounds—the average being one or two pounds. The name has long been applied or mis-applied to certain varieties of true whitefish in some localities. Thus in Lake Champlain and Memphremagog the fishermen for years have made catches of what they called shad, but which proved to be true whitefish, of the smaller elongated species known as *Coregonus quadrilateralis*. Official statistics have long recorded catches of shad in these inland lakes of Eastern Canada; but they have been demonstrated to be really catches of whitefish.* These catches, it may be added were made in November, the close season for whitefish ; but being regarded as shad, the law was never applied, and the fish were thus destroyed in the November spawning season. The term shad is misapplied in Lake Ontario—being there used to signify a small and worthless clupeoid, which dies mysteriously in vast schools every summer. Mr. A. Nelson Cheney, State Fish Culturist for the state of New York, writes of this fish 'It is abundant along the Atlantic coast, entering streams to spawn, and also found in the interior lakes of this state, where it is scientifically known as variety *lacustris*. The name saw-belly is given to it in Lake Ontario and the St. Lawrence, and, I think, in Lake Cayuga, where it swarms and where great multitudes die every year in early summer. From the best information obtainable the fish die from a change in the temperature of the water. Coming from the deep cold water of the bottom into the warm surface water, heated by the summer sun, they make a spasmodic movement, turn over and die in such quantities that the surface of the water is covered with them, and it is sometimes a problem to get rid of their decayed and decaying bodies.' They are very generally called shad along the Canadian shores of Lake Ontario, and the name is of course wholly inappropriate, as is also a name frequently

*Dr. Hart Merriam pointed out in 1883 that the shad in Lake Champlain were really whitefish. Bull. U. S. F. Comm., Vol. IV., p. 287.

applied to these small landlocked gaspereau, viz., menhaden, which name belongs to a very different member of the herring family and should be confined to *Brevoortia tyrannus*. The term shad is also wrongly applied to another clupeoid *Dorosoma cepedianum* indeed, excepting the somewhat absurd name 'Hairy-back,' the four or five popular names which are given to that species all imply that it is a shad—the terms in common use being: gizzard shad, hickory shad, mud shad, and white-eyed shad, whereas it is not a shad at all; but a large-sized member of the herring group, having a hard muscular stomach, deep body, small head, and a long hair-like projection from the hind border of the dorsal fin, really the last bony ray of that fin. In certain rivers in Louisiana, in which Dr. Evermann stated that there was no evidence of the existence of any species of true shad (*Alosa*), a herring-like species *Signalosa atchafalayæ* is called shad by all the fishermen. The term 'whiting' which is really the popular name of a European fish closely related to the haddock and cod, and named *Gadus merlangus*, is applied along the Canadian shore to a widely different fish, viz., the silver hake (*Merluccius bilinearis*) which resembles the true whiting in scarcely a single prominent feature. On the Pacific coast the name whiting is similarly applied to *Merluccius productus*, while in New York State the whitefish (*Coregonus*) is known as the whiting in many localities. A similar error was made in the case of *Menticirrhus Americanus* and *Menticirrhus littoralis* neither of which fishes are in any way allied to the Gadidæ, to one of which the name whiting has been for centuries applied.

The term shad-waiter, though an erroneous name, is not seriously confusing. It has been adopted in many lakes in Eastern Canada for the small whitefish *Coregonus quadrilateralis*, for which the name shad has been erroneously chosen in other places as mentioned above. Along the Atlantic coast the terms horse mackerel and mackerel shark are applied to the tunny (*Thynnus thynnus*) both names, having this element of justification that the tunny is a gigantic and voracious member of the family *Scombridæ* the mackerels, but the horse mackerel is in reality *Caranx trachurus* the scad or h mackerel, represented on our shores by *Caranx hippos* or *Caranx crysos*, and the mack shark is *Lamna cornubica*—known also as the porbeagle shark.

There is less objection to the use of the word loach or loche for the burbot, or fresh-water ling, also called the cusk, and the name is confined mainly to the province of Quebec,* no doubt brought by the early French immigrants, who were familiar with a small eel-like fish, the groundling or stone-loach (*Nemacheilus barbatula*) which Dr. Day states is known as *la loche franche* in France. It is a peculiar specialised little fish, lurking at the bottom of stony brooks and rivers, and rarely exceeding five inches in length. The burbot, at a cursory glance, recalls the brown, slimy, eel-like European loach, and la loche was a name instinctively chosen, though, as stated on a later page, the Canadian fish rejoices in no less than fifteen or sixteen more or less inappropriate names; perhaps the most absurd and unsuitable for this ugly, slimy, dull-coloured, and inactive fish, is the term trout, which in some localities in the United States has been applied to it. Dr. Jordan gives the name of Alekey trout, as one of the popular names of this voracious fresh-water cod, or rather ling, (*Lota maculosa*) which some old authority, it is recorded, pronounced to be a hybrid between an eel and a trout.

A fourth mode of false nomenclature is that of the adoption of names already appropriated and universally accepted for certain fish and their application to other wholly different fish; some fancied justification being found in the habits, the form or the teeth of the fish. Thus the word 'pike' has become venerable as the distinguishing name for the Esocidæ, yet the term pike, usually qualified by the word 'yellow,' or 'blue,' is very generally applied to fishes more closely related to the perch family, indeed the long-used scientific name *Lucio-perca*, or pike-perch, was an appropriate and descriptive one. In Canada these fish, of which there are at least three species in the Dominion, are called pickerel, and the yellow species, or American Sandre, (*Stizostedium vitreum*), is called doré in Quebec, and indeed amongst French-Canadians generally. The sauger, or Canadian sandre, also called blue pickerel (*Stizostedium canadense*) is often called blue pike by United States fishermen and sportsmen, who also distinguish both species as wall-eyed pike. Similar confusion has arisen in relation to the word 'pickerel,'

*The name losh or loche, is in use in Alaska.

which in Canada always signifies the doré, sauger, sandre, or pike-perch; but in the United States means a small species (or small specimens in some cases) of the long-nosed pike (*Lucius*) i.e. members of the *Esox* family. Mr. A. N. Cheney, whom I have already had reason to quote, has written very aptly upon this question of the confusion of the names 'pike,' 'pickerel,' &c., and I venture to give his words at length:—'In New York State the pike, *Lucius lucius*, is almost universally called pickerel, although some concede so much as to call it great northern pike. If the word pike alone is used, it generally means the pike-perch or wall-eyed pike. I have tried over and over to separate the pike, the pickerel and the pike-perch by describing them, and the reason why I refer again to the "pickerel" is that I recently looked over a lot of fish applications made to the Forest, Fish and Game Commission in which "pickerel" were asked for, and with one exception I concluded that the applicant really wished the pike. The State does not propagate any of the pike family, but the maskinonge; but it does propagate the pike-perch, and it has distributed the pike and the pickerel on occasions, but always adult fish. Great care is exercised when pike or pickerel are distributed in State waters to place them only where they will do no harm to other fish, and that means that unless the pike or pickerel are already in the water the State will not furnish them for planting. Pike and pickerel for distribution are procured only when netting inland lakes for other fish, and this year none of the pike tribe were taken. They can be hatched artificially, and have been in Germany, but it is not necessary, for they are perhaps the most prolific of the fresh-water fishes, and being spring spawners they require but a few days for their eggs to hatch, and if they have half a chance during the breeding season fair angling will never materially reduce their numbers in a pond or lake, but they have always been the mark for the man with spear and gun when they run into the shallows to spawn. The late Count von dem Borne told me of propagating the pike and the black bass in his fishery in Germany, and how the pike fry worked through into the black bass pond and lived on the bass fry before he knew of the mingling of the fishes. I have already given the details in 'Forest and Stream,' but from memory I will say that at five months from hatching the pike that had been living on black bass fry weighed something over two pounds, and were seventeen inches long.'

A fifth and most unjustifiable mode of affixing names to North American fish is that which can only be described as the thoughtless and wilful misapplication of names either already appropriated for wholly different fish, or newly devised names without appropriateness or utility. It is surprising how many cases may be found of this erratic and harmful, and even culpable, mode of choosing names for fishes. Thus the term 'salmon,' or usually 'jack-salmon,' is used on the Mississippi River for the Canadian pickerel or the wall-eyed pike. The editor of the *American Angler* (June, 1896) stated that great attention has been paid by the State Fish Commissioner of that section (the county adjacent to St. Louis) to the propagation of the pike-perch locally called the 'jack-salmon,' while in Pennsylvania it is called the 'Susquehanna salmon.' Similarly the word 'trout' is applied to the large-mouthed black-bass, often called Oswego bass in Florida and most of the southern states. It is there also applied to the sea bass, probably the striped bass. Frequently the name 'green trout' is given to the black bass as though to reconcile the sportsmen to the misuse of the term, for a green trout could hardly be mistaken by the least observant for the silvery, richly-tinted speckled beauty of northern waters. The black bass, however, endures much maltreatment in the way of inappropriate naming, for the *American Angler* (June, 1892) p. 419, tells us that 'there is no fish, not excepting the chameleon brook trout, that shows greater variation than the black bass of both species ..... known as green bass, yellow bass, moss bass, black perch, yellow perch, black trout, green trout, &c. This much maltreatd fish bears in the Neuse River, North Carolina, the meaningless and foolish name 'Welshman,' when for the use of intelligent people the name black bass is available, and in most civilized regions it is the name generally adopted. Similarly the name 'Dutchman' is applied to the English trout or brown trout in the Beaver-kill waters. Again it is difficult to see what rational ground there can be for applying the name trout to a member of the carp family, really a chub, as is the case with (*Mylocheilus caurinus*) the Columbia River chub. Great numbers of these small inferior fish are

caught and called trout almost universally by the local people. It is said that they 'bite very quickly and when they take them off the hook they find their stomachs full of salmon eggs.' Equally unjustifiable is the custom of calling another cyprinoid, the small mud-minnow, *Umbra limi*, by the name dog-fish—a term applied most commonly to certain small members of the shark tribe, but also given to the Bow-fin or Mudfish, *Amia calva*. The bow-fin also bears the name 'lawyer,' a distinction which had already been bestowed on Lake Ontario and Lake Michigan waters to the burbot or fresh-water ling.

A sixth mode of naming fish to which there is every reason to object is that of putting in circulation a new name in place of an old and universally known name for some comparatively trivial and unscientific reason. The most flagrant case of this evil course is found in the name very often given to the original brook trout or spotted trout of European streams and rivers (*Salmo fario*). It is by many United States authorities called Von Behr trout, a name wholly unknown in any other country, and wholly inappropriate. Even so eminent an authority as Dr. Jordan speaks of *Salmo fario* as the Von Behr or brown trout, neither of which names are commonly applied to it in any country in which the fish is indigenous. Mr. Livingston Stone, in a paper on American Fish Culture, two or three years ago, thus spoke of the reason for calling the common brook trout of Europe by the name of a German fish-culturist, and urges some considerations in order to justify the policy. He says:—

'It was the writer's privilege to carry on a delightful correspondence with Herr von Behr for several years. Dropping all official forms and, indeed, all formality whatever, his letters were earnest, confidential, and full of enthusiasm. They expressed the same love and admiration for Professor Baird that Americans felt for him at home, and never lacked in expressions of his great admiration of American fish-culture. They also record his sad domestic bereavements, and told how, after the loss of his three sons, he had resolved to devote the remainder of his life to the cause of fish-culture in Germany. I am aware that much criticism has been expressed because Von Behr's name has been given by Americans to a European trout since its introduction into this country; but whatever may be said of the judiciousness of the act, no one can deny that it was a fitting compliment to a man who richly deserved the honour, nor can any one deny that it reflects credit on the kindly feeling which sought in this way to recognize America's indebtedness to Von Behr, and to perpetuate in America the name of the distinguished German fish-culturist.'

A parallel case occurred in Canada, some years ago, when an effort was made to perpetuate the name of a pioneer fish-culturist of the Dominion viz.:—the late Mr. S. Wilmot. The name Wilmot's salmon was applied to the salmon which formerly occurred in some abundance in Lake Ontario; but is now practically extinct. The fish, it has been agreed, differed in no structural respect from the sea salmon (*Salmo salar*) and the name Wilmot's salmon never attained any currency and rightly so. As a matter of fact records show that these Lake Ontario salmon were prior to the middle of the present century extremely abundant in the lake. So late as 1856, large schools still occurred, but about 1865 it is reported that only a scanty remnant existed, destructive poaching, especially merciless slaughter on the spawning grounds, chiefly small shallow creeks and streams, had decimated them. In 1865, says an official report, the scanty remnant referred to were snatched from extinction through the efforts of the Fishery Department. This remnant was afterwards utilized by Mr. Wilmot, who conceived the idea of restocking the stream by artificial reproduction. His initial experiments, purely of an individual character, were prosecuted during two years under much outside difficulty and at very considerable personal labour and expense. They were, however, successful, establishing the important fact that salmon eggs could be hatched out there and the young fish reared through proper means and intelligent care. Aided to a very limited extent in the following years by the government, Mr. Wilmot persevered, and he was able to exhibit upwards of 140,000 well shapen, healthy and active salmon fry from three-fourths of an inch to one and a half inches long, and fully capable of being fed and reared to that stage of vigour and growth when naturally they would emigrate from their native stream and return as adolescent salmon. It was officially stated that these fry were no hybrids—no doubtful or inferior members of the salmon family—but the

thorough progeny of the true salmon (*Salmo salar*) which form so valuable a product of the sea-coast and tidal river fishings in other parts of the Dominion. 'Their identity is an ascertained certainty,' says the official report, 'in spite of a doubt which is known to exist in the minds of many persons, and demonstrating that the commercial value of fish so bred renders the subject of its increased production worthy of greater attention. Grilse, or in other words, two-year-old salmon, of the experimental hatching of 1866, having revisited the creek in the fall of 1868, are actual progenitors of part of the present large hatch of salmon fry. The female grilse is not known to propagate on her first migration from sea, but the male does. The few full grown stock fish, male and female, which were last autumn accompanied by the large number of grilse returning to the stream, were rendered available towards supplying the fecundated ova laid in the hatching troughs.'

The hatching troughs referred to were those in the private establishment inaugurated by the late Mr. Wilmot, in which he carried on for some years fish culture before the Dominion government took up the work, when the buildings were transferred to the Department of Marine and Fisheries, and fish-breeding has been carried on there until the present time. No doubt this special effort on the part of a private individual, gave that individual, in the eyes of some people, the right to confer his own name upon them; but the principle is one which has no claim to approval on general grounds, and there is on scientific grounds every reason for strongly condemning it. The name *Salmo Wilmoti* is one, therefore, which could not by any means be justified or gain currency. That vigorous and enthusiastic fish authority, the late Fred Mather, expressed himself thus clearly on this application of personal names to fish. 'I find frequent reference,' he wrote, 'to German trout, and I wish to protest against the use of that name for the brown trout.... the United States Fish Commissioner has seen fit to ignore the name brown trout, which, as the original importer, I have the right to give, and has called it "Von Behr trout," a name that will never stick.' The right claimed by the importer of a foreign fish, here urged, may be questioned; but it is certain that so long as the name Von Behr trout is used by fishery authorities on this western continent, their brethren in other lands will not know to what fish they refer. Certainly the name will never be recognized or adopted in any other country on the face of the earth. Quite a number of fishery experts have felt the inappropriateness which the selection of an unknown name for a well known fish possesses, and the hindrance it is to clearness and intelligibility, and Mr. A. N. Cheney thus strongly places himself on record in a recent issue of *Forest and Stream*:

'For years I have inveighed against the use of the term German brown trout, because it was absolutely improper. As well call our native brook trout New York brook trout or Connecticut brook trout, because they happened to come from either of the states named. Over and over I have written that the brown trout is the common brook trout of Europe. In Germany it is called brook trout and in Great Britain it is called brown trout. We cannot adopt the translation of the German common name, as we have a brook trout of our own, but we can call it by its English common name, brown trout, the trout of Izaak Walton, and the first brown trout eggs that ever came to this country came from England, though the first eggs that came here to a State or national hatchery came from Germany, and the name German brown trout has stuck to the fish in one of the State hatcheries ever since. The State of New York made a fish exhibit at the State Fair in Syracuse, and when I reached the building where the fish were and read over one of the tanks, "German Brown Trout," I felt I was wounded in the house of my friends, as well as stabbed in my vitals. It required but two seconds to pull down the cards bearing this misinformation, and it required at least five minutes talk to the man who prepared the cards and put them over the tanks, and the tail end of the talk was that such an offence should be deemed just cause for the dismissal of the offender from the service of the State.'

The same authority just quoted added great force to his argument, if any additional force were needed, in the considerations which he urged in a communication to the *New York Sun* when he pointed out that the fish in question is the common brook trout of Europe—Izaak Walton's trout, native to the waters of Great Britain and the Continent, introduced into the United States, New Zealand, South Africa, India, &c. In Ger-

many the fish is called *Bachforelle* (brook trout). Dr. Day, in 'British and Irish Salmonidæ,' persistently writes it down brook trout; but as we have a brook trout of our own we cannot adopt the translation of the German name which Day seems to prefer. In England the fish is generally called the common trout, although it is sometimes called by other names. This is particularly true in Scotland. The name German trout became attached to the European trout from the fact that the first eggs of this species sent to the country for a public hatching station were presented to the United States Fish Commission by Dr. von Behr, President of the German Fisheries Association, and were taken from German waters, although a private fish breeder in Massachusetts had previously imported brown trout eggs from England. The United States Fish Commission, out of courtesy to Dr. von Behr, named the fish von Behr trout, but in New York State the Fisheries, Game and Forest Commission adhere to the English name brown trout, and under this name it is hatched and distributed in some of the public waters of the state.'

Lastly, there is the method, too commonly adopted, of conferring a great variety of names upon one fish, instead of adhering to a single, generally accepted name. There may be an element of appropriateness in each of the names as in the term 'smelt' which is applied on many lakes in New York State to a lesser whitefish, whose specific distinctiveness was first noticed by that able and gifted fishery expert, Dr. H.M. Smith. Dr. Smith called it *Coregonus osmeriformis*, (now called *Argyrosomus osmeriformis*) the specific name having reference to the smelt-like character of its external appearance. Both the smelt and this lesser whitefish belong to the same family (*Salmonidæ*), and the misnaming is certainly not so outrageous as calling the whitefish a bass, a practice on some waters in New York State: the term 'Otsego Bass' being most unjustifiably applied to the lake whitefish. The name smelt is also given to *Notropis hudsonius*, a widely distributed minnow, ranging from Lake Superior to South Carolina. So also the name 'Mullet,' which really belongs to a family having most of the characters of the perch, viz., the *Mugilidæ* (applied likewise to the Surmullets or *Mullidæ*) has been conferred in many localities to members of the carp family, from which they wholly differ. The mullets are marine fishes, though some of them come into brackish water. The chub-sucker (*Erimyzon sucetta*) is called mullet in North Carolina, while in Ontario the *Moxostomæ*, or large scaled suckers, are called mullets, e.g. white mullet, *M. pupillosum*; blue mullet, *M. coregonus*; jumping mullet, *M. cervinum*, carp mullet, *M. carpio*, or simply mullet, *M. aureolum*. There is probably no case, however, which for variety of popular names can excel that fresh-water Gadoid, *Lota maculosa*, which rejoices in at least fifteen distinct names. It is called the burbot, the fresh-water ling, (to distinguish it from the sea ling), the losh or loche in Quebec and Alaska, the eel pout in Eastern Canada and some Eastern States, the dog fish in Lake Erie, the 'chub eel' in Mohawk River, New York State; the 'fresh-water cusk' in St. John River, N.B.; 'the ling and lawyer' in Lakes Ontario and Michigan; the 'lake cusk,' and 'fresh-water cod,' of Lake Winnipigoegee; the 'maria' in Lake Winnipeg; the 'methy,' by the Cree Indians, and 'eel pout' in many districts, and the 'mathemeg' in some western areas. It is also called 'spotted burbot,' but, as Professor Ramsay Wright some years ago suggested, the name American burbot is at once most distinctive and appropriate and should supplant all other names. Only one species is recognized by experts, though a small species was at one time named and distinguished as *Lota compressa*, the lesser eel-pout. Amongst the French Canadians the same lack of uniformity exists for M. Mo..tpetit points out that 'Les Canadiens Francais de Montreal appellent improprement ce poisson la loche; à Québec on lui donne tantôt le nom de queue d'anguille, tantôt celui de barbue.'

If great variations obtain regarding the naming or misnaming of this fish, a corresponding diversity of opinion exists regarding its edible qualities. At a remote Hudson Bay post, in the Canadian North-west, I found that the flesh was regarded as poisonous, indeed, cases of poisoning after Indians and employees of the post had eaten the fish were mentioned, and it was pointed out that even the dogs would not eat it. The dogs are usually fed on the excellent whitefish and decline being put off with inferior fare, and it is a fact pointed out by various explorers that the dogs of the North-west, used in the dog-trains, refuse to eat the burbot. I found, however, at another Hudson

Bay post, that the fish was often eaten and was regarded as most excellent, no ill effects having been noticed. Belonging as it does to the cod family, it should be an excellent fish for the table, like its near relatives the cod, haddock and hake. In one of the lakes in New York State, (Lake Winnipiseogee) it is pronounced equal to the whitefish for table use, and the liver is generally considered a rare delicacy.

Dr. Richardson (*Fauna Boreali Americana*) is recorded to have said that 'the flesh of the fresh-water cusk is firm, white, and of good flavour; the liver and roe are considered delicacies, when well-bruised and mixed with a little flour, the roe can be baked into very good biscuits, used in the fur countries as tea bread.' Professor Brown Goode spoke of it as a very excellent fish, especially for boiling, though Dr. T. H. Bean pointed out that apart from the liver, the fish is not esteemed in the Great Lake region and northward, but in the rivers of Montana the burbot is in great favour.

Perhaps the name 'minnow is more generally applied, or misapplied than any other common popular term in use. When it is remembered that the term 'minnow, may on scientific and popular grounds be justifiably applied to small species of Pimphales, of which there are at least four kinds, of Leuciscus, twenty-two species; of Notropis, one hundred and three species; of Fundulus, forty-one species; of Cyprinodon, eleven species; of Gambusia, nine species, and of Gastrosteidæ at least fourteen species or varieties, or a total of just over two hundred distinct varieties of small fishes, it can be imagined how much uncertainty and confusion is bound to arise when the name minnow instead of being confined to this somewhat numerous group of seven genera, is indiscriminately applied to any small fish if of a minnow-like appearance, whether the young of a well-known large species, or the adult of some small species. Indeed in my own experience I have heard characterized as minnows the young of salmon (that is the parr stage) of black bass, of pike, pike-perch or pickerel, of whitefish and of many other familiar kinds in immature and young stages.

More than one word is scarcely called for on the matter of traders' names or commercial names for fish. Such names are not, strictly speaking, popular names at all, and as a rule are confined to the circle of traders which have adopted them. They do not mislead the public to any great extent, though they often vitiate official statistical records, except in such cases as that of the small immature herrings caught in the Bay of Fundy and along the Atlantic coast, and used chiefly for canning purposes. These small fish, put up in oil and other liquids, are sent into the markets as sardines. They are not true sardines, but fishermen, dealers and local inhabitants never refer to them as herring. The traps or weirs are called sardine weirs; the nets, sardine nets; the fishermen, sardine fishermen; and it would be difficult to get into common use any other name than that universally adopted along the shores, viz., sardine. As already pointed out, the danger of such misnomers is that in official reports and statistical returns the information collected may often be misleading unless special care be taken to discriminate between an erroneous local or trade name, and the correct and distinctive name which is in general use. It is plain that if it were open to any one at will to use, say, the term 'dog' when referring to the horse, and when speaking of cats use the term 'bears,' no one would know what was meant, for not only would confusion result, but far worse, viz.: the spreading of misleading and erroneous statements. Yet, this is precisely what has taken place all over North America in regard to fish. Well-known names have been misapplied and misused, the same name has been given to fishes placed by naturalists wide apart, and on the other hand a variety of names, really belonging to diverse fishes have been applied to one fish.

As Dr. W. C. Kendall has pointed out in a paper on the fresh water fishes of Washington County, Maine, published in the Bulletin of the U.S. Fish Commission, 1894, vol. XIV., p. 44, that local names are as a rule far from clear, and he gives such apt illustrations from the part of Maine referred to that I venture to quote the examples which he gives: 'Local names,' he says, 'are always more or less confusing, and they are especially so in many instances in Maine, where distinct species in neighboring localities are often known by the same name. The name "chub" is applied indiscriminately to the larger fishes of the family *Cyprinidæ*; "young chubs" or "shiners" to the intermediate sizes, and "minnies" to the young *Cyprinidæ* and to the *Cyprinodontidæ*. The catfish *Ameiurus nebulosus*, is known generally as "hornpout," as also in some places in stickle-

backs *Pygosteus*, *Gastrosteus*, and *Apeltes*. *Catostomus teres* is commonly designated as "sucker." *Semotilus bullaris* is widely known as "chub;" but the adult *Fundulus heteroclitis*, in places along the coast, are likewise called "chub," and the young of the same species "minny." *Salvelinus fontinalis* is everywhere recognized by the names "trout," "brook trout," and "speckled trout." *Salvelinus namaycush* is known as "togue," "lake trout," or "salmon trout;" *Salmo salar sebago* as landlocked salmon and "salmon trout." The brook-trout when large, also has sometimes been misnamed salmon-trout. *Salmo salar* is commonly known as "salmon" or "sea salmon."

If the use of popular names is to be anything else than a hindrance and a false guide, some uniform method of popular nomenclature will require to be adopted. The adoption of a cast-iron rule of priority might, as in the case of scientific nomenclature in ichthyology, result in the suppression of generally accepted and well-known descriptive names and the unearthing of questionable treasures in the shape of uncouth and unknown names from the lumber pile of musty antiquarian ichthyological records. Nomenclature should be a help, not a hindrance, and its terms as far as possible should be descriptive and convey information instead, as is too often the case, of mystifying and bedevilling the intelligent student and inquirer.

III.

ACCLIMATIZATION OF FISH, FRESHWATER AND MARINE.

BY PROFESSOR EDWARD E. PRINCE, DOMINION COMMISSIONER OF FISHERIES, OTTAWA.

Fishes are frequently divided into freshwater and salt-water species, though there are some kinds, like the salmon, shad and eel, which occupy a kind of neutral position; and have the habit of spending part of their time in fresh water and part in the sea. Those which ascend rivers for spawning purposes, their young brood descending at a sufficiently advanced age to the ocean, are distinguished as "anadromous" or "ascending" species, while those which have their habitat in fresh water lakes and rivers, and migrate to the sea for spawning purposes, are known as "catadromous." But while these distinguishing names apply accurately enough on the whole, there is abundant evidence that numerous species, which are essentially marine species and neither anadromous nor catadromous, are able to live in fresh water and *vice versa*.

The power of endurance which enables a marine fish to live and grow, and even reproduce in fresh water, or in brackish water, is in some species so remarkable as to open up to the fish-culturist possibilities which hitherto have received little or no attention. If waters remote from the sea can be stocked with fine species of fish, normally inhabiting salt-water, the possibility of conferring immense benefits upon the public becomes apparent. The introduction of new species of fish into various countries, as for example the brook trout of this country into England has been a great success. Plants and trees in the same way have been distributed. I had for many years been impressed with the remarkable adaptability to new and unaccustomed conditions of certain Canadian fishes and it had occurred to me that some of the so-called alkaline or saline lakes—many of considerable extent—in the North-west Territories, might be stocked with fish capable of enduring profound changes of environment. I had a long conversation in 1893 with Sir John Schultz upon the subject, and as a result, Sir John, at that time Lieutenant-Governor of Manitoba, arranged for a discussion of the matter with the Rev. Father Lacombe. I therefore arranged a scheme for introducing certain species of fishes, new to western waters, into the barren and unpromising lakes in the west. Various circumstances interfered with the realization of the plan which I devised in detail; but in 1896 an attempt was made, to which I referred in my report upon fish-culture in that year (29th Am. Rep. Dep. Mar. and Fisheries, 1896, pp. 290 and 291). The frost-fish or tom-cod on account of its hardy nature, habits of spawning and excellence as a table fish, appeared specially suited for transference to the barren western lakes, where the conditions are somewhat unfavourable to most kinds of edible fish.

Few people have any idea of the number of species, which can be safely transferred from their usual habitat to conditions wholly different in many respects. To the fish-culturist, whose work includes the introduction of valuable species, in adult or immature stages, into new waters, as much as the hatching and rearing of the usual kinds, the fact is of profound importance.

That certain marine shell-fish are able to survive removal from their usual surroundings has long been known. In a paper read Nov. 19, 1825, to the Wernerian Society of Edinburgh, Mr. Henry Witham described a bed of sea-cockles (*Cardium edule*) as existing in a peat moss in Yorkshire at a distance of no less than 40 miles from the sea. The peat-moss was about two miles from Greta bridge, and not many miles from the river Tees. The bed of cockles, which were living on the sandy bottom of a channel or drain passing through the peat-moss, had existed for a long period, indeed the adjacent

farm was called Cocklesbury in allusion to the occurrence of the shell-fish. Specimens of the cockles were exhibited at the meeting of the Wernerian Society, and they differed in no respect from those occurring on the vast beds of the estuary of the Tees, excepting that on tasting them they were less distinctly salt in flavour. Over a hundred years earlier Mr. John Brand, in his book entitled 'A Brief Description of Orkney, Zetland, Caithness, &c.' (Edinburgh, 1701,) referred to the occurrence of living cockles in the fields more than a mile from the sea. When ploughing the fields, cockles were turned up in numbers and were eaten. Of this remarkable occurrence Mr. Brand wrote :— 'How these shell-fishes came there, and should be fed at such a distance from their ordinary element, I cannot know, if they have not been cast upon land by a violent storm, much of the ground of this parish, especially what they labour, lying very low, and the sea hath been observed in such storms both to cast out stones and fishes ; or if these cockles have been found in some deep furrow, from which to the sea there hath been a conveyance by some small stream, upon which the sea hath flowed in stream tides, especially when there is also some storm blowing. If only shells were found such as oysters and the like, the marvel would not be great, seeing such are found upon the tops of high mountains, at a greater distance from the sea, which, in all probability, have been there since the universal deluge ; but that any shell-fish should be found at some distance from the sea, and fit for use, is somewhat wonderful and astonishing.' Specimens of the sea-whelk, *Buccinum undatum*, have been found in Shetland, living on the margin of a freshwater lake (on the island of Yell) about a mile and a half from the sea. The shells were somewhat thinner in texture than those found on the adjacent rocky coast. and their coloration differs markedly, being very distinctly banded. Many showed the tip fractured, lending support to the theory that crows or water fowl had carried them to the locality, but that they were found living in fresh water, and according to competent observers differed from the marine forms in certain features seemed to show that they had long lived in their new surroundings. The lake had an extremely small outlet emptying by a minute rivulet into the sea, and it was practically unaffected by the tides. The well known Scottish geologist, the late Dr. John MacCulloch, suggested to a resident on the Isle of Guernsey, viz., Mr. Arnold, that experiments, in the acclimatization of many species of marine animals, might be tried in a closed pond about four acres in extent, and separated from the sea only by an embankment. The inflow of fresh water (non-saline that is to say) was very deficient in summer, but abundant in winter, hence it was nearly fresh in winter, very salt in summer and brackish in varying degrees at intermediate periods. The experiment which was tried, was not therefore conclusive in establishing the permanence of the adaptibility of the creatures tested, to fresh-water conditions, yet a variety of sea fishes as well as crabs, shrimps, oysters, and mussels, survived in health and vitality. The test was, however, not decisive as to the possibility of keeping these creatures alive at a distance from the sea and in water which was invariably fresh. That oysters can endure transference to water, not merely brackish but almost destitute of salinity, has been demonstrated. They do not breed under such conditions, nor do they maintain a fully healthy state, though they may fatten and increase in size.

From an economic standpoint the acclimatization in fresh water of fishes wholly or partially marine is, however, of prime importance. That a fish, like the salmon, which habitually spends much of its life distant from the sea, should either naturally or under circumstances artificially devised, take to a purely fresh water existence is not surprising. The ouananiche or land-locked-salmon of eastern Canadian waters is a familiar example. No doubt the land-locked species of salmon found in certain lakes in Maine, U. S. A., and in Chamcook and other lakes in New Brunswick, has acquired the habit of remaining permanently in fresh water, owing, as in the case also of Lake St. John in Quebec, to certain physical difficulties which may have at one time existed in the way of admitting free migration to and from the sea. The experiment has been tried of retaining the fry of sea-salmon in fresh water ponds and lakes with a view of originating a non-seagoing variety, but with no satisfactory success, so far as has been demonstrated.' Perhaps the earliest attempt, at any rate, one of the earliest attempts artificially to raise a land-locked variety of the sea-salmon was that made in Lier, in the south of Norway. A quantity of salmon fry were in the year 1857 put in a small fresh

water pond. Their growth was found to be slow, for after a period of five years, they had only attained a weight of 1⅜ lbs : less than one tenth the weight normally reached by the migratory salmon In the same year 2,000 salmon and sea-trout fry were placed in two lakes in Luardal, Lower Thelemarken, and the experiment proved somewhat more satisfactory than the initial attempt at Lier. In 1862 some of the salmon were found to weigh 3½ to 5 lbs. each, while the sea-trout averaged half that weight. At a later date an experiment near Throndhjem, and another near Christiania resulted in salmon weighing from 2½ to 8 and 9 lbs. While the experimenters found that growth is more tardy than is the case with those having access to the salt water, yet the maximum growth seems to be largely influenced by the size of the waters. The larger the lake the speedier their growth. In small ponds the experiment proved no very marked success. Even in large inland seas, like Lake Huron, the late Mr. S. Wilmot stated that he found them somewhat stunted. 'I took the eggs of *Salmo salar*, impregnated them, hatched them and took them up into the rivers running into Lake Huron,' said Mr. Wilmot in 1883, and to day some of the true *Salmo salar* are found in Lake Huron, though smaller than those found along the coast.' The Lake Wernern salmon in Norway are said in size and every other feature to equal if not rival the sea-salmon (see Day, *British Salmonidæ*, p. 104.) Sir James Maitland in Mar., 1881, hatched fry from the eggs of sea-salmon, and kept some of the brood until 1884 when he took eggs and milt from them and in Mar., 1885, produced young salmon from small parent fish (smolts) which had never been to the sea. In 1886 some of these young fish were 5½ in. long as Dr. Day has recorded.

Apart from the influence of the water, its salinity and chemical character, there are other conditions which must also be taken into account. The area, depth and geological character, and above all the fauna have a potent influence. The last is but another name for the food-supply, and of the influence of that, Mr. J. Harvie-Brown of Dunipace (Scotland), has given to the scientific world a remarkable instance. Mr. Brown says :—

"I put a ¼ lb trout, along with others, into a previously barren loch, in two years some of these trout attained to 4¼ lb. weight, developed huge fins and square or rounded tails, lost all spots, took on a coat of dark slime, grew huge teeth, and became *feroces* in that short time. The common burn trout, taken from a very high rocky burn up in the hills, in two years became indistinguishable from *Salmo ferox*. The first year they grew to about 1 lb. or 1¼ lb., took on a bright silvery sheen of scales, were deep and high shouldered, lusty and powerful, more resembling Lochleven trout than any others. This was when their feeding and condition were at their best ; but as food decreased, and they rapidly increased in number, spawning in innumerable quantities, and with no enemies, the larger fish began to prey on the smaller, grew big teeth, swam deep and lost colour, grew large fins and a big head, and became *Salmo ferox* so-called. In two years more the food supply became exhausted, and now the chain of lochs holds nothing but huge, lanky, kelty-looking fish and swarms of diminutive 'black nebs,' neither of the sorts deserving of the angler's notice. The first year they were splendid fish—rich and fat. Now they are dry and tasteless."

Dr. Barfurth ascertained that when migratory fish ascend into fresh water and find no suitable spawning ground they refuse to shed their ova, and an anatomical examination showed that ovarian disease had resulted, and the eggs had degenerated. Certain marine fish, for example, flounders, have been noticed in an egg-bound condition, due to some physiological cause, and the specimens were found to grow sick and ultimately they died. Dr. Barfurth reported that in the case of trout, which were prevented from spawning, the ovaries not only became diseased, but the eggs and brood of the same fish in the following season were very inferior, and had been affected detrimentally. It was this consideration which compelled me to withhold approval of the plan, inaugurated in Canada by the late Mr. S. Wilmot, of retaining parent salmon in sea-water ponds long after they should naturally have reached the upper waters, where the spawning beds are located. In most cases the land-locked salmon, those that is to say which became land-locked naturally, can descend to the sea. There is no insuperable obstacle in the way of their descent to the ocean. The ouananiche of Lake St. John, in the province of Quebec, are occasionally found in the Saguenay river, far below the Grande Décharge,

and the variety of salmon, evidently a land-locked variety, similar to the ouananiche, and found in Grand Lake, Lake Onawa, and the head waters generally of the St. Croix river, on the borderland of New Brunswick and the state of Maine, can also readily descend to the sea, if they desire to do so. The famous fish-culturist, Mr. Charles G. Atkins, once said of the land-locked salmon in Maine, U.S.A., 'it is likely that it has sometimes occurred to stray individuals to descend the St. Croix river, or the Presumpscot to the sea.' The catadromous habit, however, seems to have been lost, largely, no doubt, owing to the abundance of food, especially the dainty land-locked smelt, which is plentiful in most lakes inhabited by non-migratory salmon. Specimens which do descend such a river as the Saguenay cannot readily return, but this difficulty of return does not apply to land-locked salmon waters generally. It is possible, as already indicated, that the non-seagoing habit was assumed when the physiographic conditions were different. A slight geological elevation or subsidence in the St. Croix river basin would very much alter the means of access to the sea from inland lakes, and some such changes may have been effected, while we know that the basin of the Saguenay is geologically a most remarkable one. The late Mr. Wilmot spoke on this matter in London, in 1883, and remarked:—It might be said, how could the salmon in Lake Ontario be said to be land-locked when the St. Lawrence emptied that lake into the sea? Salmon were feeders in the sea and breeders in fresh-water; they migrated annually to the rivers to reproduce. When they were abundant in the waters of the gulf, they passed up the St. Lawrence, entering every stream on either side up into Lake Ontario; and were it not for the great barrier of Niagara Falls the salmon would be found in the upper springs of Lake Superior. It was their instinct to go onward and onward until they found a suitable spot for spawning, and they would have passed into Lake Erie and Lake Superior, the same as Lake Ontario, were it not for the falls; the consequence was they entered into the smaller streams which fed the lake and went back into Lake Ontario instead of into the sea, where they had remained up to the present time, as the true sea-salmon only acclimatized to fresh-water.

It appears to be wholly different with the large Pacific salmon, known as the spring salmon or quinnat (*Oncorhynchus quinnat*). The California State Fisheries Commissioners, in their report 1876-77, quoted in the report of the U.S. Commissioner of Fisheries, 1878 (Washington, 1880), state of this fish that it readily adapts itself to a life in fresh water, and reproduces its kind where it has no opportunity to go to the ocean. When the dams were constructed on the small streams that go to make the reservoirs of San Andreas and Pillarcitos—which supply the city of San Francisco with water—as also when the dam was constructed on the San Leandro, to supply the city of Oakland, the young of the salmon that had spawned the year previous to the erection of these dams remained in the reservoirs and grew to weigh, frequently, as much as ten pounds; these reproduced until the reservoirs have been stocked. As the supply of fish increased the quantities of food lessened, so that the salmon have gradually decreased in weight until now, after nine years, they do not average more than two pounds. From the fact that, when food was in abundance, they grew to weigh from eight to twelve pounds, and that, as they increased in numbers, they averaged less in size, but still continued to spawn and produce young fish, it would seem that the Sacramento salmon may be successfully introduced into large lakes in the interior of the continent, where, in consequence of dams or other obstructions, they would be prevented from reaching the ocean. The history of this fish in these small reservoirs shows that all that is requisite for their successful increase is the abundant supply of food, to be found in large bodies of fresh water. Salmon, fully mature, weighing two pounds, and filled with ripe eggs, were taken, in September, 1877, in the waters of San Leandro reservoir. These fish were hatched in the stream which supplies the reservoir, and by no possibility have ever been to the ocean. The San Leandro is a coast stream, not exceeding fifteen miles in length, and empties into the Bay of San Francisco. It contains water in the winter and spring, at which time, before the reservoir was constructed, the salmon sought its sources for the purpose of spawning. There was never sufficient water in the months of August or September to permit the fish to reach their spawning grounds. After the construction of the reservoir, large numbers of the salmon that came in from the ocean in January and February were caught at the foot of the dam and transported

alive and placed in the reservoir above. The descendents of these fish thus detained in fresh water and not permitted to go to the ocean, have so far modified the habits of their ancestors that they now spawn in September, instead of in January and February. Inasmuch as these fish spawn in the McCloud, in the headwaters of the Sacramento, and at the sources of the San Joaquin, in the Sierra Nevada, in September, and in short coast range rivers in January and February, and as, when changed to other waters, their eggs ripen at a time when the conditions of their new homes are most favourable for reproduction, they show a plastic adaptability, looking to their future distribution, of much practical, as well as scientific, importance.

This large Pacific salmon, unlike the true or Atlantic salmon, can endure a very high temperature—indeed it is stated to ascend rivers in California, the water in which is no less than 70° F. The colder waters of the eastern sea-board would indeed appear to be less favourable, as there is no clear evidence that any adequate results, indeed any results at all have followed the planting of quinnat salmon in the waters of Ontario and the maritime provinces. The retention of young salmon in restricted waters such as Parker's Lake near Campbellton, N.B., in the Restigouche basin, and at the pond close by the salmon hatchery at Tadoussac, P.Q., has not had satisfactory results. The fish seem dwarfed and never reach more than a third of their usual growth, while there is no evidence that they breed at all. The species of Clupeoid found in Lake Ontario and erroneously called shad, though it is really not distinguishable except in size from the Gaspereau or Alewife, which migrates up rivers from the sea in the maritime provinces, is supposed not to be native to the interior waters. If artificially introduced it is now thoroughly established and has become extremely abundant. It is said to spawn in spring in inshore shallows, and vast schools of them die and are stranded on the lake shore, causing great annoyance to the residents. They accumulate in some seasons in decaying masses, fouling the water and polluting the air. It has been argued that this extraordinary mortality is due to the difficulty of readily descending to the sea, which the Gaspereau along the sea-coasts can easily accomplish. Probably that is not the explanation of the fatal epidemic which occurs every summer. Of a great variety of fishes it cannot be said that change of habitat from salt to fresh water, or vice versa, has had any such serious effects as that just detailed. Many species voluntarily appear to make the change and suffer no apparent inconvenience, others have found themselves involuntarily in their new environment, and become thoroughly acclimatised, while others have been transferred artificially by man, and have flourished under the change.

There is no well established case of a marine species of shark or dogfish taking permanently to fresh-water, except one instance recorded in the *American Angler*, March, 1897, (Vol. xxvii, p. 87.) Among the strange things told us (says the narrator) was his (Mr. Broder's) chance meeting with a live salt-water dogfish, about fifteen hundred miles from its natural habitat—the ocean and its estuaries—and the writer quotes Mr. Broder as saying: I saw and handled this dogfish in 1881, near the headwaters of the Bruno river, in Elko county, Nevada, about twelve miles from Mountain City, a mining camp. I was accompanied at the time by ten vaqueros (cowboys) and a Mexican named Via. These men were working for Mr. Dan Murphy, who at that time was rated as the largest land owner in the world, as he owned about two million acres in Mexico and a like amount west of the Rocky Mountains. One of the vaqueros brought the dogfish to me, it having been nearly killed by one of the train wagons when crossing a small stream. I think the fish was following the salmon from the Pacific Ocean up the Bruno river, a distance of at least 1,500 miles.

Sharks are known to ascend the Amazon and other great rivers to considerable distances, but not beyond the influence of salt water, while there is a saw-fish (*Pristis perottetii*) in the Senegal river, and some South American and Indian species of Electric Rays (*Torpedo*, *Narcine*, *&c.*), which are purely fresh water in habitat. A shark (*Carcharias gangeticus*) frequents the Ganges and is found nearly 200 miles from the ocean. In this connection it may be mentioned that of the order of whales also three are residents in fresh water, viz.: the small *Platanista gangetica*, which lives in the Ganges, and *Inia* and *Pontoporia*, found in the Amazon and South American rivers, and belonging to the Grampus and Porpoise family. The Beluga, or large white whale,

ascends the St. Lawrence river in considerable schools for nearly a hundred and fifty miles from the open sea, passing, indeed, up the Saguenay river for some distance.

The small gadoid, *Microgadus tom-cod*, Walbaum, the tom-cod or frost-fish, a valuable little food fish, which varies from 4 to 12 inches in length, is capable of enduring great changes in regard to the salinity of the water in which it lives. It ranges on the Atlantic coast of this continent from Labrador to Virginia, and is in great request for the table wherever it is found. Though so dwarfed it is a true cod in all the usual external characteristics, and in its excellence for table use. Occurring as it does to so large an extent in brackish water, especially in harbours and about piers and wharfs, it is found to make its way up rivers as far as the limits where the water is essentially fresh. Its artificial retention in fresh water does not appear to have been attempted, nor are there records of such being accomplished, as there are in the case of the smelt, the sea-herring, striped bass, &c. The field open to the fish culturist in regard to the acclimatization of species of fishes, usually regarded as marine, is a wide and promising one. But much information will be necessary before any successful attempts in this direction can be carried on upon an extensive scale. We know how species vary in their powers of endurance, so that it is impossible except by experiment to presage the tenacity of life which a particular species may possess. Thoreau has said of the catfish or common bullhead, *Amciurus nebulosus*, that specimens are only killed with extreme difficulty, for they have been observed opening and shutting their mouths for half an hour after their heads have been cut off.

Professor Jordan's studies of the fishes in the waters of Yellowstone Park, state of Wyoming, have yielded some quite unexpected results. The alkaline character of the waters, the calcareous and siliceous matters which so strongly impregnate the ponds, geyser basins and outlets, and the streams and lakes in that remarkable region of hot springs does not seem to be fatal to fish life, nor is the high temperature seriously detrimental in a great many cases. In Yellowstone Lake, trout are especially abundant. Dr. Jordan reports about the hot overflow from Lake Geyser Basin. The hot water flows for a time on the surface, and trout may be taken immediately under these currents. Trout have been known to rise through a scalding hot surface current. They also linger in the neighbourhood of hot springs in the bottom of the lake, and the fact is evident that geyser water does not kill trout. In Heart Lake, trout are most plentiful about the mouth of the Warm Witch Creek. Suckers and chubs (*Leuciscus atrarius*) ascend this creek for some distance, although half its water comes from geysers and hot springs. The chubs are found in water in which the temperature is about 85° F. Dr. Jordan has published many interesting details, and I quote the following:— The Hot River, which drains the Mammoth Hot Springs, flows into Gardiner River. Trout abound about the mouth of this stream, and here, as in numerous other places in the Park, the conventional trick of catching a trout in cold, and scalding it in hot water, is possible. Below the mouth of this Hot River young suckers (*Catostomus griseus*) were found in a temperature of about 88°, and young trout in a temperature of about 75°. The small Miller's Thumbs abound in the Gibbon River about the hot springs. Three were found boiled in the edge of the river below Elk Park, at the mouth of a hot tributary. The volume of hot water poured into any river is greatest in the Firehole, below the upper Geyser Basin. The stream, however, is hardly warm, and the water has little mineral taste, though the abundant vegetation gives it something of the flavour of stewed plants. Even this stream, it would seem, is probably not so hot nor so heavily charged with mineral substance as to be unfit for trout. Its waters constitute a very dilute alkaline siliceous solution. * * * * There are, however, numerous springs in the Park which discharge sulphurous liquids (some of them the black ammoniac sulphide, being very offensive in odour and doubtless fatal to fishes.) Most of these springs have but a very slight discharge, and so exert no appreciable influence on the streams. The upper part of Obsidian Creek between Twin Lakes and Beaver Lake is the only running stream noticed as likely to prove uninhabitable by fishes.

Professor Jordan found the red horse sucker (*Catostomus ardens*) abundant in the warm waters of Witch Creek, while the diminutive *Agosia nubila* was found in the same heated location. The Utah chub (*Leuciscus atrarius*) ascends the same creek in great numbers, going up further than any other fishes and being found in water no

less than 88° F. Thus cyprinoids and trout (the red-throat or Rocky Mountain trout) endure conditions of temperature and chemical impurity of water under which it would at first sight be regarded as improbable not to say impossible, for them to survive. We know that the fresh water species of trout can all at will take to a seawater habitat and, as in New Zealand, become so vastly changed that a specialist would hardly recognize the transformed fish as belonging to familiar species, yet the young salmon and the young trout cannot for more than a few seconds endure salt water. Indeed in the young larval stages they die very soon after transference to salt water—the physical nature of the yolk sack becomes so seriously altered. The whole subject is not only one of great biological and physiological interest, it is also of immense practical importance. If the cyprinoids, the salmonoids, and the gadoids, can furnish examples of this transformation of habitat—the exchange of a fresh water life for life in salt water, there is every reason to think that a much larger range of genera will be found to possess powers of endurance no less remarkable.

The Bras d'Or Lakes in Cape Breton as is well known are peculiar inclosed lakes of sea water, or rather of water whose salinity is markedly less than that of the sea outside. Lobsters, cod, and other valuable marine creatures, are found in these waters, but not in any great abundance. The lobsters are said to be of large dimensions, but by no means so numerous as along the shores washed by the ocean. Cod of very large size too are captured, some 56 and 58 lbs. weight having been taken in Little Bras d'Or Lake; but it has been remarked that the head in these specimens is disproportionately large, as though they were not so well fed as their congeners in the open sea. Cod indeed occur in all parts of the extensive Bras d'Or waters, numbers being taken with hook and line through the ice at Whycocomagh which is at least 30 miles from the sea coast (to the north-east), and 25 miles from the coast (on the south-east) of Cape Breton Island, and the water in some places is almost fresh.

Only one or two members of the cod family (Gadidæ) are, however, known to be truly fresh water species. All the rest are marine. The fresh water codfish known as the cusk, burbot, ling and eel-pout, and by many other names, is a typical Gadoid somewhat resembling the sea-ling *Molva molva*, and ranges from 2½ lbs. to 10 lbs. or 12 lbs. though in extreme north western lakes it is recorded at 50 lbs. or 60 lbs. weight. An allied form belonging to the hake family (*Merluccidæ*) has been found to forsake the salt water, and in winter at any rate resort in considerable numbers to freshwater. An instance of this is afforded by Darling's Lake, near Rothesay, New Brunswick. In this lake, which communicates with the Kennebeccasis River, a considerable branch of the River St. John, large numbers of silver hake (*Merluccius bilinearis, Mitchill*) are caught on hook and line through the ice. This being a salt water fish, its presence in the waters of Darling's Lake is explained by its habit of following the shoals of gaspereaux or alewives when they ascend in spring from the sea. The true cod (*Gadus morrhua*) is found in moderate abundance in the Baltic Sea, the waters of which are of low salinity especially in the bays and inlets along the shores. Other members of the family *Gadidæ* occur there such as the haddock, the ling, the whiting, the pollock and the green cod; but none are so numerous as the true cod. As might be surmised, the cod does not reach the size which it attains in the open sea, rarely exceeding 12 or 15 pounds, whereas in the salt water outside it reaches a weight of 50 or 60 lbs. * The specimens indeed become more stunted the further one goes up the Baltic, in the Sound and southern part of the Baltic, off Copenhagen, the size ranges from 3 to 6 lbs., whereas 300 miles further up, off Gothland Island, they run from 2 to 3 lbs: at 150 miles further up near Stockholm, nearly 500 miles from the Sound, the weight is barely 1 or 2 pounds. They differ in colour, being darker, and showing few spots, in contrast to the rich brownish red mottled markings and spots of the cod nearer the sea or out in the open ocean. The Baltic cod spawn in comparatively shallow water somewhat late in the season off Gothland and Stockholm. A similar instance of the sea-cod's change of habit is recorded in Iceland. In Olufs Fjord lake, a sheet of fresh water near the mouth of the romantic Olufs Fjord, and separated by a neck of land from the sea out-

* The well known Scottish authority, Dr Parnell, was certainly wrong when he said 'Cod are never found but in salt water, and remain habitually in the depth of the sea (Fishes of the Firth of Forth, p. 334).

side, there are found cod, not distinguishable from the marine cod except by their smaller dimensions. This freshwater species, locally called 'Mauronger' is not found elsewhere in Iceland. In a Norse journal it is stated that M. Elisée Réclus specially mentions this fish as a kind of cod acclimatized to fresh water; but an opinion exists that a subterranean passage did or does allow of communication with the sea, and the cod may have found entrance in that way. Herring, it is stated, have found their way into this freshwater lake, and having passed the winter months there have died. In England, small cod 5 to 8 inches long are found considerable distances up rivers. Thus they are common at Goole, a town on the River Ouse, which empties into the estuary of the Humber, in Yorkshire. In Canada at least five species of Clupeoids very closely allied to the true herring migrate up rivers to spawn in fresh water (viz., the gaspereaux or alewives, *Pomolobi*) two species of shad (*Alosa*) have the same habit, one species of *Dorosoma*, the Gizzard shad, which ascends the St. John River in New Brunswick, and one species of *Brevoortia*, viz., the Menhaden or Pogy. Four other species of clupeoids, at least, have become completely acclimatized to a non-marine environment, viz., the goldeye (*Hiodon alosoides*), found in the Red River, Lake Winnipeg, and western waters, the mooneye (*Hiodon tergisus*) of more eastern lakes and rivers, the blue herring (*Pomolobus chrysochloris*) and the alewife (*P. pseudoharengus*) in Lake Ontario and eastern waters. The last-named occur in Lakes Cayuga and Seneca and in western New York State; but as they annually die in enormous numbers, especially in June and July, some unfavourable circumstance exists, and experts are generally agreed that they are not indigenous. They certainly reach barely half the length of the marine forms (i.e. 6 or 7 inches instead of 12 or 13 inches). There are few records of the acclimatization of the true herring but it is interesting to note that a special race of herrings is native to the Baltic Sea called 'strömming.' They are smaller than the herrings found in perfectly salt water, and paler in coloration; but, contrary to the opinion of experienced herring fishermen, who claim that herring-spawn cannot survive the influence of fresh water, the Baltic herring spawn in suitable grounds irrespective of their salinity—indeed authorities have declared that in brackish water, where rivers debouch into the sea, there is more abundance of minute food for the young herring fry to live upon, and such localities are especially favourable for breeding herring. In the Baltic there are local races of herring and, like their congeners in the sea, they spawn at two periods, viz., spring and late summer, indeed in the Southern Baltic the spawning takes place as late as October. Nowhere indeed has such conclusive evidence been furnished of the very limited and local range of the schools of herring as in the Baltic Sea. Overfishing and unfavourable circumstances have resulted even in that comparatively limited area, (not much more than five times the area of Lake Superior) in the entire destruction of certain local herring fisheries, the schools frequenting other bays and coastal areas not moving in to fill the vacant places of the exterminated fish. Loffoden herring are caught in Borgefjord and in Lake Pollen, the latter almost fresh water but both connected with the Polar Sea by a narrow sound and the catch per annum amounts from 30 to 50 tons. They live and propagate away from pure sea water. Sea herring, and a smaller species closely allied, the sprat, are mentioned as successfully confined in fresh water or rather brackish water by Mr. Arnold, of Guernsey, in his experiments already mentioned, but they did not breed or become transformed into a fresh water form, as is certainly the case with the Baltic herring, specimens of which, some years ago, were kept for a long period in a freshwater tank at the St. Andrew's Laboratory, Scotland, under the superintendence of the eminent zoologist, Professor McIntosh.

Many instances are known of the smelt (*Osmerus mordax*) taking to a life in freshwater, though really a marine species, frequenting brackish water and migrating into freshwater mainly in the fall and in spring. It spawns in brackish water in spring. Colonel Meynell, of Yarm, in north Yorkshire, England, nearly seventy years ago, acclimatized smelts and successfully bred them. It is recorded that they lived 'for four years in a fresh-water pond, having no communication with the sea, and continued to thrive, and propagate abundantly. They were not affected by freezing, as the whole pond, which covered about three acres, was so frozen over as to admit of skating. When the pond was drawn, the fishermen of the Tees considered that they had never seen a

finer set of smelts. There was no loss of flavour nor of quality'. The late Sir James Gibson Maitland successfully tried the same experiment and said 'either the fresh water smelt of America or our own *Osmerus eperlanus*, which I have successfully hatched, and am now rearing in fresh water, if introduced into a Highland loch, for instance, Loch Tay, would enable it to carry a very heavy crop of some of the inland species, for instance land-locked salmon, &c.' (Culture of Salmonidæ, Lond. Int. Fish Exhibit. 183.)

In New Brunswick, Dr. Philip Cox has described a land-locked smelt—indeed they abound in Loch Lomond, near St. John, N.B., and in the Chamcook waters in the same province. These land locked varieties, Dr. Jordan, the eminent ichthyologist, regards as forming at least two species, or rather subspecies, distinguishable from the sea-running smelt. One form, the Wilton smelt (*Osmerus mordax spectrum*) is land locked in Wilton Pond in Maine, and the other form, the Cobessicontic smelt (*Osmerus mordax abbotti*) is found in the neighbouring waters of Cobessicontic Lake, in Maine. In some instances there are narrow outlets to the sea. But the smelt having acquired the habit of remaining permanently in fresh water, shows no tendency to migrate to salt water. The land locked smelt in Lake Onawa, Maine, cannot descend to the sea and they abound in the lake.* The true smelt belongs to the family salmonidæ and is therefore allied to the trout, salmon and whitefish: but the so-called sand smelt, often termed the Atherine (*Atherina*), of which six species occur in more southerly waters on the Atlantic shores of this continent, is more nearly related to the mullets (*Mugilidæ*) and the sand-rollers (*Percopsidæ*). The atherine to the untrained eye might be readily regarded as a smelt, and like the smelt it has been acclimatized to fresh water, indeed the Guernsey experiment demonstrated this, as the atherine in Mr. Arnold's pond were amongst the most successful species. The mullets are essentially sea fish yet instances are numerous of the retention of these fish in fresh water inclosures. In the Guernsey pond the mullet survived, but did not breed or become properly acclimatized, but in a fresh water pond in Tampa Bay, Florida, mullet are found in great numbers along with sheepshead (*Sparus* or *Archosargus*), red fish (*Pagrus*), &c. A correspondent in the *American Angler*, April, 1898, describes this lake, which is named 'Salt Lake,' as [illegible] long by 1½ miles broad, having two small fresh water streams pouring into it, and one small outlet through low marshy woodland, connecting it with Tampa Bay at high water. Twenty five years ago this arm of the bay was salt, and peopled by salt water fish, but during a violent storm a bank was heaped up cutting off the lake, and inclosing some schools of marine fish. Some sharks and sting rays were imprisoned, but seemed unable to survive the winter (1885). The water became a little brackish: but, says the writer referred to, 'it is now perfectly sweet and fresh, and has a slight current towards the small outlet where the water drains off'. Red fish are caught in the lake weighing 38 lbs. and of much richer red colour, and of finer and more delicate flavour than those taken in the sea outside. This last remark applies to mullets and many sea fish when acclimatized in fresh water. Thus Dr. J. C. Mitchell, an authority on the fishes of Egypt, tells us that three species of mullet frequent brackish water there, and when retained in fresh water ponds attain a greater size and a more excellent flavour. He describes Lake Menzaleh, which communicates with the sea by an ancient mouth of the Nile. It is brackish, but varies in salinity at different seasons. Near the fresh water inlets it is comparatively fresh, but near the sea entrance it is more salt, and while there is a preponderance of marine species in the salter portions, the influx of flood water from the Nile affects the salinity of the whole lake, and many species, wanderers from the sea, succumb to the changed conditions. Dr. Mitchell states that all the mullets spawn in the sea and they as a family are essentially shore fishes; but they have a preference for the mouths of rivers, and cut-off lakes where the water is brackish, while not unfrequently they are found to enter rivers,' indeed *Mugil cephalus* and *Mugil capito* have been caught more than 600 miles up the Nile, as far south that is to say as Assouan. 'When kept in fresh water

*Land locked salmon frequently occur in lakes inhabited by land locked smelt, and the latter may account for the loss of the migratory instinct in the former as the salmon are found to mainly feed upon the smelt.

ponds' adds Dr. Mitchell, 'mullet are found to improve rapidly in weight and condition,' and he suggested to the Egyptian government the experiment of stocking fresh water ponds with mullet fry, which in midsummer abound in the inshore shallows of Lake Menzaleh.

The flat-fishes are without exception marine, yet certain species of flounder are found to wander up rivers long distances from salt water. The common flounder *Pleuronectes flesus* as Frank Buckland stated 'inhabits every part of the British coast, and often ascend to rivers beyond the reach of the tide, thriving alike in salt, brackish or in fresh water. Now that the Thames is getting purer, the flounders are returning to the river above London Bridge.' Many years ago I caught specimens of the flounder at Riccal, near York, on the Ouse, in the north of England, fully fifty-five miles from the sea, and they are recorded on tributaries of the Ouse (viz., the Nidd and Ribble), over eighty miles from the mouth of the Humber. As the species of flounder mentioned and most of the flat-fish, indeed, possess floating eggs not at all favourable for deposition in rivers and running water, it is probable that they do not successfully breed away from the sea, as their eggs would appear to have little chance of survival. Dr. Parnell makes the claim, which has already been mentioned in connection with other species of fish, that flounders found in fresh water are more highly esteemed for the table than those taken in salt water. He also makes the questionable assertion that they spawn in brackish water in March and April, but they certainly make their way into fresh water in many cases at a very early stage. Thus, Professor McIntosh describes them as occurring numerously in May at the outlet of a mill stream, which pours fresh water into St. Andrew's Harbour, Scotland, and their length at that time was barely half an inch. Young flounders very little older, Dr. McIntosh adds, can be captured considerable distances up the fresh water stream. Other species of flat-fishes appear less hardy and venturesome. The plaice (*Pleuronectes platessa*) has, however, been successfully retained and fattened in fresh-water ponds, as Dr. Parnell states, and the highly esteemed sole (*Solea vulgaris*) and the turbot (*Rhombus maximus*) were thoroughly acclimatized by Mr. Arnold, in Guernsey. There is only one record of the occurrence of the sole under natural conditions in practically fresh water limits, viz., near the mouth of the Yorkshire Ouse, in the estuary of the Humber. Such fishes as the striped bass, which, like the smelt, regularly ascends for some distance fresh-water streams, might be expected to survive retention, and this has been proved to be the case. In some of the larger Canadian rivers, the St. John River and the Miramichi River for example, striped bass (*Roccus lineatus*) migrate for distances of from thirty to forty miles above the limits of sea water, and congregate in large schools in deep holes in the bed of the river. There they remain in a dormant condition, resting on the muddy bottom, and are captured in great numbers by a kind of scoop net. Dr. Perley in his 'Sea and River Fisheries of New Brunswick' (1852) says 'the places which they frequent are easily discovered, the fish being seen through the clear ice when it first makes; large holes are cut in the ice, and the fish are lifted out with a circular net on a strong wooden bow, called a dip-net. All the fish in each locality, of whatever size are thus taken; and in many of the northern rivers, especially the Richibucto, and North-west Miramichi, where they were formerly very abundant, they are now quite scarce and only found of small size.' There is record of a striped bass confined in a fresh water pond which grew to a weight of 20 pounds—a considerable weight for a fish retained for some years in abnormal surroundings. The flavour too of the impounded striped bass is stated to improve, for Dr. MacCulloch personally vouched for the superiority of the flavour of the specimens confined in Mr. Arnold's fresh-water lake in Guernsey.

Fish vary so greatly in their tenacity of life, that until experiments have shown what any particular species can endure without permanent injury, it is not possible to foretell its capabilities. The German carp, for example has peculiar tenacity and endurance. A member of Parliament informed me, a year or two ago, of a fine specimen of carp that was found several miles from Lake Erie where they were planted and now abound. This carp was a very large specimen and was wriggling along a plough-furrow in which there was little or no water, evidently kept moist and alive by the thick damp herbage, just as they may be kept alive in damp moss. The accomplished

angling authority of New York, Mr. Wm. C. Harris, records a hardly less extraordinary case of the tenacity of the German carp: 'Many clubs are draining their ponds in the hope to eradicate this fish; but it will be well to do the work thoroughly, for Mr Louis Papineau, of Montebello, Canada, tells us of a carp pond being drained, cleaned and exposed for some days until it was thoroughly dry. On the sixth day water was introduced, and some hours after several large carp were seen swimming near the surface. This is another striking instance of the vitality of this fish, which evidently burrowed into the mud as the pond was drained.* Many fishes are able to survive dry seasons by immersing themselves in mud; but they are specially organized for that peculiar habit. The bull-head tribe, (*Siluridae*), are hardy and tenacious and being exceptionally good table fish afford a fine field for experiment in acclimatization.

The Catfish family, including so many forms notoriously hardy and tenacious of life might be supposed to present numerous examples of acclimatization by transference from fresh water to salt water. Yet the records of successful transplanting are few. There are thirty or forty species which are strictly marine; but certain of the fresh water species have been found to be capable of enduring life in salt water. Thus the *Fishing Gazette* (of New York) announced in April, 1896, the capture of a freshwater catfish in the sea at Gravesend Bay, Long Island. A few days later, six 'squaretailed bullheads', of the same kind as the foregoing, were taken in a hoop- or fyke-net, and they were kept alive for some days by alternately supplying fresh and salt water in imitation of the tidal inflow and outflow, but the fish could not be kept in captivity very long. No doubt by a gradual process of change the common catfishes of our lakes and rivers could be acclimatized, and their increasing market importance would give great value to the experiment. If the fresh water species could be so acclimatized as to endure or rather live in health in water strongly impregrated with saline and alkaline matters, their suitability for introduction into certain barren waters in the north-west of the Dominion would be demonstrated. But while numerous instances are to hand of salt water fishes becoming completely reconciled to a fresh water environment, the cases seem to be far rarer of fishes, native to fresh water, assuming a salt water existence. Yet Bloch somewhere states that the grayling, one of the most delicate and fastidious of the salmonoids, frequents the Baltic and the Caspian Sea. Sir Humphrey Davy, curiously enough, laid special stress upon this very point, that while salmon and trout readily endure such changes of conditions, the grayling (*Thymallus*) will not bear even brackish water without dying. Grayling and perch undoubtedly live in certain parts of the Baltic which Linnaeus stated, after drinking some of the water, is very slightly brackish, even a mile from the shore in the upper portion. The perch (*Perca flavescens*) is found very abundantly at the mouth of the Miramichi and other Canadian rivers, where the water is quite saline, indeed where the estuary is practically part of the sea.

There are numerous species of very small fish, of no importance from an economic point of view, which frequent indifferently sea water and fresh-water. Thus the *Gasterosteidæ* or stickle-backs are found in astonishing abundance in shallow estuaries, and the three spined species nests, breeds and passes its whole life frequently in small pools just above high-water mark, where high tides thoroughly impregnate the water with saline matters; but which during most of the year are kept slightly brackish by trickling streams of fresh water from the adjacent land. There are of course genuine marine species in the family, one (*Gasterosteus spinachia*), the fifteen spined species, builds a large nest of *Fucus* or other marine plants attached to rocks between tide-marks, another *G. gladiunculus* is found in the east Atlantic coast amid floating sea weeds. *Gasterosteus pungitius*, the ten spined species, is recorded from brackish and salt water, but its relatives, especially *Gasterosteus aculeatus*, are found distributed, from lakes and streams far inland and up the highest mountains to low lying marine swamps and estuaries. Indeed the species named often abounds in pools just about high-water mark making its small mound-like nest and rearing its numerous families regardless of the variety of conditions obtaining in these various situations. There is no more remarkable feature presented by fishes than this incapability, on the one hand, in some species, of enduring salt water or even brackish water; and on the other hand in other species, the capability

* Recorded instances of carp flourishing in hot and in alkaline waters are questionable (See Bulletin U.S. Fish Commis. Vol. IV., p. 126 and Vol. V., p. 427.

of living and flourishing in the midst of a fresh water, brackish or even extreme salt-water environment.

The plasticity of various species in this respect is a matter upon which experiments would be of great value. Changed conditions certainly work the most marvellous results. Probably no more curious example could be instanced than that of a small fish* found in Ceylon and in the Celebes, which has so accustomed itself to living on damp rocks out of water that the late Professor Balfour once declared that from what he saw of its habits he expected that the fish would be inevitably drowned by long immersion in water. 'These fishes,' says Dr. Gunther, 'are able to progress out of water, on humid places, and to hunt after their prey, which consists of terrestrial insects, using their muscular fins to spring with, they jump along by a series of leaps, over rocks, seaweed and the surface of the water, and prefer escaping in that way to swimming beneath the surface.' The accomplished Dr. John Davy, brother of Sir Humphrey Davy, carried on some experiments, forty years ago, on the vitality of fishes, and his conclusion may be stated as follows,—that the enduring power of each fish in relation to variation of temperature, &c., differs in degree, the Salvelini, to which our native brook trout belongs, being most intolerant, the Cyprinidæ least so, though of course there are limits to the endurance and accommodative power of every fish, even the most plastic and hardy.

*Periophthalmus.