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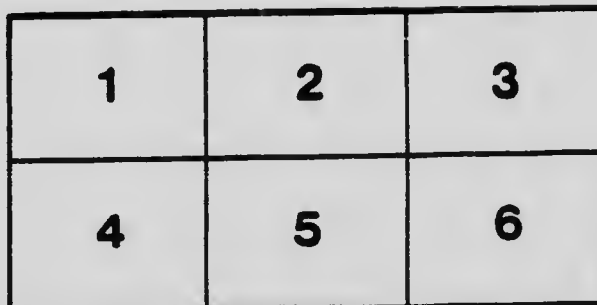
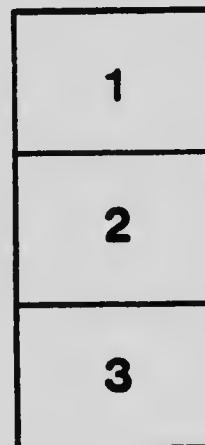
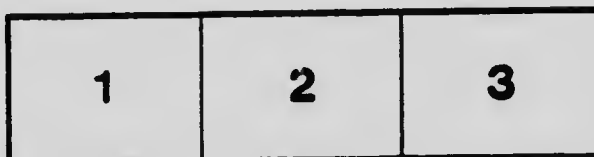
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SPECIAL REPORTS

BY

PROFESSOR E. E. PRINCE, F.R.S., CANADA

Dominion Commissioner of Fisheries

I. THE WHALING INDUSTRY AND THE CETACEA OF CANADA.

II. THE PROGRESS OF FISH CULTURE IN CANADA.

III. THE SCOTTISH HERRING CURING EXPERIMENT IN CANADA.

By Mr. JOHN J. COWIE, Lossiemouth, Scotland

(With Explanatory Preface by Professor PRINCE)

1905

OTTAWA
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1906

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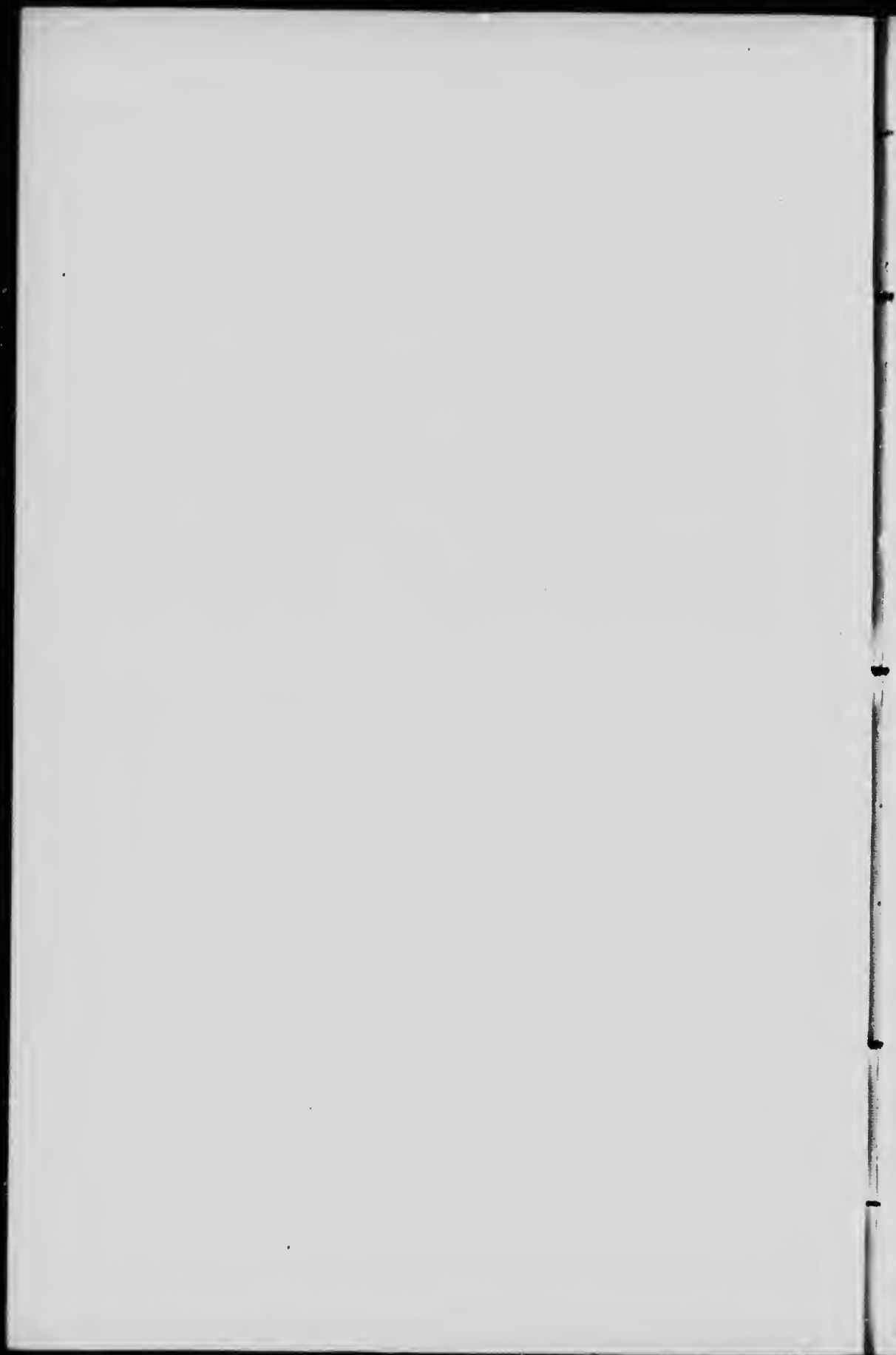
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SPECIAL APPENDED REPORTS

THE WHALING INDUSTRY AND THE CETACEA OF CANADA.

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

Public attention has been so prominently directed to the valuable whaling resources of Canada, and so many inquiries are being made upon the subject that a brief report upon our whales and upon the possibilities of our whale industries could not be more opportune than at present.

On the Pacific, as well as on the Atlantic shores of Canada projects are now afoot for the prosecution of whale hunting, and the utilization of whale economic products.

No less than seventeen kinds of the fifty species described by naturalists have been recorded in the waters of Canada, yet the whale fishery has never been developed to any adequate extent in the maritime provinces, in British Columbia or on our Arctic shores. The rich whaling grounds of the extreme northern waters, Hudson bay, the vicinity of Franklin Land, and the seas off the Mackenzie river estuary, though unsurpassed for their abundance of the most valuable of these huge monsters of the deep, have been exploited chiefly by European and United States whalers, and with the exception of Gaspé, and a few scattered centres in the Gulf of St. Lawrence, no residents in Canada have taken any considerable part in that most remarkable and profitable of old maritime pursuits, whale hunting. In 1895 I called public attention to these priceless products of our Arctic and other seas, and pointed to the startling fact that in Canadian waters were the last resorts of the Arctic baleen whale, the walrus, and other valuable marine creatures. In an account which I prepared for the Canadian handbook of the British Association for the Advancement of Science, 1897, I made passing reference to possible whaling industries, especially the utilization of the beluga or white whale and various species, in the Gulf of St. Lawrence and other readily accessible resorts of these large marine mammals.

During the last seven years whaling has been pursued with unwonted energy in Newfoundland owing to the enterprise of firms stimulated or controlled by United States citizens. From 1,000 to as many as 1,200* whales have been killed annually in recent years in the waters surrounding Britain's oldest colony, and as I stated in an address last year†, 'the companies carrying on the enterprise with adequate means and methods of utilization, have paid dividends of from 40 to 50 per cent per annum, while other firms prepared to only partially utilize the numerous products of the whale, or confining their operations to the manufacture of whale oil only, have been able to easily pay 6 to 7 per cent, besides adding substantially to their reserve funds each season. Some Norwegian concerns, it may be added, have paid as much as 300 to 400 per cent a few years ago. These enormous returns are due to the fact that the most recent methods of killing allow of the taking of the large and very numerous

† Lit. and Sci. Society of Ottawa, Session 1904-5.

*The number given for 1905 is 1,200 whales, and for 1904 about 1,000 in Newfoundland waters.

inferior whales, which were formerly neglected, while the adoption of mechanical reduction processes secures the utilization not only of the blubber and whalebone, but of the flesh, blood, massive viscera, &c., formerly cast away to be disposed of by voracious sharks, seals, &c. Now, however, not a scrap of these materials is wasted, and to the by-products is largely due the vastly increased profits referred to.

Of the sea's living inhabitants, regarded as marketable commodities, the whale tribe includes, not only the largest, but by far the most valuable examples. It is therefore hardly credible, in view of the fact that no country on the face of the globe has whaling areas to compare with those of Canada, that the whales should have been largely ignored by us, or rather, been left for other countries to profit by, thus bestowing on them immense wealth, which could have been retained by our own people.

PRESENT AND PAST ABUNDANCE IN CANADA.

From the earliest times, travellers and explorers voyaging in Canadian seas have noted the remarkable abundance of various species of whales in the Atlantic and Pacific, and especially the northern waters.

Jacques Cartier and his crew in 1535 saw more whales in the St. Lawrence estuary near Anticosti than they could remember ever having seen before. John Davis in 1587 met a great many whales in August off the Labrador coast, and later travellers, such as Charlevoix, described multitudes of these great creatures off Matane and Tadousac, nearly 200 miles west of Anticosti.

Occasionally specimens wander much further west, as in October, 1833, when a whalebone whale ascended as far as Montreal, a distance of over 600 miles from the Gulf, 80 or 100 miles of which is fresh water, and being pursued by a number of boats, was at last taken at Boucherville. In 1901 a small roxqual 33 feet long passed up the St. Lawrence to Montreal, where it was seen for some time by thousands of citizens disporting itself opposite the city below which it was stranded and died.

From the sixteenth century onward hundreds of French, Basque and English vessels mainly bent on taking cod, captured also seals, walruses, and whales. Of 300 or 400 of these vessels referred to by Richard Hakluyt in 1578, no fewer than 30 of them were Biscayan whalers. Whales were found off the New England coast, indeed hump-backs (*Megaptera*) occurred off the Bermudas, but authorities have raised doubts as to the identity of reported baleen whales, in the Gulf of St. Lawrence and south, with the right whale of Greenland and the Arctic seas. Eschricht went fully into the matter and favours the view that it was a different baleen whale. 'The existence, however, of a right-whale,' he says, 'with comparatively short bone in the seas round Newfoundland, does not, of course preclude the appearance of the Greenland whale in the same sea.' From these waters it appears now to be entirely absent. The territorial waters of British Columbia have been long regarded as famous resorts of valuable whales. Explorers in past times make constant reference to that important fact. "Hitherto," as I recently stated in an exhaustive article on British Columbia fisheries in the annual number of the 'Pacific Fisherman' (Seattle, January, 1906), the schools of whales have been of no value to the province whatever, but the action of the Dominion Government, by its encouragement of whale factories on modern principles will create in a few years a vast and remunerative industry all along the coast. A trip from Victoria to the Naas river suffices to show how plentiful these valuable creatures are, as whales may be seen 'blowing' in schools of from two to twenty individuals, all the way from the Straits of Georgia north."

EARLY EXTERMINATION POSSIBLE.

Whaling is, however, a doomed industry unless restraints are placed on foreign poaching, and wise measures taken without delay to secure the perpetuity of the fishery as a permanent and paying enterprise of Canada. It is no doubt true that the

money returns of whaling shows an increase in recent years, but this is partly due to the disproportionate rise in the value of certain whale products, and partly to frenzied efforts by whalers, a 'last great onslaught' much like the final attack in a prolonged struggle, when in spite of the reduced numbers of the belligerents the number of killed is yet greater than at earlier stages in the campaign.* Whales must succumb for two principal reasons just as the herds of wild elephants are practically extinct in Africa. First, their numbers must always have been limited, owing to their size, habits, peculiar food and slow growth. If no enemy of the whale tribe existed these huge creatures could never have increased like deer or rabbits, their power of surviving unfavourable conditions of life being so small. Secondly, their low rate of increase—one calf or young whale being usually produced at birth in probably every third year. No animals produce so few young and reach maturity so slowly.

Professor W. C. McIntosh in his widely-known work, 'The Resources of the Sea,' which on the whole favours the inexhaustibility of the fish supply in the oceans of the world, says of the whale tribe: 'The resources of the sea, however, are limited in the case of the large air breathing forms pursued by man, such as the right-whale or bow-head, which has steadily decreased in numbers during the present century. The reckless slaughter of the young whales accompanying their dams, a sure method of capturing the unfortunate and solicitous mothers, has intensified the effect of this eager chase by various nations for whalebone and oil. Producing but a single young one at a birth, this huge and harmless mammal will probably disappear unless measures are taken for its preservation. The same may be said of other whalebone whales which are pursued for profit, and of the dugong and manatee, the oil, skin, and skeletons of which are of value. The huge Pacific grey whale (*Rhachinectes glaucus*) of the lagoons of the California coast, has, indeed, been entirely destroyed by man.

The effect of the slaughter of hundreds of the caving whale (*Globiocephalus melas*) is not so clear, but the xiphioid whales captured in the north seas for their oil are in great danger. In no species has the inability of recuperation from constant attacks been better illustrated than in the sperm whale, the numbers of which have been seriously diminished within recent times.' The captures in former days are truly astonishing to contemplate. Professor Lilljeborg, of Upsala, an eminent authority, speaks of their slaughter by hundreds of thousands in past centuries, and we have reliable records that the Dutch whalers in Davis Straits and other Arctic hunting grounds killed 6,896 huge baleen whales between 1719 and 1778. While Professor Eschricht recorded the killing of 3,391 of these valuable creatures in four years (1827 to 1830), and added, 'the persecution was carried on with great success, and very extensively, until the profits... began to diminish, and the fishing trade to dwindle away, till it reached its present (1861) comparatively unimportant state.... If we ask what influence this violent war of extermination, continued during more than a century, has had upon it, we see that the whale until this day appears within precisely the same limits in which it was found at the beginning of the persecution, but in numbers so diminished that the fishing at least in the ordinary method.... will hardly repay the trouble and expenses attending it, the whales, therefore, are in peculiar danger of extermination under modern destructive and systematic methods, if unrestricted.

WHALES ARE NOT FISH.

All the whale tribe are commercially valuable, indeed, increasingly so; but they are also profoundly interesting both to the scientific man and the ordinary observer. They are the last of the leviathans which flourished in the seas of past geological ages before the advent of their arch-enemy, man. They are so fish-like that even

* The seventeen North Atlantic U.S. sperm whaling vessels brought 9,650 barrels of oil last season, the largest returns for many years, taking into account the number of boats engaged.

well-informed persons speak of them as fishes, and the professional whalers always refer to them as 'fish' and their calling as 'whale fishing,' although it would be as correct to call a beaver, or a moose, a fish, and speak of beaver or moose fishing, because these animals so frequently resort to the water. Not one of the chief characteristics of the fish tribe applies to the whales except their boat-like form, their paddle-like hands or flippers, and their double-fluked tail. Fishes are somewhat cold blooded, usually clothed with scales, breathe by gills, produce in the majority of species, eggs, never possess hair, and do not require to come to the surface of the water to breathe. Whales on the contrary have warm, indeed very hot blood, their skin is smooth and pliable, and some parts in early life are hairy*, while their young are born alive, and suckled like calves, and resort to the water's surface at short intervals, of necessity in order to empty and refill their capacious lungs. When whales are stranded they perish miserably, not owing to the clogging of the gills, as in the case of a fish, but from injury to their unwieldy bodies and from hunger, and most probably terror, as they are with one or two notable exceptions most timid creatures.

HUGE DIMENSIONS OF WHALES.

Their monstrous dimensions are an impressive feature. In length they range from four or five feet (the porpoises of the Amazon and Ganges—fresh water whales—for example) to 30 or 40 feet, up to 80, 90 or 100 feet. No doubt there has been much exaggeration in descriptions of the size of whales, but on reliable authority one was seen at close quarters several times this year (1905) off Barclay Sound, Vancouver Island, which was estimated to be not less than 110 feet long. It was a sulphur-bottom whale (*Balaenoptera sulfureus*). In the fall of 1903 the whaling steamer *Humber* harpooned a finner or rorqual of the same length (110 feet) in the North Atlantic, and it towed the steamer at the rate of seven miles an hour, though the engines were reversed at full speed, creating a net grade movement equal to eight miles per hour, and the whale did not weaken for twenty-nine hours. At the shoulder, one of these monsters will measure 12 to 15 feet; the tail, which is horizontal, measures 18 to 20 feet across, and the flipper or hands are from 7 to 15 feet long—the last measurement being that of the hump-back (*Megaptera boops* or *longimana*). Professor Owen gave in his book on 'The Skeleton and Teeth,' a figure of a rorqual (*Balaenoptera musculus*) 96 feet long, while Scoresby's well known whale stranded at North Berwick was 78 feet long and weighed 140 tons, though there are records of whales whose total weight approached 250 tons. The Bowheads or Arctic right-whales are not so large as the less valuable rorquals, though they range from 50 to 60 feet and may even be 70 feet in length. The monstrous mammoth is diminutive when compared with the largest whales. Thus the huge mammoth or hairy elephant in the Imperial Museum at St. Petersburg is 9 feet 3 inches high and about 10 feet long, while the still finer example, in the Chicago Museum, is 9 feet 6 inches high, and nearly 12 feet in longitudinal measurement. A whale was captured 8 or 9 years ago on the Scottish coast, with a harpoon in its body which had been 50 years in its use, thus indicating that their great age is in keeping with their huge size.

BREATHING OR SPOUTING OF WHALES.

The method of breathing or spouting as it is called, is so remarkable in whales and so generally misunderstood that a brief reference to it is necessary. Artists so frequently picture whales in the act of throwing up lofty fountains of water, that it is necessary to point out the impossibility of any whale breathing out water. These creatures breathe out air, their lungs being of enormous size and extending

* A few stiff yellow hairs occur at the tip of both jaws and near the blow-hole; and in toothed whales hair occurs only along the upper lips.

much further back than in most air-breathing creatures. The organs are broad and not divided into lobes, but their substance is so elastic that any air contained in them can be completely squeezed out, and each lung becomes, as it were, a solid mass. Thus easily emptied, the lungs are as easily filled, as one well known authority pointed out, so closely do the air cells open into each other, that 'by blowing into one branch of the trachea, not only the part to which it immediately goes, but the whole lungs are filled.' The inspiratory muscles and the diaphragm are greatly strengthened and the latter has a very small tendon. Elastic tissue abounds in the lungs and makes the expiration process easy. Whales are compelled to come to the surface of the sea to breathe. If detained under water too long they die. They are drowned, precisely as a human being is drowned, by asphyxiation and water-choked air passages. The nostril or blow-hole (in some cases two nostrils or blow-holes) are situated on the top of the long ponderous snout, the breathing being called 'spouting,' because the breath is spasmodically forced out like a jet of vapour resembling the snorting of a hard-driven horse, but on a gigantic scale. Each spout is followed by a sigh like that of the piston of a mighty Cornish engine. The huge finners or rorquals, the porpoises, belugas, and others send forth one column, but the Arctic whale, called the bowhead or right-whale, and the sperm whale or cachalot, force two high columns into the air. As the well-known Arctic authority, Dr. Brown, has said:—

This 'blowing,' so familiar a feature in the cetaceans, but especially in the right whales, is quite analogous to the breathing of the higher mammals, and the 'blow-holes' are the perfect analogues of the nostrils. It is most erroneously stated that the whale ejects water from the 'blow-holes.' I have been many times only a few feet from the whale when 'blowing,' and, though purposely observing it, could never see that it ejected from its nostrils anything but the ordinary breath, a fact which might have almost been deduced from analogy. In the Arctic air this breath is generally condensed, and falls upon those close at hand in the form of a dense spray, which may have led seamen to suppose that this vapour was originally ejected in the form of water. Occasionally when the whale blows, just as it is rising out of or sinking in the sea, a little of the superincumbent water may be ejected upwards by the column of breath. When the whale is wounded in the lungs, or in any of the blood vessels supplying them, blood, as might be expected, is ejected in the death-throes along with the breath. When the whaler sees his prey 'spouting red,' he concludes that its end is not far distant, for it is then mortally wounded.'

Some of the whales spout eight or nine times and then go below the surface for half an hour. The monstrous sperm whale spouts with regularity for three seconds and then a ten seconds interval follows before the 'spouts' recommence. The intervals appear to vary, some whales spouting every thirty seconds, some every minute and a-half, while Professor Alex. Macalister observed a *Megaptera* rising regularly every two minutes.

Whales have been known to remain down for half an hour—or even an hour and a-half, a most remarkable thing for an air-breathing animal with warm blood to do. We know that the pearl-oyster divers after long experience and training can remain under water for five minutes, but not longer; and the whales are able to keep below the surface for lengthened periods owing, it is considered, to an enormous development of arteries around the spinal cord, especially in the region of the ribs, where the ribs are articulated to the backbone, also inside the vertebral column, the basis cranii, and other places, these *retia mirabilia*, of which the details are given on the next page, being present not only as devices for storing blood, but for repeating the heart's rhythmic impetus, as we find is the case in other gigantic creatures, the elephant for instance possessing considerable arterial plexuses near the base of the hind limbs and in other parts of its huge body, these acting as supplementary hearts.*

* In the Sloths which creep in a reversed posture *retia* are present at the base of the limbs.

HEART AND BLOOD CIRCULATION.

The heart and blood circulation are also remarkable. The pumping organ is large even for such large creatures as whales, the main artery or aorta where it leaves the heart being of the diameter of a man's waist, in the great rorquals; while the heart itself, as Professor Owen stated, 'may be more than a yard in transverse diameter and not much less in length,' while its apex or pointed end is often rounded or indeed flattened and sometimes partly divided, though far less so than in the dugongs or Indian sea-cows in which it is deeply cleft. When a whale is injured or harpooned it bleeds profusely, so abundant is the blood, that the sea becomes reddened for a considerable area. At each pulsation of the heart 10 to 15 gallons of blood are driven through the body, this amount per stroke being 240 times the quantity driven at each heart-beat in man. The huge heart, capacious arteries and rich vascular system are necessary to contain the enormous quantity of blood in the whale's system, but a very marvellous provision exists in addition for the storage of the fluid. In the head a network of arteries, supplied by the inner and outer carotids, is found round the base of the skull, while a similar enormous plexus or network extends into the canal of the vertebral column*. Dr. Robert Knox found inside the skull a blood plexus under the *dura mater*, which constituted no less than one-half of the contents of the cranium, and similar coiled masses of arteries lining the sides of the chest close to the ribs. These convoluted intercostal arteries are not branching, but simply complexly folded as a garden hose-pipe might be coiled up so that as Professor Owen stated, 'they can be unravelled and traced to a great length without sending off branches or changing the calibre.' These astonishing blood reservoirs no doubt fulfil several functions, keeping the neural axis and nerve system supplied with oxygenated blood and retaining a quantity of the same during the lengthy periods of submersion, when the act of inspiration and purification of the blood is impossible.

WHALE'S MILK.

Whales give birth to living young, usually one calf, though in very rare instances twins have been observed. On the Finmarken shore (Norway) ten or twelve years ago a female whale was noticed with two calves, but until then no such event had been observed since 1865. Whalers so rarely have noted such an occurrence that it must be unusual. Like cattle, the calf is fed with milk which the female whale produces in quantity. The fluid is very dense, like soft tallow, of a yellowish white colour and possessing an offensive fishy odour. The mammary glands are two long narrow bodies, below the blubber, situated on the under side of the body, not on the breast, but a long way back. Each has a main tube or duct, and terminates in a teat, concealed in a groove, which no doubt opens widely so that the teat projects for the nourishment of the calf. Professor Owen thought that the muscles near the two milk glands had little to do with the pressure and ejection of the milk, this being accomplished, he thought, by the great 'pressure of the surrounding water... upon the extended surface of the mammary gland, hence we may readily conceive that when the nipple is grasped by the mouth of the young, and the pressure removed by the retraction of the tongue, the milk will be expelled in a copious stream by means of the surrounding pressure alone, independently of muscular aid.'*

Prominence has recently been given to a proposal to save and utilize the fluid from the two huge lacteal glands of female whales, several barrels being obtainable

*Knox pointed out in 1834 that the blood plexus filled three-fourths of the spinal canal and surrounded the spinal marrow and nerves, and was two inches in thickness in some places. Dr. John Hunter had described this system in 1787, Dr. Barclay (in the beluga) in 1795, and Bresebet still later, in 1834.

* Anat. of Vertebrates, Vol. III., p. 778.

from one whale, but this is a revival of a very old proposal made by Professor William Macdonald, a venerable teacher in the University of St. Andrews half a century ago. He said that as whales give milk like cows and goats, a large specimen might be secured by a long chain near such a city as Edinburgh, and supply milk daily to the city. A quantity of this milk, which I examined when it was being described by Professor W. C. McIntosh and analysed by Professor Thomas Purdie, did not appear very inviting though its nutritive qualities were very high. The Greenlanders have long regarded whales' milk as an esteemed dainty.

The calf of the various species of whales and porpoises is disproportionately large, newly-born specimens being recorded, which measured 16 feet in length, while a calf still suckling was captured which measured about 20 feet in length—it was a baleen or Arctic whale. In some museums there are specimens (unborn whales) from 2 to 3½ or even 8½ feet long, but at birth the size is extraordinarily large as stated. From evidence obtained by scientists the whale is held to produce young every second year, not annually.

The mother whale has a strong attachment for her young, and often rushes to certain death to rescue or defend her offspring. Whalers are, indeed, accustomed to secure the calf first, as they can rely upon the mother before long approaching and affording an easy opportunity of capture.

WHALES NOT FEROCIOUS.

The whale tribe as a whole are not 'fierce, destructive monsters,' as Michael Drayton described them, and even the popular idea that they are hideous and uncouth beyond description is far from the truth. The late Professor Blackie once likened the great Forth Bridge in Scotland to a whale, because of its extreme ugliness, but no one can watch the movements of a porpoise or a whale gliding with ease and grace through the water, without realizing their perfect adaptability to the conditions of life to which they are subject. Sailors' stories of the ferocity of whales are almost wholly groundless, although a harpooned specimen in its agony will bound and rush about with terrific speed and power. By nature they are gentle and even timid, like most animals of huge size. Newspaper correspondents, ignorant of the true nature of whales, publish for their eager gaping readers glaring paragraphs of a sensational nature. Not long ago a British Columbia newspaper published an account of whales, by some writer not very thoroughly posted in the habits of these monsters, stating that the porqual is the fiercest of all the whale tribe, a statement almost as true as that the lamb is the fiercest of all the sheep tribe! As an example, I clipped from a paper, a few years ago, the following paragraph, which is a type of newspaper notices published frequently:—

'DESPERATE ENCOUNTER WITH WHALES.—Despatches from San Francisco received at Queenstown yesterday contain intelligence of the arrival at San Francisco of the whaling barque *John Winthrop* on October 20, when the captain reported that on September 23 a large whale was sighted, and two boats were sent to capture it. As soon as the whale was struck by harpoons it wrecked both the boats, killing three men and breaking the legs of two others by striking them with its tail. The seamen were thrown into the sea, but were rescued by a third boat from the ship.'

Even the ancients knew better, and amongst many narratives referring to these creatures the delightful account of Pliny the younger, telling of Hippo's enamoured dolphin, is an example. The whale's enormous muscular powers enable it to roll, leap and plunge, with terrific force when its body is pierced by sharp harpoons. It will writhe and lash the waves into foam by the tremendous contortions of its mighty frame in its agony. But the affectionate and harmless nature of whales generally is remarkable, and instances are not uncommon which show that they have a sociability and an attachment to each other, stronger perhaps than that of any other living

mammals. Cases are on record of whales escaping from an imprisoned school which had been driven through a narrow gully into an inclosed harbour, and those escaping after lingering about in the open sea looking out for their comrades, returned to rejoin their unfortunate companions and were slaughtered by the whalers—evidently declining all opportunity of escaping again and leaving the imprisoned school. In one case, a large bull-whale escaped and swam out to sea, turning round continually as if to induce his companions to follow. Backward and forward he went, while the men were butchering those impounded in the bay, and, at length, seeing that all his efforts were in vain, he swiftly swam back to the imprisoned whales, rejoined them and allowed himself to be killed with the rest. The docility and intelligence of some of the great whales prompted an old writer to picture tamed and trained whales harnessed to vessels and speeding across the seas from port to port. A British naval commander wrote to a London paper a few years ago letters recounting his experiences with whales, and amongst other things, he said:—

‘One afternoon two of these lovely creatures passed under us amidships. They spouted a little distance off and dived. While they were doing so they looked like two brown hills sporting about with the water breaking all gently round them—not being a poet I cannot describe their grace—but I have realized that a thing of beauty is a joy for ever through that scene, though it contained only two whales, a ship and the ocean. But to come to matter of fact; suppose they had dived when we came in their way, so as to be level with our bottom, no one would have heard of us again. What a pity it is that we cannot build a whale with a ram, or something to work like one, or use them as we do the elephants, for war purposes.

‘On the coast of Africa, many years ago, large numbers of black whales kept round me (I was in a thirty-two foot boat) for two days and a night. Their wash often gave us an additional roll. I was going to fire at one, but the coxswain beckoned me not to, as we should be sent to splinters if I did. They were not so large as the mid-Atlantics, nor did they impress me so much with their grandeur. However, this little epistle will prove that they are rather friendly than spiteful. In my youth I remember a large Atlantic fellow swimming alongside a ship I was in, often right under the swinging boom.’

When H.M.S. *Herald* visited Moreton bay, some years ago, the natives entreated the tars not to shoot the small whales abounding in the locality. They were comparatively tame, and when a signal was given to them by the natives they drove schools of fish ashore. The natives struck the water violently with their paddles and, it is affirmed, the whales did their work like Scottish sheep dogs. Mr. Lee, who had charge of the famous English aquarium at Brighton, had porpoises on many occasions in the great tanks, and I myself spent much time watching their lively and graceful movements in the sea-water aquaria. Mr. Lee cherished the idea that, like Captain Salvin’s trained cormorants, whales and porpoises could be taught to drive fish upon Brighton Beach, and thus supply the daily requirements of the aquarium.

They are playful in the highest degree and their colossal gambols are impressive to behold. Every one knows how porpoises and larger members of the whale order will race with steamers when crossing the ocean at high speed; but in the late fall they are especially lively and even the most monstrous whales will leap entirely out of the water with a peculiarly wriggling or worm-like movement, ascending perpendicularly high above the surface of the sea, and then helplessly falling back into the water.

In the North sea, and in the Atlantic, I have on many occasions watched these marvellous gambols, the sea being tossed into mountains of white foam in the vicinity of the leaping monsters. Recently when off Cape Mudge, and in the neighbourhood of Rivers Inlet, British Columbia,* I saw mighty humpbacks and rorquals ascend

* During my official trip with Captain Holmes Newcombe in December last.

perpendicularly out of the water, so near to the Dominion cruiser *Kestrel* that I could see the 'reeves' upon their under surface, and white streams of water coursing down the whale's huge sides, like torrents down a precipitous mountain. The dark shining skin and the peculiar bodily vibrations of the whale, and its slender form viewed in front or from the dorsum, recalled a gigantic leech springing out of the sea. Time after time whales will make these great leaps, aided by the powerful horizontally-placed tail. Sheer animal spirits and playfulness will account for some of these gymnastics, and late in the fall the female pursued by the male, will act in this manner, but it is a spectacle that once seen can never be forgotten by the spectator.

THEIR ENORMOUS PROPELLING POWER.

Their enormous locomotive power is due to the muscularity and form of the tail. Their ordinary rate of progression is believed to be 12 to 14 miles an hour, and Sir Wm. Turner, of Edinburgh, has stated that to carry a whale of 74 tons through the sea at a rate of 12 miles an hour a force of 145 horse power is necessary.

There are few spectacles more weird and impressive than that of a large whale noiselessly moving through calm water producing only gentle ripples, as he rises and puffs out a cloud of dense vapour, or again in the rolling waters of a rough sea suddenly heaving above the waves, like a moving island, exposing his massive smooth sides for a moment, and sinking again into the trough of the sea, a spectacle seen by me more than once off the west coast of Ireland.

My first personal experience of the kind was in 1885, and on subsequent occasions, I have been in the close company of some of the largest of existing whales. My fishery duties had taken me out with the Peterhead (Scotland) herring fleet, and all day long our crew—the crew of one of the largest Buchan yawls—had been on the look-out for 'farks,' really the old Norse name 'hval,' another form of the name being the German 'Walfisch.' Just as day faded we saw white clouds, rising here and there from the water, like jets of steam or puffs of mist. Some shot up very near, i.e., within 100 or 150 yards, and very soon we saw huge backs, and monster spreading tails, all around, indeed, we seemed to be surrounded by the gently gliding monsters. To a novice the sight was somewhat terrifying; but it filled our fishing crew with delight. It was to them the surest sign of herring shoals. Each puff or spout was accompanied by a sigh like the gasping of a great engine's piston. One very large whale rose not more than 3 or 4 yards from the bows of the boat where I stood, and I could see his great length—far larger than the ship in which I was sailing. It was so close that I could distinctly see the eye, bright and intelligent, and small for so huge a creature, like the eye of an ox, but brighter and even gentler in expression. Its shoulders rose above the waves like a large dark mound, and after giving a mighty puff, it wheeled over so that I saw the small back fin followed by the flattened and wide-spreading tail.

FISHERMEN OPPOSE WHALE INDUSTRY.

When in the midst of 'farks' the North sea herring boats, as an established fact, usually make very large catches of fish, hence the recent proposals to operate whaling factories, and slaughter the whales has aroused intense opposition from the Scottish fishermen, and in a similar way caused a stirring controversy in Norway some time ago and more recently in Newfoundland. His Majesty's secretary for Scotland regarded the feeling as so weighty that he authorized a special commission to investigate the probable effects of a whaling industry in the waters off the north of Scotland. The main complaints were two, and it was upon these that the committee reported in July, 1904, viz.:-

1. That the treatment of the carcasses has been the cause of nuisance and danger to public health, and even to navigation; and

2. That it will injure the herring fishing.

As to the first question, the conclusion at which the committee arrived was that under proper regulations and inspection the industry is not open to objection on the grounds of nuisance or danger to public health. Regarding the second question, the committee were of opinion that while unrestricted whaling might be a possible danger to the herring industry, they were not satisfied that valid reasons had been brought forward for the total prohibition of whaling. They were of opinion that total prohibition would have consequences more dangerous to the herring fishing industry than regulated and limited whaling. They recommend that whaling should not be entirely suppressed, but should be regulated and limited. In the whole matter they came to the conclusion that the new whaling industry ought to be permitted to continue, but only under limitations and regulations, and that with such limitations and regulations it would not be a danger to the herring industry.

Such proportions did the antagonistic feeling attain in Norway, that the government had to appoint a commission of inquiry to determine whether this was so or not, and, though the commission's report was rather against the popular view, the agitation remained unquelled and last year the Norwegian parliament had to enact a law forbidding the prosecution of the whale fishery on its own coast or within its own territorial waters for a period of ten years, in order to satisfy popular clamor, the 'whalery' owners whose property and vested interests were thus summarily treated, being indemnified in part for their losses. In Newfoundland the past two years a similar agitation has been in progress, and the Legislature was deluged with petitions praying for action by the Government in the premises for fishing, a close time, a buying-out of the factories, and a regulating of the industry being among the solutions proposed. But the unexpected decline of the fishery, collapsing from excessive development, resulting in bankruptcy and loss to many firms rendered less urgent any action. The fishermen held the opinion that the scarcity of caplin, so valuable in attracting inshore the valuable schools of cod, and the decrease in the squid, the best of baits, were due to whaling operations and the killing off of whales. Recent reports state that public discussions held in St. Johns did not bear out the fishermen's views of the matter and the resulting conclusion showed that whaling was not detrimental to fishing interests. It was argued that the idea of whales affecting the movements of caplin and squid was delusive. The whale does not eat squid at all, yet squid has been as scarce as caplin. If caplin leave the shore because whales are scarce what causes squid to leave?

TIMIDITY OF WHALES.

They are so inquisitive that they will approach vessels without fear, indeed like the seal tribe they will run great risks in order to satisfy their curiosity and will often come great distances to gambol round a steamer or sailing boat. But they are also timid and easily alarmed. They have a habit, the largest whales especially, of floating quietly without any movement near the sea's surface in quiet weather. Just the mound-like nose or the protruding back may be seen; but long before the ordinary steamer can approach the creature appears to wake up, dive down and with a flip of its mighty tail descend beyond danger. The well known hunter Captain Campbell McNab, of the lower St. Lawrence, turned the timidity of the whale tribe to account in a plan for capturing belugas or white whales in the Gulf of St. Lawrence. He fixed up vibrating rods, the effect of which was so unfamiliar that the belugas were terrified. I quote from an account published two or three years ago before Mr. McNab's death:—

'Sportsmen who have visited the Saguenay will remember how many of these great white cetaceans may be seen disporting themselves upon the surface of the St. Lawrence, near the mouth of the former mentioned river. They appear like shapeless masses of blubber as their arched backs show from time to time above the surface. They are doubtless attracted to the mouth of the Saguenay by the large number of salmon which

enter the river throughout the season. As each porpoise is supposed to eat from one to three barrels of fish per day, it is comparatively easy to form some idea of the fearful ravages which they make among the salmon, the herring and the cod. They are largely gregarious, though they frequently hunt their prey in couples. Mr. McNab has often peered over the edge of an overhanging rock to watch them catching salmon at the mouth of a stream, and sometimes a long distance up a river where they follow their prey. They chase a salmon into a shallow and then approach it from either side. The salmon appears unable to move, as if paralysed by fear. If he attempts to run from one of his pursuers he falls into the open mouth of the other. The porpoise is equally expert in fishing for the slippery eel. Mr. McNab opened one of these animals the other day and found more than forty eels in its stomach. To prevent their wriggling, and probably also to aid digestion, the porpoise cracks the skull of the eel between his teeth before swallowing it.

The porpoises are captured by being imprisoned at low tide on the shoals, over which they have journeyed when the tide was high, in pursuit of their prey. Hitherto the difficulty has been to find any barrier strong enough to retain such enormously heavy beasts, and so many of them together as are sometimes inclosed. Mr. McNab has made the interesting discovery that the enormous nets through which they often broke are not necessary to hold back the porpoises. They are unable to stand the slightest vibration in the water, and so all that the hunter now finds necessary is to fasten a long, thin pole like a fishing rod, to a stake in the mouth of the stream, the bay or the estuary within which it is desired to retain the porpoises. They remain to be stranded and killed upon the shallows rather than venture past the vibrating rod. This sensitiveness is believed to have its seat in the ear of the animal, which has so small an opening that it might almost have been made with a pin. For years McNab has held firmly to this theory only to be laughed at for his pains. He has now proved 'beyond peradventure.'

CLASSIFICATION AND ANATOMY.

The order of whales or cetacea has been divided into three sub-orders, viz.:—

- (1) *Mystacocete*, Right-whales, Finners and Hump-backs.
- (2) *Denticete*, Sperm-whales, Beluga, Porpoises.
- (3) *Zeuglodontia*, extinct whales with long snouts and a neck and three kinds of teeth.

The skeleton of the large whales is very massive, the skull being as large as a good-sized breakfast table, excepting in the right-whales in which the skull measures from 17 to 20 feet in length and weighs about a ton. The total weight of the skull and jaw-bones of a whale, about 50 feet long as given by Professor W. H. Flower, is over 3,000 lbs., or more than 1½ tons. The ribs are several inches in diameter and 10 to 15 feet long and their number has long been regarded as so constant, that specimens not agreeing in the number of ribs are regarded as not belonging to the same species. The number of ribs and vertebræ is held to be constant in the different species. Thus the Arctic right-whale has 13 pairs of ribs, whereas the Japanese and the southern right-whale have 15 pairs of ribs. Naturalists do not regard them therefore as belonging to the same species. Of the fin-back whales, which many authorities have been inclined to collect together under one species; *Balænoptera rostrata*, the pike-whale, has 11 pairs of ribs, whereas *B. musculus*, the rorqual, has 15 pairs, and the rorqual called *B. gigas*, by Professor Eschricht, the greatest authority on the subject, has 14 pairs. On the other hand, *B. laticeps*, which is possibly of the same species as *B. robusta* of Lilljiborg, for in both the lower jaws are less curved than in the pike-whale or the great rorqual, the number of ribs is 13 pairs. A Danish school-

master, Mr. Thomson, studied and figured a 'killer' whale, which had 12 ribs on one side and 11 ribs on the other, 'a difference,' as Professor Eschricht points out, 'that seems to denote that the number is not quite constant.' The number of bones in the spinal column is held to be strictly constant, there being 65 bones in the rorqual and 48 in the Arctic right-whale. The bones of the neck are united together, so that the whales cannot twist or turn their heads. The flippers or fore limbs are really hands, exhibiting a thumb and four fingers, but in the rorqual and in *Pontoporia* the thumb is absent. A common sheath of muscle and skin incloses them, so that they appear like a fin; but the arm, wrist, and manus, or hand, are all present. There are in many whales rudimental hind-limbs. In a 64-foot right-whale, the pair of bones representing the pelvic girdle are 16 inches long, and there are often nodules of bone representing the free limb or leg. The arched bones, often 12 to 15 feet or more in length, which have been familiar objects as gate-posts, &c., are the two huge mandibles, which bear massive lips of a remarkable form in the whalebone-whales. The maxilla and premaxilla above, and the curved mandibles below, define a mouth cavity of vast capacity, in some species not less than 200 cubic feet. The floor is formed by the soft cushion-like tongue, which is very full of oil and is attached over most of its lower surface to the floor of the mouth. In toothed whales teeth may be present in the lower jaw only, and are always conical, single-fanged, and numerous*.

WHALEBONE AND BLUBBER DESCRIBED.

In toothless whales the mouth is armed with massive plates of whalebone attached to the transverse folds of the palatine mucous membrane. These plates are wide at their attachment, but narrow towards the tip, and on the edge, turned towards the tongue, a strong fringe of bristles exists. The plates are from 5 to 12 or 15 feet long, and 12 inches broad, at the widest part. The plates are set in a series one behind the other, from the front to the back of the mouth, on each side. There are 300 to 400 large plates on each side, and as Prof. Eschricht said, 'their number is really the same in the new-born as in the full-grown individual,' and he added, 'the foremost and hindmost laminae of both sets must grow very slowly, for not only in a 22 feet long female, but even in a 44 feet long quite full grown male, these laminae were very short, the smallest blades being only 2 inches long.' The longest blades may reach a length of 15 feet, but it has been found that while the female whale as a rule is larger than the male, the largest blades of whalebone occur in the male—and the blades continue to grow even after the body has reached its full size. The whalebone of rorquals and humpbacks is very different and commercially far inferior to right-whale whalebone. It is shorter—often paler in colour and of a less elastic, drier nature. Whalebone exhibits two portions, when minutely examined, a cortical outer layer, and an interior medullary part consisting of horny tubes in which soft filaments extend. In the rorquals these filaments extend very far into the medullary tissue, which is thus hollowed out, but in the right-whale the filaments are very short, and the horny tubes are hollow only near the base of the blade, hence the whalebone is more compact and is of far finer structure. A full-grown Arctic whale will yield about a ton or a ton and a-half of whalebone, which is valued at about \$3,000 per ton. During last season (1904-5) a San Francisco whaler captured six bow-heads or Arctic whales, from which 12,000 lbs. of whalebone were taken, a very remunerative result, apart from the blubber and oil which are of some value, though the oil realizes only half the price which it brought 40 years ago. Whalebone in drying loses about half its weight, but it is possible that were the blades, especially those of the dry crisp nature of the rorqual's whalebone, soaked for a time in dilute glue or 'size,' the weight and elasticity might be increased, and the commercial quality improved.†

* The extinct *Zeuglodon*s had two-fanged teeth with serrated crowns.

† The late Frank Buckland said, 'The hairs of baleen are united one to the other by a kind of animal glue. By boiling and hammering I find the baleen can be reduced to a state of hair.'

The uses of whalebone are remarkable. It is no longer used as a supporting frame work in ladies' attire or as 'ribs' in umbrellas, but out of it artificial feathers of exquisite lightness and elasticity, and wigs or 'toupees' of a most lasting character, are made. Shredded into fine filaments it is woven in with the silk fibres in the manufacture of the finest French silk fabrics, imparting buoyancy and elasticity to the rich materials, and greatly enhancing their value. Underneath the smooth dark epidermis occurs, in all the whale tribe, a dense layer of fatty tissue or blubber, an immensely thickened 'panniculus adiposus,' which forms a blanket around the body, retaining heat in the midst of the icy Arctic waters. This layer of fat is present in all mammals excepting the hare (*Lepus*); and in the bear family (*Ursidae*) it is very thick, especially before winter hibernation. Usually the epidermis can be easily detached from the fatty layer beneath, but in the whales, porpoises, &c., the network of strong fibres, in which the oily matter is stored, is closely attached to the outer skin, and sharp knives or spades are used to separate it. The blubber may range from an inch, in the porpoises, to 5 or 6 inches in the rorquals, or 5 to 6 or 10 inches, but in the right whales it is 14 or 15 inches or more, indeed the famous Scottish whaler Captain David Gray wrote to Frank Buckland respecting one large whale taken by him, 'his blubber measured 22 inches thick along the back.' The best quality of oil tried out of whale's blubber is used for soap-making, ointments and the like, while the inferior grades are sold to tanners, very little is now used for illumination purposes, but chiefly for oiling machinery, &c. It is of special value in the manufacture of jute, as a lubricant in working the fibre. Hence Dundee whaling and Dundee jute industries were mutually associated.

While the toothed whales live upon fish, squid, and other marine creatures of some size, certain species like the kill. (*Orca*) attacking seals and even larger whales, the great whalebone whales are wholly non-predacious. The huge mouth of the right-whale or the rorqual takes in a mass of water full of floating molluscs, shrimps, jelly fishes, and in Arctic waters, pteropods and heteropods, and on closing the jaws and elevating the great flabby tongue, the contents of the mouth are pressed against the sieve-like arrangement of whalebone plates, which act as a strainer. The water is squeezed between the bristly plates, but every particle of solid matter is retained and swallowed. The rorquals and shoals of cetaceans which follow the herring are, as Dr. Harry Goodsir pointed out to Dr. Robt. Knox, feeding on the same food as the herring themselves, viz., the minute copepods, &c., known to Scottish fishermen as 'maidre' or 'maither,' as Knox himself had surmised in 1843, never having found any fish in the stomachs of large whales he had examined.

SPERM WHALES.

Of the toothed whales the cachalot or sperm-whale is the most valuable*. It is unfrequent in the more northerly waters, indeed it is absent from the Polar seas, and prefers more temperate and equatorial latitudes. It is occasionally seen off the British Isles, a large one being recorded in 1769 in the Firth of Forth, and a male specimen 50 feet long was cast ashore in 1825 off the Yorkshire coast, the skeleton of which is preserved at Burton Constable, and a 70 feet example off Caithnesshire in August, 1863, but reliable records of its occurrence in Canadian waters are rare. That it inhabits our seas both on the Pacific and Atlantic is well-known, and a fine specimen was taken two years ago off the Newfoundland coast, but unfortunately it was not recognized as a sperm-whale until a great part of the valuable spermaceti had been wasted. The head is enormous, occupying one-third of the length of the body. Its huge size is due to the great chamber or 'case' which may be called the forehead of the whale. It is a network of fibrous bands inside, and the interspaces are filled

* *Callignathus stmus*, Owen and *Kogia Floweri*; Gill, the latter only 12 feet in length, are close allies of *Physeter macrocephalus*, the common cachalot or sperm-whale.

with a clear watery fluid which crystallizes into white spermaceti—a semi-transparent, brittle lamellar material long used for making the best wax candles. It is regarded as a cetylate of oxide of cetylene, and after crystallization leaves a clear yellow oil as residue. The thick blubber yields sperm oil. The Caithness specimen already mentioned, produced 1,620 gallons of oil and blubber. On each side of the lower jaw occur 22 or more beautiful ivory teeth, and they are used for tearing up squids and cuttle-fish upon which it largely feeds. The purpose of the enormous head is not easy to decide, unless it be to act as a buffer and thus save the brain and skull from danger of concussion. The sperm-whale cannot see directly in front, and one which by accident ascended a narrow arm of the sea in Scotland across which a bridge had been built, caught its huge snout against the bridge, and carried the structure bodily away on the top of its head. They often bump against vessels out at sea. Sir J. E. Alexander tells of a Nantucket whaling captain in the south Pacific, who sent three boats after a school of sperm-whales. The mate's boat was struck by one of the whales and he had to return to the ship for repairs. While engaged in repairs, a sperm-whale, 85 feet long, broke water 20 yards from the ship on the weather-bow. The creature must have been moving at the rate of about three knots an hour, and the ship at nearly the same rate, when he struck the bows of the vessel just forward of her chains. The collision of two such mighty masses caused the ship to tremble like a leaf. Incensed by the pain of the blow, the whale made a second rush, and stove the vessel in by a tremendous bump from his head, so that the vessel soon sank, and out of 25 of a crew only 5 survived to return home.

AMBERGRIS.

Ambergris is the most valuable product of the sperm-whale. It is a gray speckled waxy material, very buoyant and of a peculiar musky odour. The Hindoos knew of the properties of ambergris over a thousand years ago and were aware that the sperm-whale produced it. In the middle ages wondrous properties were attributed to it, indeed it was said to float up from the bottom of the sea. It is probably a product of disease and often contains the fragments of cuttle-fish, the horny jaws, &c., though whether the accumulation of disintegrated cuttle-bone, which consists of calcareous and glutinous matter, in the intestine of the whale, originates this intestinal concretion is uncertain. Ambergris has a musky odour so peculiar that it has never been artificially imitated, and its amazing property of exalting any perfume in which it is placed makes it invaluable. The minutest grain makes itself perceived in the most fragrant perfumes. It is probably the most costly product produced upon our planet, and never realises less than \$5 per ounce; indeed it usually sells for \$10 per ounce. A vessel bound for Portland, Maine, picked up a lump which weighed over 100 lbs., and sold it for over \$16,000, and four or five years ago a piece found floating in the Bay of Fundy must have been worth \$8,000 or \$10,000; but the fisherman who found it took it to Digby, where it was boiled for nearly a week to convert it into soap, and the fragment that remained was identified by a chemist, who gave a handsome price for it.

In December last the *New York Tribune* published a report from Seattle, Washington State, that a whaler just returned from north Pacific waters had found that a substance which the crew had obtained from a sperm-whale and used for greasing their boots, oars, masts, &c., was ambergris. They threw away more than they used, but kept a 5-oz. bottle full for future use. In December a local druggist offered \$73 for the contents of the bottle to the great astonishment of the possessor, who said that some quantity could be obtained in Arctic waters, but none of the men knew what it was or realized its value other than as a lubricant.

Perfume manufacturers are on the lookout for ambergris, which is of such immense value and utility to them.

Just as amber was once thought to be the congealed tears of sea-gulls, and as pearls are produced to alleviate the pain of the injured pearl-mussel, so the precious ambergris is possibly a result of disease in the huge cachalot

THE FINBACK, HUMPBACK, GRAMPUS, &C.

For many centuries the whaling industry was dependent upon the right whales of the Arctic and Antarctic, and upon the sperm whales, which are wanderers in every sea. The rorquals, sulphur-bottoms or silver-bottoms, humpbacks, grampuses and smaller kinds were not hunted, as they were in some ways more dangerous to pursue and were of much inferior value.

In recent years the industry has so revolutionized its methods that every species of whale and porpoise is now of value, hence a brief reference to other whales is desirable.

Of the huge fin-back whales there are probably at least seven species, the largest being *Balænoptera sulfureus*, Cope, a Pacific whale probably the same as the Atlantic sulphur bottom *B. borealis* sometimes called *Sibbaldius borealis*, as both these whales are known to have reached a length of 110 feet.

A despatch from St. John's, Newfoundland, dated October 11, 1903, stated that the whaling steamer 'Humber' harpooned a whale 110 feet long on October 5, 1903, off Cape Spear, a specimen whose size ranks amongst the largest on record.

The sharp-nosed rorqual or fin-back *B. physalus* is the common whale of the Atlantic and German ocean. It has yellowish or pale whalebone and an acuminate snout; but other fin-backs, such as *B. gigas*, *B. musculus*, the Razor-back, *B. rostrata*, the pike whale; *B. laticeps*, the herring whale; and *B. sibbaldii* are all characterized by a similarity of form and habit. They are quicker in their movements than other large whales, and unlike the right-whale they do not rush to the bottom or 'sound' when struck, but spurt forward with terrific speed, pulling out the whole harpoon line at a single rush, and necessitating the cutting of the rope in order to save the whaling boat and crew. The head and dorsal parts are of a black or uniform dark colour; but the under surface is paler and often grayish white. All alike exhibit the deeply furrowed throat, the under parts from the chin to a point midway along the body being grooved by curious 'reeves' or cuts, the purpose of which is obscure. They appear as if narrow strips of skin 1½ or 2 inches wide had been cut with a sharp knife and removed from the whale leaving over 100 sharply defined grooves or furrows upon the throat and chin. I counted 98 of these furrows in one huge finner, and they possibly aid in enlarging the vast capacity of the mouth when feeding—opening and closing like the folds of a fan, or they may facilitate rapid progression, as the rorquals and humpbacks are swift swimmers and possess these 'reeves.' The grampuses, porpoises, sperm-whales, and right-whales, have a smooth unfurrowed throat, being destitute of these 'reeves.' Of the hump-backs there appears to be really one species, though the four species determined by Dr. Gray were for long accepted. Professor Eschricht held that there was one *Megaptera* only, viz.: *M. boops*—the so-called *M. longimana* being a variety only. The Japanese have a hump-back whale with long flippers—one-third of the length of the body—but they identify it with *M. boops*, and the same view respecting Temminck's *M. antarctica* is no doubt correct. The *Megaptera* with gleaming white pectoral flippers, and deeply scalloped inner margin appears to differ from *M. boops* and has been distinguished as *M. longimana*; but its osteology and structural features generally are apparently the same as *M. boops*.

The killer whale *Orca gladiator*, Lacep, is a familiar cetacean with its high fin protruding from the water. It is distinguished by a white oval spot above the eye and by the irregular mass of white along its under surface. The late Professor Moseley observed in the South Polar circle large numbers of *Orca* with a large white saddle patch behind the dorsal fin and a white blotch on each side in front of the pectoral

flippers. This is identical with the Japanese *Orca* usually classed with *Orca gladiator*. The lesser killer *Orca schlegelii*, has the white spot slightly further behind the eye, and Prof. Lilljeborg describes a patch behind the pectoral flipper and a purple streak behind the high dorsal. The killer whales are very frequently called grampuses; but the name grampus best applies to *Grampus griseus*, Cuv., which is of a slate gray colour with white markings. These whales range from 18 to 30 feet in length, the latter dimensions being those of an *Orca gladiator* which I saw captured at St. Andrews, in Scotland, in 1884. The ca'aing whale, black fish, or pilot whale,* called the 'grind whal' in the Faroes, congregates in large schools—indeed in August, 1873, 657 of these creatures were killed in three hours at Thonhaven. They are driven in like a flock of sheep, and in the Faroes in 35 years, 1843 to 1878, over 6,000 of these creatures were slaughtered valued at over \$100,000. They abound in the Gulf of St. Lawrence, and have been frequently killed off Prince Edward Island. They are of a rich deep black colour excepting a white spot under the throat and along the under surface. The skin is smooth 'like oiled silk' and the pectoral flippers are very long and narrow, a 22 feet pilot whale having flippers over 5 feet long. The most striking feature is the blunt rounded head, the forehead being very prominent, hence it is known in some localities as the round-headed porpoise. The head is short and the jaws extremely so—the upper projecting a little beyond the lower. The dorsal fin is over a foot high and about a yard along its bases. The bottle-nosed dolphins, the white beluga and the porpoise, owing to their less commercial importance demand no detailed notice, nor is the curious Bottlehead, *Hyperoodon rostratus*, of any value at present though it occurs in both the Atlantic and Pacific. These inferior species will no doubt be turned to account with the development of the most recent methods of utilizing the whales. Of no commercial value, but interesting in such a review of whales and whaling as that here given, is the existence of certain species of fresh-water whales, including the small susu (*Platanista gangetica*) only 3 or 4 feet long, and nearly blind, the eyes being practically closed. It inhabits the Ganges. *Inia* and *Pontoporia* are also small toothed whales found in South American rivers, more especially the Amazon. They all possess numerous small teeth in the upper and lower jaws. The narwhal, or sea unicorn, is a whale which loses its teeth with the exception of the upper-jaw canine on the left side. This left upper tooth grows out as a long spirally marked ivory tusk 5 to 7 feet, or more, long. Its use is very obscure. The narwhal (*Monodon monoceros*) reaches a length of 22 to 24 feet. The ivory tusk as a rule is present in the male on the left side, though occasionally on the right, and very rarely in the female—one female on record, however, possessed two very long tusks.

RECENT WHALING METHODS.

The old methods of pursuing the whales far from shore, of harpooning them and lancing them from small whaling boats, of towing them to the large whaler, securing the whale bone, removing the endless strip of blubber as the carcass lay suspended alongside the vessel, have been supplanted. Formerly the carcass, the entrails, most of the skeleton and all the involved products were wasted, the blubber was preserved in casks in a rancid and offensive condition, indeed the methods were as wasteful as they were dangerous and disagreeable. Excepting in the remote Arctic seas the whaling is now done from a centre—a group of buildings on shore called the whaling station, and operations are, as a rule, completed within 20 or 30 miles from shore. The modern harpoon is six feet long of malleable iron with an anchor-like arrangement near the pointed head. Four hinged barbs lie flush with the shaft, but these spring out as soon as the harpoon forces itself into the whale's body. The conical bomb-head explodes by means of a time fuse and by tearing the whale's vitals, and shock to its system stuns and kills it. The bomb-harpoon is fired from a short cannon—moving on a swivel and pedestal, supported on the bows of the boat, a small well-built steamer, or small clipper, 100 tons burden, twin screw, and of 12 knots per hour speed. The vessels are specially built,

* *Globiocephalus melas*.

and thoroughly braced to resist concussion with infuriated whales in case the harpoon is not effective, and able to turn in their own length to dodge a rushing whale. If the whale is fatally struck a hole is bored into the carcass and air is pumped into the stomach converting it into a huge floating buoy, a plug is inserted in the whale, and a man in a boat is left alongside, while the steamer goes off in quest of other whales.* 20 or 30 whales may be captured in a week by this rapid and ready method, and over 250 large whales have been taken by one whaler in a season.

CANADIAN WHALING LICENSES.

When the various captures are towed to the whaling station, the utmost despatch characterises the processes to follow. All the products of the whale should be handled in as fresh a condition as possible. If allowed to decay, the offensive odour and dangerous pollution resulting from such enormous masses of putrid organic matter as the carcasses of monster whales, are such that a whaling station would be a menace to the public health and a nuisance to a widespread community.

Hence the Dominion Government following on the very excellent lines adopted in Newfoundland requires parties to apply for a license before entering on any whaling scheme in Canada, and amongst other conditions lays down that:—

'(a) No license shall be issued until the site of the factory has been approved by the Minister of Marine and Fisheries, and no site shall be approved within fifty miles of any other whale factory, or in such proximity to any inhabited place or places as, in the opinion of the Minister of Marine and Fisheries, may cause any danger or detriment to the public health;

'(b) No license shall be issued until the applicant therefor has given assurances to the Minister of Marine and Fisheries, of a satisfactory nature, that he (the applicant) is in a position to convert any whale captured into commercial products within twenty-four hours of the landing of such whale, and that he is also in a position to conduct his whale factory and business in such a manner that no noxious or deleterious matter will be introduced into any public waters, bays, creeks, rivers or harbours;

'(c) No license shall be issued until the applicant has filed with the Minister of Marine and Fisheries plans and specifications of the machinery to be contained in the proposed factory, and particulars of the reduction process; and the machinery proposed to be used shall be of a kind already proved efficient for such purposes, and of the most approved type theretofore used in the whaling industry.

'3. No license shall be for a period exceeding nine years: Provided always that the Governor in Council may renew a license in favour of the licensee from time to time for periods of nine years, upon receipt of an application, in writing, for a renewal, six months previously to the termination of the current period.

'4. The holder of any such license shall not operate more than one whaling steamer in connection with the whale factory under license.

'5. The license shall become void and forfeited unless the factory named therein is erected, equipped and working within two years from the date of the issue of the license.

A number of subsidiary conditions are included in the Act of which the foregoing is an extract (4 Edward III., chap 13, August, 1904):—

FLENSING AND UTILIZING THE VARIOUS PRODUCTS.

When a whale has been towed to the licensed whaling station it is brought alongside an inclined floating slip. From a winch on the slip is sent out a steel line, which

* From time immemorial the Eskimo tribes have inflated captured whales, a feature which is quite new in recent whale hunting methods.

is attached to the animal, and by steam power it is hauled out of the sea. The flensing process is then begun, which consists in stripping off the fat with knives specially adapted for the purpose. Two or more men are usually detailed specially for this work, and are known as 'flensers.' They raise the fat in strips, attach the chain from the winch, and the whole slip, forty or fifty feet long, by eight or ten in width, is torn off. The fat averages from four to six inches or more in depth. After the fat is stripped the whale is opened and the intestinal fat removed. The long strips after removal are placed on the landing, where a number of men engage in cutting it into strips of from ten to twelve inches. This is then placed in a chopper, operated by steam, which minces it finely and carries it to the elevator, from whence it is taken up to the boilers. Here men are at work stirring the fat, who keep it agitated while the steam heater is rendering it into oil. After a few hours the oil is drawn off, left to cool, then barreled, weighed, and made ready for shipment.

The whalebone, which is very valuable, is removed whole, and each plate separated from the other by means of a sharp knife. The bone is then placed in a solution of soda, scraped and placed to dry in the same manner that codfish is treated; after drying it is stored ready for marketing.

A more important and, withal, more intricate method is the manufacturing of the carcasses into guano, and the chemical treatment of whale and bone oil, in order that it may equal in value and quality the oil of the fat. For many years the Norwegians had extracted the oil from the meat and bone, but it was almost valueless, the dark colour preventing a ready or remunerative sale. After the whale is stripped of all its fat it is turned over to be processed and torn by winches into small pieces, which are made still smaller by means of axes and saws, and then thrown into tanks into which water has been placed. Steam is then turned on, and chemicals used to hasten dissolution. After a certain time the oil, of a very dark colour, is dipped off and placed into tanks; the blubber from these tanks is drawn off into other tanks standing under, and the process recommences. After a sufficient quantity of the solid waste residue of the tanks has been obtained, it is conveyed to the driers, which are long revolving heated cylinders, converting the material into a dark brown earthy material, which needs little further treatment to make the most valuable kind of guano.

WHALE BEEF.

The choicer fleshy portions of the whale's carcass are converted into 'beef,' and after being smoked and prepared are as good as much of the smoked meat on sale in the American markets. A canned whale-beef industry is also being inaugurated with great promise. The Indians of British Columbia have long used whale flesh as a dainty food, and in Iceland, Norway and other countries it has been a recognized dish. Dr. Robert Knox, in 1834, with some of his Edinburgh medical students, tried a steak of young rorqual or fin-back whale, grilled on a grid-iron, but they did not hesitate to express their preference for a steak of West Highland beef. Sir J. E. Alexander described whale hunting by Gaspé boats, in July, 1849, near Seven Islands Bay, adjacent to Anticosti. After a most exciting chase his vessel came alongside the whaler, and they watched the process of removing the blubber by means of sharp spades used by a number of men standing upon the floating body of the victim. One of the pectoral flippers was removed and required the strength of four able-bodied men with powerful tackle to hoist on board. The whaling captain had a large piece of flesh like an immense round of beef cut off, and presented it to Sir J. E. Alexander, who tells us that 'during the succeeding part of this voyage we breakfasted and dined frequently off the portion of the whale which fell to our share of the spoil, the lean of which was really excellent, and when cut into slices and broiled was indistinguishable from tender beef-steak; the fat

* Most of the details given are from the Newfoundland official reports and from papers kindly supplied by Dr. Rismuller.

I did not admire, the smell of it bringing forcibly to my recollection the odour of oil-lamps with which the darkness used to be rendered visible in the city of Dublin in my younger days.' As it has been found possible to remove the offensive odour and flavour of eggs which are not bad, but slightly 'turned,' by a recent method of chemical treatment, so the removal of the odour and taste of whale-meat affected by the fatty matter of the whale has proved feasible. Whale flesh can now be prepared without any trace of the characteristic whale-oil flavour.

Mr. Cathcart Wason, representing Orkney and Shetland in the Imperial House of Commons, London, has placed on record his views as to the uses of whale flesh. He says:—

'Whale meat is just like coarse beef, and it makes a most valuable material for making dog biscuits. What cannot be used that way can be turned into valuable manure. It all depends, however, upon the location where the amphibian is denized. Whale meat from the Arctic whale is quite a palatable diet, and the Newfoundlanders smoke the product for human consumption. It is gaining some headway in the States.'

LEATHER AND FIBRE WARE.

The intestines, which are of enormous length and of great diameter, have been tanned and prepared as leather. This leather is soft and smooth as kid, but lacks the necessary fibre and strength for many purposes. For artistic leather work it is admirable, its fine grain and texture, and the readiness with which it can be dyed all the most delicate art-tints makes it specially adapted for the purpose mentioned. The leather made from the huge lips of the whale is coarser and stronger, and could be used no doubt in the manufacture of boots, leather straps and bands, &c. Still more interesting is the 'crockeryware' prepared from the chemically macerated bones, and pressed into various shapes, in appropriate moulds, is a more enduring material than vegetable fibre, indeed whale crockeryware is so tough and resistant that heat, hot water and rough usage do not affect it; 'it can be damaged' says a recent writer 'only by smashing it with an axe.' Attempts have been made to extract glue products; but so far with only fair success. A most tenacious gummy product has been obtained, which will draw out endlessly into fine threads, so that they can be spun like fine silk fibre; but a strong adhesive hardening glue is difficult to extract owing no doubt to some residue of oil which remains in whale products unless subjected to extreme chemical treatment.

WHALE MIGRATIONS.

The movements of whales from season to season are not erratic, but quite regular, like the migrations of large game such as the caribou and the musk-ox. The Arctic right-whales cling to the margins of the ice fields, but they migrate each season with regularity, and the whalers can tell almost to a day when the schools should appear in certain localities. Incessant whaling may cause them to divert their course, and it may be that in the north the great whales have moved nearer the polar waters and forsake for a time their accustomed haunts, just as the Newfoundland schools, apart from their decrease, owing to excessive killing, have moved into the mouth of the St. Lawrence, and from the Straits of Bellisle almost to Tadousac have been seen recently in unwonted numbers.

LIMITS TO THE INDUSTRY.

In view of the fact that the whaling industry as pursued on modern lines is a comparatively untried industry in Canada, there is a great field open for enterprise. Cau-

* Salmon F'ishing in Canada, p. 261.

tion and the wise policy of conservation, which it has been always attempted to carry out, will secure the permanence of Canadian whaling on the Atlantic and Pacific coasts, as it has been established that 'whaling,' like every other fishery, may more than any other marine industry, can be unfailingly played out. There are, for example, no less than eighteen whaling plants in Newfoundland valued at probably nearly \$2,000,000, and it is becoming apparent that the supply of whales is insufficient to keep so many separate enterprises in operation. The great dividends made by the pioneers of the modern whaling in the Gulf of St. Lawrence and the Atlantic outside, incited inexperienced parties to enter upon operations on an extensive scale. The Massachusetts commissioners, who recently visited the Newfoundland factories, reported that the eighteen expensive plants fitted up could not get sufficient whales to keep half the number going, and they did not hesitate to say that the industry, which is only of few years' standing, is already overdone.

A prominent Halifax journal reviewed last year the Atlantic whaling industry, and said that an acute stage had been reached in Newfoundland, and the immense profits made at an earlier stage had not continued. 'Last year (1904),' says the newspaper referred to, 'there were eleven whaling steamers at work in our waters, whose total catch was 1,270 fish, or an average of 115, whereas in 1903 the four steamers then engaged killed 859 fish, or an average of 215. When it is considered, too, that Norwegian competition was brisk, and that as a consequence, whale oil has dropped in price just one-half of what it was three years ago, it is easy to see that the money-making possibilities of the industry are greatly diminished. Eleven steamers and crews and fourteen whale factories and gangs of workmen have had to be maintained out of a catch only half as large again as four ships of the previous year, while the price of the commercial products of the venture has declined so much that it is doubtful if the aggregate gross earnings of 1904 have exceeded those of 1903. Hence, it is scarcely surprising that only three of the eight whaling companies in working form last year have paid any dividend, two paying but 6 per cent each and the third, which operated under exceptionally fortunate conditions, 15 per cent. The others either lost money or realized such small profits that to pay a dividend was impossible. Some other companies will be in operation this season and with more steamers at work the natural tendency will be to lessen the kill per ship, so that unless the price of oil, bor and other products from the cetaceans substantially advances it is difficult to see where all of these concerns are to make their profits.'

The abundance of whales in the estuary of the St. Lawrence and along the shores of Canada from Gaspé to Grand Manan, is indisputable. Indeed, their numbers appear to have increased owing to the hunting operations along the Newfoundland coast. Like big game on land they move to new areas if harassed and disturbed. But excessive hunting and utilization will bring even our prolific supply to an end. The inshore waters of our Pacific sea-board abound in whales, hump-backs, porquals, silver-bottoms, killers, &c., but unless the annual catch be wisely limited the industry will only be a success for a few seasons.

As a Newfoundland writer, at the close of the year, stated '1906 will open unfavourably for the modern whaling industry initiated in this colony a few years ago, and now that a similar enterprise has been set on foot at Seven Islands, in the St. Lawrence and at Victoria, on the Pacific coast, it is interesting to note the vicissitudes which have befallen the undertaking here and which have caused its ill-fortune to assume the aspect of a national catastrophe.

In 1898 the new pursuit was introduced here from Norway and the pioneer company started operations, the feasibility of the venture being seconded by nearly everybody. Then after a year or two, when it was seen to be a paying speculation, opinion altered completely and everybody wanted to engage in it. The result was that applications for the organizing of whaling concerns were recorded to the number of thirty-five, though only seventeen were really started. This was the total in being last year,

and when all these steamers began fishing in waters where formally only two or three plied, it is easy to understand that misfortunes came fast and furious upon them.'

PROTECTIVE LAWS NECESSARY.

The Canadian enterprises under proper limitations, and if not overdone, have great promise. The first factory at Seven Islands, west of Anticosti, on the Quebec shore, commenced operations in August and found whales plentiful. Indeed, before the end of October the factory had handled nearly seventy large whales, while on the B. C. coast, the whaling factory operated at Sechart, Barkley sound, Vancouver island, has had remarkable success, though delayed by mishaps at the start. Before the end of December over 142 tons of oil, valued at \$17,000, had been produced after only a few weeks operation. A little later no less than nine whales were captured and utilized within one week, the products of which were worth not less than \$10,000. The oil is shipped to Glasgow, while the fertilizer and other products are sent to Japan, Hawaii and other countries.

DEPLETION IN THE ARCTIC.

The valuable right-whales of Canada's Arctic seas, once so abundant, are already almost depleted, and except for the immensely profitable captures made by foreign poachers, in the Canadian whaling areas off the Mackenzie river mouth, our Arctic whaling is a thing of the past. Protective measures such as a close season for 5 years would still preserve to us the priceless bow-heads or right-whales in our northern seas, and a specially strict enforcement in the regions between Mackenzie bay and Banks Land or Melville island would permanently maintain the supply. American whalers systematically operate for periods of 2 or 3 years, wintering near Herschell island, and bringing to San Francisco and other U.S. ports their takes, often exceeding \$150,000 in value for a single ship. Indeed one whaler recently arrived at the port named with \$100,000 worth of whalebone, apart from the oil, &c. The details of the earnings of an American whaler, whose catch had been practically all made in the Canadian waters east of Herschell island, were recently given as follows:—the earnings covering eight months' work:—captain, \$16,000; 1st mate, \$8,000, 2nd mate, \$5,000; and so on down to the inferior hands the lowest of which received \$200.

It is authoritatively stated that in the season of 1904, not more than sixty-five right or Arctic whale-bone whales were taken in the northern seas, and the whale-bone would bring between \$800,000 and \$900,000, a much smaller annual return than was formerly secured on our Canadian whaling grounds. While the whale-oil has fallen in price as already noted, sperm-oil being about 60c. per gallon, ordinary whale-oil about 42c., yet these prices are much in excess of other animal or fish oil, such as herring and pale seal oils which bring from 19c. to 36c. per gallon. A single catch of seals such as that made by Messrs. Noble Bros., in the gulf a year or two ago, viz.: 1,500 seals brought only \$3,000—at the rate of \$2 each. The value of whale-oil, of whale meat-fertilizer and above all of whale-bone must always make the industry remunerative if the whales be not depleted. If as authorities are agreed that the right-whales bring forth their calves between the end of March and the beginning of May, and that every second year the female may produce one, or in extremely rare cases, two calves, there exists a basis upon which regulations in the interest of the industry could be devised and enforced. The decline of the Arctic whaling industry, apart from the operations of the north western shores of Canada, is a melancholy story. During the last ten years the Scottish whalers have frequently returned 'clean' or with oil and hides of the little valued beluga or white whale, as in 1898, when the Dundee whaling fleet returned having taken only two or three right-whales. But this year (1905) has been for American whalers the worst on record in the 55 years during which U.S. Atlantic whalers have resorted to our Arctic waters. The British whaling fleet about half a century ago embraced 150

vessels, 20 or 30 being from the Tay ; but there are not more than 6 or 7 Dundee whalers now in the industry. Forty years ago there were 730 U.S. whalers of 233,000 tons register; but in 1893 there were only 170 of about 40,000 tons register, while in 1904 the number of American whalers was barely 38. The three U.S. whaling ports, New Bedford, Provincetown and San Francisco claimed only 25 ships, 1 bark, 1 brig and 16 schooners, or about a twenty-fifth of the number operated 50 years ago. The utilization in Canada of the numerous kinds of whales formerly neglected and unutilized will give an impetus to the whaling industry which it has long needed; but the right, whales of the northern waters merit attention and protection, while their less valuable congeners are furnishing a remunerative industry in waters near at hand.

II.

THE PROGRESS OF FISH CULTURE IN CANADA.

BY PROFESSOR E. E. PRINCE, DOMINION COMMISSIONER AND GENERAL INSPECTOR OF FISHERIES FOR CANADA.

Fish culture is one of the most ancient of human pursuits, for the Chinese are known to have practised it from almost prehistoric times. In Europe, and on this western continent, it is of recent date. There was, indeed, no necessity for aiding Nature's recuperative processes in the rivers, lakes, and sea, so long as these abounded to excess in the most valuable kinds of food fishes. Even to-day those waters of Canada, not depleted by man's reckless wastefulness, are populous with the finny tribes, and over the Dominion generally, the enforcement of protective laws, close seasons, netting limitations, &c., has warded off exhaustion, though in international waters the difficulties of wise preservation are very great. Hence, the aid of artificial fish culture has been enlisted, not as a substitute for judicious fishery laws, but as supplementary and subordinate. The story of its development and progress in Canada is an interesting one.

It was not until 1853, so far as I can ascertain, that any attempt was made upon this continent to artificially breed fishes. Dr. Theodatus Garlick, of Cleveland, Ohio, was the pioneer. He obtained parent brook-trout in Canada, taking them across from Port Stanley in Ontario, to his establishment in Ohio. He was an enthusiast, and his exhibits of young fish, hatched from Canadian trout-eggs, were a feature for many years at agricultural exhibitions in the various states bordering on the great lakes. Canada soon followed suit. The initial attempts were, of course, largely experimental. The late Mr. Samuel Wilmot claimed to have originated fish-culture in Canada; but I find this claim was disputed, and with justification, by a well-known citizen of Ottawa, the late Richard Nettle. Stimulated no doubt by recollections of famous streams in his native Devonshire, Mr. Nettle, as early as 1856 or 1857, began the incubation of salmon and trout eggs for purposes of artificial stocking, in hatching tanks in the city of Quebec. He disputed the accuracy of the claim frequently put forward on behalf of Mr. Wilmot. The Bishop of Ottawa, (Dr. Hamilton) incidentally confirmed the claim of Mr. Nettle in a recent conversation, his lordship informing me that he himself saw the young fish and the hatching arrangements about the time referred to. Mr. Nettle was then superintendent of fisheries for Lower Canada. From a report by the late Mr. Wilmot, dated December 31, 1878, it appears that he commenced experiments in fish-hatching in 1865, eight or nine years later than Mr. Nettle's experiments, and he carried it on as a private enterprise until the Dominion government took the work over and gave Mr. Wilmot an appointment as a government official. In 1866 Mr. Wilmot acted as a fishery officer, with authority from the government of Upper Canada, and on May 30, 1868, he became an officer under the Department of Marine and Fisheries; but it was not until eight years later (1876) that he became superintendent of fish breeding. For his initial experiments he was paid, in 1869, the sum of \$2,000 by Order in Council.

The Hon. N. W. Clarke, in an address to the State of Michigan Legislature (February, 1871) referred as follows to Mr. Wilmot's initial efforts:—

'The government of Canada has an extensive breeding-house, located at Newcastle, on Lake Ontario, under the successful management of Samuel Wilmot. Some five years ago, this gentleman commenced on his own account to breed salmon, and

his efforts were crowned with such perfect success that the government stepped in, paid him for his outlay, and employed him to manage it, which, under their laws, it had a right to do. He has since hatched out, and is now hatching large numbers of salmon, and turning them out in the public waters of Lake Ontario.'

Thus fish culture in Canada, at first a private enterprise on a small scale, received a kind of semi-official sanction, but in 1868 it became distinctively a branch of the Dominion government service, the Newcastle Hatchery, possessed by Mr. Wilmot, being transferred to the Department of Marine and Fisheries. This hatchery, Mr. Wilmot affirmed, in his report dated February 3, 1875, 'has been the nucleus from which all of the national and state fish breeding establishments in Canada and the United States of America have taken their rise.' Additional hatcheries were soon built, the famous Restigouche salmon institution in 1872 (twice rebuilt), and the Miramichi Hatchery in 1873. In 1874 the Gaspé Hatchery was commenced, and in 1875 a large mill was purchased at Tadoussac and converted into a fish-breeding establishment, supplanted by a new building later. The work expanded, so that Mr. Wilmot, in February, 1875, was able to speak of five hatcheries in Canada, four of them in full operation.

Much interest naturally centres in the Newcastle Hatchery on Lake Ontario, where forty years ago the work commenced. The building, enlarged and improved, is situated on a narrow stream at the head of a small creek or marsh opening into the lake near Bowmanville, and about thirty-five miles east of Toronto. A sheltered and secluded valley of great sylvan beauty incloses the site, but the work has always been handicapped by its distance, both from good spawning grounds, and from suitable areas for planting the fry. Mr. Wilmot erected the hatchery, as was natural, near to his own residence, and at a time when salmon frequented Lake Ontario, and resorted to the creek in question for purposes of spawning.

So late as 1856 large schools of salmon still occurred in the lake; but as commissioner Whiteher and Mr. W. H. Venning stated in their report as fishery officials, they were a mere scanty remnant nine years later, having been destroyed by poachers, especially on the spawning grounds in shallow creeks and streams. In 1865 this scanty remnant 'was snatched from extermination' (as the official report states in 1869) by the efforts of the fishery department. This remnant was utilized at the Newcastle hatchery in early fish-culture experiments, conducted under difficulties, with inadequate knowledge and training, and aided at a later date to a limited extent by the government.

Thus for many years salmon have been practically extinct in these waters, and the hatchery failed in its original purposes of keeping up the supply of Lake Ontario salmon, which Mr. Wilmot claimed to be indistinguishable from the sea-going Atlantic salmon. From 1868 to 1873, over a million fry were sent out from this parent hatchery (an average of 200,000 per annum). A small private hatchery was also carried on during these earlier years of Canadian fish-culture, by the well-known salmon fisherman and merchant, the late John Holliday. Mr. Holliday was born on the banks of the famous salmon river, the Scottish Tay, and was stimulated, no doubt, by the salmon-culture work at Stormonthfield, in Perthshire, commenced in 1853 by the proprietors of the salmon fisheries on the Tay. He built a hatching establishment on the Moisie river (north shore of the Gulf of St. Lawrence), which has continued its operations to the present time. Messrs. Brown and Co., also erected a trout hatchery at Galt, Ont., and, in 1868 had no less than 10,000 parent trout impounded in one of their ponds for the purpose of taking spawn for hatching purposes. Other hatcheries privately conducted with zeal and success might be named, such as the Credit Forks Hatchery carried on by Mr. Chas. Wilmot, the Silver Creek establishment near Toronto and others.

In the United States, it was not until 1871 that fish-culture became a recognized department of work under the auspices of the federal government. Previous to that year individual states had made attempts in this direction, indeed, New Hampshire, in 1865, had commenced fish-hatching operations, and agents were sent to the rivers of

Canada, where they were permitted (as Mr. Charles G. Atkins tells us) to take salmon from the spawning beds, and were thus enabled to secure some hundreds of thousands of eggs, which were 'hatched with a measure of success.' Pennsylvania and the State of Connecticut followed in 1866. In 1867, 1868, 1869 and 1870 the states of Maine, New York, California, New Jersey, and Rhode Island, severally began fish-culture in their respective territories.

In Canada the salmon and brook-trout naturally claimed first attention; but in 1867 and again in 1868, whitefish were successfully impregnated and hatched by Mr. Wilmot as he tells us in one of his reports.

In October, 1870, Mr. Wilmot obtained a small quantity of char (*Salmo umbla* or *alpinus*) from the Keswick hatchery operated under the supervision of Mr. John Parunaby, of Leeds, England, who had visited the Newcastle hatchery some years before. Though Canada is the home of the char genus, our trouts not being congeners of the *Salmo fario* of European ichthyology, these were no doubt the first old country char introduced on this continent, and the experiment has a very special interest.

A pioneer fish-culturist in the United States, Mr. N. W. Clark of the state of Michigan has been credited with first successfully handling the eggs of the whitefish (*Coregonus clupeiformis*) on this continent, but the statement published by Mr. Wilmot gives four or five years priority to the Canadian, if, as Mr. Clark said, the first whitefish eggs in the United States were artificially hatched in 1872 (see U. S. Fish Comm. Report, p. xxvi, 1872-73). In 1875 a whitefish hatchery of large capacity was completed at Sandwich, Ontario, and has carried on, with marvellous success, the incubation of the eggs of that species on the Detroit river.

Under the zealous and indefatigable Samuel Wilmot, fish culture in Canada made rapid strides, and the Dominion has generally been acknowledged to be in the front rank in this work. France and Germany were in advance, it is true, so far as exact scientific methods and knowledge were concerned, and the United States has taken the lead in making most munificent provision from the public funds for pisciculture, and Great Britain has set a worthy example in private enterprises and in costly experiments under skilled superintendance, witness the Stormonthfield*, Howicktown, Cray's Foot, and Guildford establishments.

Canadian fish-culture was no doubt conducted in a rough and ready manner, the Superintendent and his staff being practically self-taught, so that many blunders were committed, and many erroneous methods for some years adopted. But the conditions were so favourable, the purity of the water and the abundance and coldness of the supply, the robust and healthy nature of the parent fish, and similar circumstances compensated for much that was lacking in manipulation and technical knowledge, during the early years of Canadian fish-culture. 'The most important requisite . . . is pure water, it is indeed to a hatchery what coal is to a steam-engine' said the late Sir James Gibson Maitland (Int. Fisheries Exhib. London, 1883), to whom Scottish fish-culture owed so much. It may be doubted whether any other country can offer conditions so favourable as Canada, and it is certainly remarkable that in the vast number of fry of various species, hatched year after year in the Dominion hatcheries, abnormal or deformed fishes hardly ever occur. Monsters as a rule are familiar enough in the tanks of European hatcheries, but nothing is so rare in Canadian establishments.

All fish-culturists are aware that the nature of the water in which fish eggs may be placed during incubation has the most remarkable effect upon the ova, favourable or unfavourable. Some of the older hatcheries have been placed at a disadvantage on that account. A water supply once pure and cool, becomes limited in quantity, warm and impure, as the country around is more thickly settled. At the earliest hatchery this became a serious consideration many years ago. As the officer in charge reported so long ago as 1884:—

* Now supplanted by Dupplin.

'The water supply at this hatchery is not as pure as it should be. Owing to various reasons the stream upon which the breeding establishment is erected has of late years become very much changed in its nature. At one time the water was pure, cold and limpid, but latterly, especially during the hot weather, it is warm, foul, and too unhealthy for the rearing of the higher orders of fish, which are hatched in this establishment.'

In such cases steps require to be taken to secure a more plentiful supply and of purer quality. But the difficulty is increased when the impurities are chemical or mineral. In Manitoba and the North-west some sources of water supply are of a more or less pronounced saline nature. In other cases as on the Pacific coast, the supply may contain saponaceous and other mineral impurities. But it is above all things essential that for the hatching of salmon, brook trout, &c., there should be no mixture of sea water. Professor McIntosh, of St. Andrews, Scotland, nearly 40 years ago (see *Quart. Journ. Micros. Sci.*, London, N.S., Vol. VII., 1868, p. 153), showed that sea water converted the yolk in the sac of the young salmon, from a readily-flowing liquid, like syrup, into a hard material of the consistency of india-rubber, and the later experiments, in 1896, of Mr. O. Nordgaard in Norway, in which different degrees of salinity were arranged and the results noted, demonstrated that while a saline solution of 2 per cent strength was fatal to the eggs of salmon and sea trout, a weaker solution, 9 per cent salinity, had no ill effects, but the eggs were fertilized in it, and the fry hatched out in a normal way.

The following brief résumé of the progress of fish-culture operations in Canada gives at a glance the stages of its advance. The Newcastle (Ont.) hatchery, as already stated, came under government control in 1868, or rather 1867, and in it have been hatched, since that date, Lake Ontario salmon, Pacific spring salmon,* brook trout, black bass, German carp, Great Lake trout, doré or pike perch and lake whitefish. Ontario salmon became practically extinct within a few years after the hatchery was started, and Pacific salmon do not appear to have thriven, one or two questionable records only of their capture having been announced, while black bass proved only partially successful and carp were a total failure. Brook trout, being mainly a game fish and of inferior commercial importance, was eliminated in 1892, though its culture was a marked success. Thus the hatchery has confined its work to the incubation of Great Lake trout, the eggs being secured by government officers at Wiarton, Georgian bay, and the lake whitefish, transferred from the Sandwich hatchery, early in the year, generally February, in the eyed stage. The hatchery was enlarged in 1875, and many subsequent improvements were made at later dates.

The four earliest hatcheries, which were constructed after the Newcastle institution, were located at the mouths of the most famous Canadian salmon rivers, viz., the Restigouche, the Miramichi, the Saguenay, and the York and Dartmouth, and have for thirty years been devoted to the hatching of sea salmon, being admirably located for the purpose.

* Professor Spence F. Baird generously sent from the United States at various times eggs of the Quinnet or Spring salmon.

The following table embraces details of the twenty-eight Dominion hatcheries arranged for conciseness and convenience of reference.

Founded.	Location.	Kinds of fish hatched.	Annual output.
1867.....	Newcastle, Ontario.....	Lake trout, white-fish, &c.....	2 to 6 millions.
1874.....	Flatlands, Restigouche R. ¹	Salmon, lake trout, &c.....	1 to 3 "
	South Esk, Miramichi R.....	Salmon and sea trout.....	1 to 1½ "
1875.....	Tadoussac, Saguenay R.....	Salmon and ouanaiche and sea trout.....	1 to 3 "
	(Cape, P. Q.) ²	Salmon.....	1 to 1½ "
1876.....	Sandwich, Ont.....	Whitefish, pike-perch or doré.....	10 to over 100 "
	Bedford, near Halifax, N. S.....	Salmon, lake trout, rainbow trout and whitefish.....	millions.
1880.....	Grand Falls, St. John R., N. B.....	Salmon, lake trout and whitefish.....	2 to 4 "
	Dunk R., P. E. Island ³	Salmon.....	1 "
1881.....	Magog, near Sherbrooke, P. Q.....	Lake trout, whitefish and brook trout.....	1 to 4½ "
1882.....	Sydney, Cape Breton ⁴	Salmon.....	1 to 2 "
1884.....	New Westminster, Fraser R., B. C.....	Sockeye, quinnat and other Pacific salmon and trout.....	2 to 10 "
1890.....	Ottawa Hatchery, Ont.....	Lake trout, whitefish, salmon and various trout.....	1½ to 7 "
	Bay View, near Picton, N. S.....	Lobsters.....	80 to 170 "
1894.....	Selkirk, Red R., Manitoba.....	Whitefish.....	4½ to 32 "
1901.....	Granite Creek, Shuswap L., B. C.....	Sockeye, salmon and trout.....	4 to 7 "
1902.....	Lake Lakelse, Skeena R., B. C.....	" ".....	4 "
	Margaree R., Cape Breton.....	Salmon.....	1 "
	Mont Tremblant, Labelle, P. Q.....	Lake trout and trout.....	3 "
1893.....	Shemogue, Cape Bald, N. B.....	Lobsters.....	17 to 100 "
	Nimkish R., near Alert Bay, B. C. ⁵	Sockeye, salmon.....	1½ to 3 "
	St. Alexis, Maskinonge, P. Q.....	Ouananiche and trout.....	3 "
1904.....	Shippegan, N. B.....	Lobsters.....	50 to 100 "
	Block House, Charlottetown, P. E. I.....	" ".....	60 to 100 "
	Kelly's Pond, " ".....	Trout.....	1 "
	Canso, N. S.....	Lobsters.....	8 "
1905.....	Windsor, N. S.....	Salmon, trout and shad.....	1½ to 2 "
	Harrison Lake, B. C.....	Sockeye and other B. C. salmon.....	6½ "
	Pemberton, Lillooet, B. C.....	Sockeye, salmon.....	20 "
	Oweekayno L., River's Inlet, B. C.....	" ".....	10 "

¹ The two earlier hatcheries were located at Deeside; the Flatlands hatchery was opened in 1900.

² The original hatchery on the Dartmouth river outlet was closed and the present hatchery built in 1902.

³ This hatchery was burned down in 1887, and the Charlottetown hatchery, Southport, opened 1905.

⁴ Sydney hatchery ceased operations in 1897, and in 1902 the Margaree hatchery was opened.

⁵ Nimkish hatchery was built by Mr. S. A. Spencer; but burned down in 1904, and the present hatchery is operated by the B. C. Packers' Assoc. under Dominion supervision.

The total quantity of fry of all kinds distributed from the foregoing institutions since fish-culture has been carried on by the Dominion government, that is from 1868 to 1905, both years inclusive, is no less than 4,806,416,100. The average annual quantity during the last 20 years has been 221,000,000. In 1895 the output was extraordinarily large, amounting indeed to nearly 300 millions. For the last nine years vast quantities of lobsters have been hatched, the annual average being no less than 100,000,000. Deducting these from the total output, we find that the average output each year, during the last twenty years has been 85 millions, mainly of the three kinds, salmon, Great Lake trout and lake whitefish (*Coregonus*), which are all fishes of great economic value.

While the hatching of species of fish valuable from a commercial point of view has always been the principal feature in fish-culture under the Canadian government; experiments with fish, important from a sporting standpoint, have not been wholly ignored. Indeed, so early as 1872, Mr. Wilmot experimented with black bass at Newcastle, Ont. He secured a number of adult fish, obtained by fishermen through the ice, near Belleville, and conveyed in barrels to the ponds near the hatchery. In the fol-

lowing year he carried out a similar scheme on a more extended scale obtaining five parent bass in May from the drag-seiners operating on the shores of the Bay of Quinté. These were placed in small ponds near the Newcastle hatchery. Mr. Wilmot in his report states that on 'May 25, some of the bass began to pair off, and to commence making nests; some being made in the deepest parts of the pond, others in the shallow places; some were formed on gravel beds; others, where sunken sticks were fastened at the bottom of the pond. They were invariably hollowed out a little, and made clean by the action of the fish, which gave them a bright appearance; the nests being round in shape, and varying from twelve to eighteen inches in diameter. Upon those, the parent fish deposited their eggs and milt. Nest-making terminated about June 10; the time elapsing from the first formation of these beds until the young fry were noticeable, varied from twelve to sixteen days, and a further period of five and six days took place, before the little fish left the beds. After the eggs were first laid, they were seen with difficulty through the water upon the nests. The surface of the beds presented in a few days a very dark appearance. When hatched out, a perfect mass of little black animals, not unlike tadpoles, covered the whole bed. After five or six days, as stated above, they disappeared from the nest amongst the weeds and other substances, where hiding places could be found.'

Such work was of an erratic and subsidiary nature and it is only in recent seasons that systematic black bass culture has been resumed. For about six years the breeding of black bass has been carried on in ponds secured by the department on the Bay of Quinte, Belleville, Ont. The principal pond is very near the bay and is about 100 feet square, a cold clear spring-fed inclosure with shelving rocks descending to the centre where it is about 5 feet deep, while at the margin it is 4 or 5 inches. About fifty large parent bass are placed in the pond and many thousands of young are each season hatched in the nests made by the fishes, where they are guarded by the parents, and move off later into a connecting channel where there is abundant feed. Plenty of insect and minnow food is essential for bass breeding. It is the same with regard to stocking. As an authority recently says:—

'To be successful with small-mouth black bass, they should be planted in ponds that are fed by clear, pure streams, or with bottom springs. Large-mouth bass will do well in a pond with a mud bottom that has a liberal quantity of vegetation. It is of great importance that ponds for either species should contain abundance of natural food, as craw-fish, minnows, frogs, &c., for it is a well-known fact that any interference whatever with the admirable balance which nature has established in the animal kingdom is more apt to lead to mischief than to success.'

In the province of Quebec the Lake Lester ponds (Eastern Townships) are used by the department for rearing trout. About 250,000 trout fry are impounded from spring until September or October, when they are 3 or 4 inches long, and are then planted in selected waters.

The introduction of eastern species into western waters and *vice versa*, and supplying other countries with Canadian fishes has long been a feature in the scheme of fish-culture in the Dominion. As stated on another page, Canadian fish were supplied gratis, or for a time, were sold for stocking U.S. waters, and on many occasions the Fish Commission of the United States and individual states have generously presented quantities of Pacific and other salmonoids for introduction in our waters. English char and Pacific rainbow trout have been planted in eastern lakes and streams. Atlantic salmon have been placed in Ontario lakes, and New Brunswick ouananiche have been transplanted to Quebec lakes. On three occasions first in 1896, second in 1901, and third in 1902, black bass have been planted in the Northwest Territories or on Vancouver island, British Columbia, a large quantity of lobsters, and of immature and of full grown Atlantic oysters have also on these occasions been shipped west under conditions designed by much careful thought and elaborate arrangement, which ensured success. To New Zealand, shipments of Canadian fish-eggs have been sent on several

occasions. In 1898 the government of that colony made a request for B.C. salmon and lake whitefish, and in 1899, and again in 1901, in response thereto, carefully packed supplies of ova were sent. These courtesies have been most warmly acknowledged by the New Zealand government.

Whatever may be said for or against the artificial hatching of fish, no fair-minded critic can doubt, that the distribution year after year, of this enormous quantity of young fish must have benefited our waters to an incalculable extent. Artificially hatched fry, unlike those hatched naturally on the spawning beds, must in the eyes of some critics, be more at the mercy of enemies when newly planted. Nothing, however, could be more helpless and unprotected than naturally hatched fry, and those turned out from hatcheries are really less at the mercy of enemies, inasmuch as they are always some days old, frequently several weeks old, before being planted, and should be more sturdy and robust than the fry exposed immediately after hatching, on the natural spawning beds. Nor is the objection better founded that the fry are suddenly transferred from the warmer water of the hatchery to the colder water of the lake or river outside. Records, which have been kept, show that the water flowing rapidly and plentifully through the tanks is more equable and cold than the shallow waters outside. The fry, it is further contended, are untaught to seek shelter, and must be gobbled up by watchful enemies. This cannot be so. The eggs are all taken from wild fish, and the young inherit the instincts of their parents. Hence when the fry have been carefully watched at the time of planting, they have been noticed to act with alertness and intelligence, and at once dart off to shelter. All the stock objections are made in ignorance of the real facts, for the facts all prove the very opposite of the theories set forth by critics, usually arm-chair critics.

Fish culture, at this late date, needs no advocacy or defence, yet recent unsolicited testimony may be adduced, sent to me as affording evidence of the success of the government hatcheries. A lake near Three Rivers, P.Q., was planted several years ago. It abounds at the present time with fine trout, says the member of parliament, who is my informant, although these fish did not formerly occur in it at all. A lake in Victoria county, Ontario, I have recently been informed by residents, is alive with trout consequent on being stocked by means of fry. Most visitors to the river Saguenay know the Tadousac hatchery, and the small lake adjacent to the building abounds in small salmon a few pounds in weight, the result of the surplus quantities of fry placed there by the hatchery officer. 'On one occasion,' says the officer in an official report, 'I permitted the Bishop of Chicoutimi, to fish in the hatchery lake. He was accompanied by the Rev. Mr. Mathieu, Superior of the Quebec Seminary, and the Rev. Mr. Lemieux, of Tadousac; they were astonished at the number of young salmon that could be caught.' A most convincing case came to my notice, however, on the testimony of a gallant and facetious member of the House of Commons, who bitterly complained that a New Brunswick lake, stocked with brook trout at much cost, had received also some Great Lake trout from a government hatchery. The latter have so prospered and grown in size and numbers, that they are cleaning out the brook trout, formerly so abundant in it. The club who lease the lake are anxious to exterminate the hordes of huge lake trout which are the direct result of fry planted there from Grand Falls hatchery, and the use of nets has been resorted to, enabling some fine specimens of these 'fresh-water sharks' to be captured. Deplorable as are the results from the club's point of view, no better testimony to the success of the government's hatchery work could be adduced.

While the Great Lake trout are valuable commercially, they are not held in much esteem generally for sport, but in certain Ontario waters, where they are usually called 'salmon,' they are fine large fish and attract great numbers of anglers, and artificial stocking has alone maintained their numbers. 'Beyond doubt the planting of the hatchery fry is a success,' one prominent authority wrote to me not long ago. Last season we had the best salmon trout angling known here for many years. The

oarsmen claim that they can tell the new salmon from the old native variety. It is quite common to hear the remark 'that is a government salmon.' Again, an able sportsman, formerly a member of the House of Commons, informed me recently that 'Lake Memphremagog shows every indication that the planting of whitefish (*Coregonus*) has resulted in stocking its waters plentifully with fine whitefish of superior quality, and weighing from 2½ to 6 lbs. each.' The department's efforts to introduce black bass into the waters of the Northwest has succeeded also, for a quantity of these fine game fish shipped in October, 1902, in charge of experienced officers, were in part planted in Buffalo lake, near Lacombe, on the Edmonton branch of the Canadian Pacific Railway, and in May, 1905, a lady fishing in that lake caught a fine 3½ lbs. fish. The lady referred to did not know what kind of fish it was, but stated that it was very game, and made a determined fight, which ended only after prolonged playing when it was hauled on shore dead. In the previous fall (1904) a similar black bass had been captured by an angler who was unaware that the lake had been stocked in 1902 by the government as an experiment.

As I have repeatedly pointed out in various blue books it is useless to expect results in artificial stocking of rivers and lakes, unless proper protective measures are taken to prevent the fish being exterminated. Thus certain salmon rivers, and some of the inland lakes, including the great lakes Ontario, Erie, Huron and Superior, have been planted for long periods of years with vast quantities of fine fish, yet the old plenteousness has not been restored. Incessant overfishing, and all kinds of destructive instruments, spears through the ice, &c., as well as the capture of small immature fish, has gone on without limitation, and yet an increase in supply has been expected from the planting of a few millions of hatched fry. Even anglers forget that streams cannot be restored if record catches are attempted each season. Scarcity of fish will inevitably continue if sportsmen will not be satisfied with an ordinary good catch. The angler who, a year or two ago, caught seven dozen river trout in a single evening in a Prince Edward Island stream, or the sportsman who took forty splendid ouananiche at the mouth of the Metabetchouan in two days, in May, 1900, or three U.S. tourists, who took out of the Niagara river, in a single day, in September, 91 black bass weighing over 200 pounds, are frustrating all attempts to supplant the present scarcity of game and of table fish by the plenitude which fish-culture would crown with certain success. The wise fisherman and the true sportsman will, in their own interest, frown upon the excessive destruction of fish. A more judicious policy, and a more sportsmanlike feeling would render the work of fishery restoration easy. Even in waters regarded as almost virgin waters like those of northwest Ontario, the effects of wanton and wasteful fishing, are being felt. There is wisdom in the observations of a well-known angler who describes his feelings on the matter, in his account of a Magnetawan trip, Georgian bay district, he says '*Forest and Stream, N.Y., C.* 23, 1899:—

'Heretofore much of the country traversed by the Magnetawan has been low and swampy, but here the islands and shore line stand high up out of the water. Numerous islands well wooded with pine, poplar, cedar and hemlock enrich the scenery. As we rounded a rocky point a lone but not lonely fisherman exultingly held up a string of twenty-five bass. I have never been able to see how any intelligent angler can be so foolish and barbarous as to kill twenty-five fish. Twenty of those fish might and ought to have been returned to the water. How often, oh, how often in the days gone by have I seen splendid bass rotting in heaps—anglers unable to use their catch and too foolish and cruel to return the fish to the water. Again and again I have seen campers trying to give fish away to the farmers. Let farmers catch their own fish and return all you can't use to the water, and fishing here at least would be good for generations to come.

To most people fish culture is thought to consist in taking some 'ripe mature fish,' just before spawning, squeezing eggs from them, fertilizing them, and placing them in jars or on trays, in a current of water until the young fish hatch out. Fish culture is, however, much more than that, it includes at least half-a-dozen different methods. Of

course, one method, and that most familiar, consists in obtaining ripe living fish of both sexes, and after subjecting them to the same process of careful and gentle pressure, mingling the two products in a spawning vessel or dish, where the eggs are rapidly fecundated, and then transferring the vivified eggs to the trays or hatching jars. The parent fish, being handled with care are returned to the water, with rare exceptions, alive and unharmed, and in the case of salmon usually continue the ascent up-stream, which had been interrupted by the hatchery officials. In B. C., it is said, the spawned fish frequently descend, but this may depend upon the sex, for Frank Buckland noticed that male salmon invariably bolt upstream if disturbed, whereas the 'hens' or female salmon bolt down stream. The fish do not die, as the signs of ripeness are readily visible to the expert officer's eye, and ripe fish are spawned painlessly and with the utmost readiness and ease. It is a curious fact that eggs from dead fish may be successfully used if death is recent. Thus the distinguished Russian naturalist, Owsiankoff, in a paper read in 1869, before the Imperial Academy of St. Petersburg, stated that he had fertilized the eggs taken from dead fishes, and in most cases with success. Different species also may be crossed and hybrids readily produced, but there are limits to the process due, no doubt, to certain microscopic peculiarities in the structure of the egg capsule.

Two methods of fertilization have been adopted, the wet and the dry, and the latter has almost universally superseded the former. In the dry method no water is added until some moments after the ova and milt have been mingled and gently stirred with a feather or the fingers. In the early days of Canadian fish-culture the wet method was followed, and the eggs were placed in water before the milt was added, and a proportion of eggs always failed to be fecundated, hence the universal adoption of the so-called dry method.

Some of the different methods followed in obtaining eggs or fry may be here instanced.

(1) The parent fish are secured some time (days or even months) before spawning, and impounded until they become ripe and swollen. Whitefish are often kept in this way, and the plan has been adopted in Canada of confining salmon in tidal ponds for many months, and apparently without harm. Indeed the salt water prevents fungus, and as salmon take no food after leaving the sea, there is no difficulty in retaining them until the spawning season, and then taking the eggs and milt. After being kept from June or July until October or November the parent fish are liberated on being artificially spawned.

(2) The parent fish are netted at the spawning time near the breeding beds. Salmon, in British Columbia, are treated in this way, also Great Lake trout and whitefish. The parent fish are rarely injured, and are thus liberated in their native waters.

(3) Parent fish are captured and the eggs taken and fertilized, but the fish are killed and sent to market. This is the plan adopted in some cases by U. S. fish-culturists, especially with the Great Lake trout. It is unavoidable as a rule, with black bass and sturgeon, even when very ripe, as they refuse to yield their spawn. It is not adopted in Canada.

(4) Parent fish are impounded in ponds or inclosures, where they deposit and fertilize their spawn naturally. The spawn is then transferred to the hatchery and incubated artificially. Bass, maskinonge, perch, carp, sturgeon, &c., have been treated in this way.

(5) A similar plan to the last is followed excepting that the eggs are allowed to hatch out in the ponds where deposited, and the fry are reared under official supervision for 6 to 10 or 12 weeks as at the Belleville bass ponds.

(6) Instead of securing the parent fish, or obtaining the eggs after being deposited, the small fry, incubated and hatched naturally, are netted and used for purposes of stocking waters. Trout and black bass have been mainly introduced into new waters by this method. Black bass, when very young, devour each other, even

when only a little over an inch in length, and the Caledonia (N.Y.) Hatchery officers have reported that their young black bass grow so rapidly that they must be shipped immediately after being collected in the adjacent marsh ponds. Nearly 400,000 of these fry are annually distributed from the American hatchery named.

The method referred to above of retaining salmon in salt water tidal ponds until they are ripe, and ready to be artificially spawned, merits a brief notice. It is a method first practised, so far as I can ascertain, in Canada, and grew out of an experiment made at the Tadoussac hatchery in 1875. In that year Mr. Wilmot selected a few salmon, as he tells,* which were kept in a salt water inclosure until 'the very time of spawning. These eggs went through precisely the same process as those that were taken from fish kept in fresh water, from the time of spawning till they were hatched out; there was no difference whatever observable during the period of incubation, nor after they became young fry. This experiment was repeated with a large number of salmon that were kept in salt water last fall, and up to the present time the results are precisely similar to last year. It may therefore be now safely concluded that the ova of the salmon will arrive at maturity, and be equally susceptible of impregnation, when taken from fish kept in salt water, as in fresh, and that no difference exists with the eggs during incubation or with the fry afterwards.'

The system has been extended and a very extensive salmon retaining pond has been operated with remarkable success at the mouth of the St. John river, near the city of St. John, N.B., whence supplies of eggs are sent to a number of hatcheries. The parent fish are bought during June and July mainly, from the net fishermen, and conveyed alive to the tidal inclosure, where they remain, in good health and condition until October or November, when their eggs are ready for the artificial spawning process. At St. John, N.B., Tadoussac and other places this method has proved very satisfactory, from 90 to 1,200 salmon being secured at the first-named place.

Broadly speaking the stocking of waters may be carried out in eight ways:—

By (1) Planting fry artificially hatched from artificially fertilized eggs, a method almost universally adopted in government fish-culture in Canada and other countries.

(2) Planting fry naturally hatched from artificially fertilized eggs, a plan occasionally carried under special stress when eggs might have been lost, through shortage of water or similar cause in the hatchery. The artificially fertilized eggs are in such cases placed on appropriate shallows, and watch kept until they naturally hatch out.

(3) Planting fry naturally hatched from naturally fertilized eggs, as has been done in the case of brook trout, black bass, &c., the newly hatched fry being dipnetted and transplanted after capture.

(4) Planting fry naturally hatched from naturally fertilized eggs, but reared artificially, such wild fry, having been netted, are retained in feeding tanks or ponds, until of larger size, and then planted as has been done with sturgeon, striped bass, brook trout, &c.

(5) Planting fingerlings and half grown fish hatched on spawning reserves or in hatchery rearing tanks, a method which is valuable, but costly and laborious with most fishes. Fifty per cent or 60 per cent of hardy fish like salmon or trout die while being reared, but of whitefish pickerel or doré not 5 per cent can be reared, over 90 per cent dying under artificial conditions, food, &c.

(6) Planting fingerlings and half grown fish procured in the natural breeding resorts.

(7) Planting eggs naturally or artificially fertilized on 'redds' or natural hatching places to incubate under natural conditions and thus themselves stock waters, without further aid. Lake Huron fishermen have planted lake-trout eggs in this way.

* See Rep. Dep. Mar. and Fish. (Supplement No 4) 1876, p. 361.

(b) Planting adult fish transferred from other waters.

It is plain that if we can secure the eggs from the ripe parent fish, fertilize them by the dry method, and hatch them under the care of experts, the results must infinitely surpass those possible under natural conditions, where a small proportion only can be expected to surmount all the dangers and difficulties of their environment. Let me give an illustration of this waste of eggs on the natural spawning beds—a waste not contrary to natural law, but obedient to the principle of compensation and adjustment, universal in the world of nature. In 1895 I spent some time closely observing certain spawning beds of the Fraser river salmon, commonly called sockeye or blueback. I noticed, not once, but scores of times, pairs of fish busy nesting, the male fish lingering near his partner until she shed a shower of eggs. Just as the eggs were cast into the rapid stream, the male fish had his attention attracted by a rival, and darted with lightning speed to drive him off, both male fish tearing at each other with gaping jaws, armed with formidable teeth, the teeth at this time being of abnormal size. Some after time I saw female fish wasting their eggs in this way, for the eggs deposited in the gravel by the female, while her partner was engaged in a fight twenty or thirty yards away, were unfertilized and would, of course, perish or be eaten by hungry enemies, suckers, trout, &c., which hovered near in hordes.

This loss of naturally spawned eggs is universally admitted, but the crowding on the spawning grounds, or 'redds' as they are called in Britain, proves injurious to the fish, as the fungoid growth, which is so terrible a disease, is transferred from one to the other, if indeed this crowding is not the original cause of the disease. The first great destruction takes place on the 'redds.' Everywhere over these are tiny raised heaps of gravel sheltering the spawn, but the shelter is insufficient to guard it from devouring enemies. These are in the air, on the land, in the water. Many members of the hungry salmonidæ themselves prey on the spawn, and it is difficult to cope with them. Bunches of wild duck and teal seek out the 'redds' in the autumn, and feed on right through the night if not disturbed. Here, too, as frequently witnessed, the swan leads her cygnets, and it is known that one of these large birds will destroy nearly a gallon of ova in a day.

The curious fact repeatedly noticed by observers, that male salmon outnumber the female; and the fierce fights and numberless resulting deaths, may be a device for reducing the surplus number of one sex. 'To me it is the strangest puzzle,' said Frank Buckland, 'why the male fish always predominate over the female,' and he asserted that frequently there occurred seven males where there might be not more than one female salmon. During the second year of the Restigouche Hatchery's work, the late John Mowat reported that the male fish were in excess of the female as two to one, and the late Alexander Russell, in his famous book, 'The Salmon,' gave prominence to Shaw's not less interesting discovery, that in the young striped 'parr' stage, male salmon are mature, 'the parr (alone) arrives at sexual maturity, and does and can impregnate the ova of the adult female salmon.'

If, to the natural loss of enormous quantities of eggs by non-fertilization, be added the depredations of ducks, loons, herons and aquatic birds, not to speak of otters and four-footed enemies, as well as destruction by floods, by mud, gravel and ice, it is easy to see how great are the advantages offered by artificial incubation, and by caring for the eggs in properly equipped hatcheries.

Anglers, as a rule, favour fish-culture, but there are exceptions, and the sportsman needs to be reminded that, whereas, the fish are liberated strong and uninjured after being artificially spawned, those taken by the angler's line shortly before the breeding season, are killed and prevented from fulfilling their task of peopling the waters with young brood. It is easy to hatch 90 per cent of salmon eggs in a hatchery, whereas, Sir Humphrey Davy estimated that not six per cent of the eggs deposited on the breeding grounds, come to perfection, and Stoddard held that only four or five fish fit for the table were the result of 30,000 ova on the spawning beds. The take of salmon in a single net may suffice to furnish enough eggs to keep up the supply

of young fish, and it is the rule at the government nets to liberate all fish not required, and these are allowed to ascend to the upper waters. Thus at the Tadousac nets in 1889, 559 salmon were taken for the hatchery, but 310 of the largest were sufficient, and the remaining 249 were turned into the river again. This is frequently done. In most of the hatcheries reliance is placed upon the departmental nets, managed by the hatchery officers. In these nets fish are trapped, and after being spawned are set free.

What the liberated fish do after being released has long been a problem, but as already stated, they doubtless continue up the river, and linger about until prompted by the necessities of a long fast to return to their feeding grounds in the sea. They do not and cannot feed to any appreciable extent in fresh water, but that they survive has been fully established in the St. John river, N.B. Thus, among the salmon set free by the department's officers at the Carleton salt water salmon pond, St. John, N.B., during the spawning operations in November, 1904, one bearing the copper tag used by the officers was caught six months later in the Kennebecasis waters, not many miles distant, viz., on April 11, 1905. A large number were thus marked and will no doubt be captured.

In some cases parent fish are bought from local fishermen by special arrangement, but the plan has, on the whole, proved uncertain, as the fishermen asked exorbitant prices, or ignored their agreement and shipped the fish straight from their nets to the markets, leaving the hatchery officers in the lurch. Many parties have entertained an ignorant prejudice against artificial hatching of salmon, not fishermen only, but men of education and social standing. Thus the lessees of certain rivers in Gaspé, refused to allow any salmon to be taken for hatchery purposes, and anglers who have been known year after year, to kill hundreds of salmon in famous pools, really spawning grounds, have declaimed against the inhumanity of taking the spawn from the small number of parent fish, which are ample for supplying a salmon hatchery.

Frank Buckland has truly observed that 'the success of salmon egg-collecting depends upon very small circumstances, and he specifies seven necessary provisions to be made by the 'spawner,' viz.: a water-proof suit, spawning pans of large capacity, a long, shallow basket to hold the fish under water until wanted, hose flannel in yard lengths for wrapping the struggling fish when spawning, dry towels to wipe slime off the hands, moss and trays, and lastly, nets.

In a report published in the Marine and Fisheries Blue Book, 1896, I described all the types of fishes' eggs known to scientific experts. I grouped them under seven heads, according to their special features, and I pointed out that they varied in shape, size, external structure, &c. The smooth, spherical, pea-like eggs of the salmon, trout, whitefish, and the like, are far more favourable for artificial incubation than slimy eggs, eggs clinging in bunches, eggs in gelatinous strings, eggs covered with spines, oval eggs, and other varieties.

The eggs resembling peas vary in size in different species. A quart measure is frequently used in counting eggs on account of its convenience. The measure holds 57.75 cubic inches, and has been found to be capable of containing 3,300 land-locked salmon eggs; 4,272 Atlantic salmon; 3,696 Pacific salmon; 5,525 Great Lake trout; 8,311 to 9,935 English brown trout, 12,063 to 13,998 American brook trout; 24,363 striped bass; 23,239 shad; 36,800 lake whitefish; 73,938 maskinonge; 152,292 pike, perch or doré; 233,280 tomcod; 335,000 cod; 496,000 smelt. In diameter the eggs vary from $\frac{1}{4}$ of an inch in the Atlantic salmon, and $\frac{3}{16}$ of an inch in the brook trout, to $\frac{1}{50}$ of an inch in the tomcod (*Gadus tomcod*, Walb) or $\frac{1}{25}$ of an inch in the silver hake (*Merluccius*).

Or, to compare the sizes in another way, the eggs of the brook trout are such that 36 will cover a square inch; lake trout, 21; whitefish, 66; black bass, 150, and pike, perch or doré, 150.

When the ripe female fish is being spawned by the hatchery operator, the eggs run freely in a stream into the pan or dish, previously rinsed in clean water, the operator

gently pressing the abdomen with one hand, while with the other he holds the fish firmly in the region of the anal fin, the head of the fish being secured under the armpit, if a large fish like a salmon. A male fish is then treated in the same way, the milt flowing into the spawning pan amongst the eggs, and the eggs are stirred with a feather, thus securing fertilization. After being washed, the eggs are placed either upon black Japanned tin trays, 15 in. x 10 in. x $\frac{1}{4}$ in., perforated with small holes and holding about 2,000 salmon eggs, or they are placed in glass vases 20 in. x 6 in. in diameter. The former are more suitable for salmon and trout, the jars being best for whitefish. Zinc trays are found hurtful to eggs, the officer of the Miramichi hatchery reporting in 1874 that a large number of salmon eggs were poisoned from this cause. The eggs, being alive, require abundant oxygen, hence a continuous stream of water must pass over them day and night until they hatch out. Under natural conditions river-water, of course, pours over the eggs, but fish-culturists are agreed that spring-water is preferable for hatching purposes, not only because the temperature is more equable, but is purer and more free from debris and vegetable matter. In 90 to 120 or 150 days, the young fish burst from the eggs; shad, however, take only from two to five days, and cod hatch in ten to thirty days. Most of the valuable fresh-water species, like the trout and whitefish take many months. In special cases where the hatching of sturgeon and shad has been attempted as in Chautauqua lake, N.Y., hatching boxes with double wire screen, top and bottom, have been placed in a running stream, or if containing mas-kinonge eggs, have been sunk at a depth of four or five feet in the lake.

The fry are transferred to large tanks for periods of a few days or a few weeks, and are distributed in large cylindrical cans, nearly two feet high and twenty inches in diameter, the narrow neck of which is devised to hold ice in hot weather, in order to keep the water cool.*

The young fish carry beneath the body a small bag of food yolk, and require no other food until it is used up—a few days sufficing in some species, a few weeks in others. If possible, the fry should all be planted before the store of natural food is exhausted. In stocking lakes or rivers it is best to select inshore shallows not frequented by large fish, or rocky ridges and banks far from shore. The fish travel by rail or team for long distances without serious harm, if ice is used with care. Short distances are, however, best; indeed, Mr. Samuel Wilmot urged the establishment of small supplementary hatcheries, where the advanced eggs could be sent just before hatching, and the fry more safely distributed from them. 'This system of carrying or rather trying to carry, young fry to distant points (particularly where no speedy means of travel by railway is to be found) should be discontinued (said Mr. Wilmot in 1877), because the time almost invariably spent in fruitless journeys of this kind, could be so much better and more profitably applied at nearer points, where the safety of the young salmon in the transit could be relied upon.' At times a few thousands of fry have been kept until they are four or five months old; but constant care is necessary, and a large proportion as a rule, die when the fry are kept out of their natural habitat in lakes or rivers. The feeding of fry is not easy, as the quantity and kind of food require regulation, or the results may be fatal. In 1887 eight or ten thousand young salmon were retained in a pond at the Restigouche hatchery, and were fed during the summer, 'yet they did not seem to thrive well, as but few were seen in October when the pond froze over (as Mr. Alex. Mowat reported) . . . I have very little faith in ordinary attempts to grow fry with artificial foods, with a view of realizing any benefit from the proceeding.' Last year Mr. Mowat again kept some salmon fry (about 10,000) in outside tanks with an ample stream of water passing through. Mr. Mowat is one of the best practical fish-culturists living, and this experiment was a success owing to special attention, the fry growing satisfactorily until they were nearly six months old. The food consisted of finely ground raw fish and liver; but

* Fry are conveyed up some salmon rivers in floating crates or perforated boxes, and 25 miles of a river can be planted in a day.

quite as important a matter was the intelligent manipulation and care of a zealous officer in charge. The fish were well fed, yet not overfed, and kept perfectly clean, by the removal of dead and decayed matter, especially waste food.

The growth of fishes, especially young fishes, varies extremely; thus brook trout are usually two inches long when four months old; three inches when eight or nine months old, and five inches when a year old. Lake trout are six inches long at the end of the first year, and black bass at the same age are four to six inches. Salmon, when confined in ponds, are often stunted in growth, thus 3,000 salmon fry were planted in a small lake near Louisburg, Cape Breton, in 1888. In 1889 they were three or four inches long, and in 1891 (in their third year) some were caught with the fly, but were not more than eight inches in length. A similar experiment at the Restigouche hatchery, resulted in producing young salmon, seven inches long, in the third year, and ready to descend to the sea. Many of this batch of fingerlings measured fully three inches in length.

In British Columbia young salmon (sockeye, coho and other kinds) have been kept until many months old, in ponds near the hatcheries, and apart from the food supplied to them, must have fed upon minute organisms which abounded amongst the aquatic vegetation. In some U. S. hatcheries as at the Rogue River hatchery, Sacramento river, large numbers of salmon fry have died when about two months old, which had been fed on canned salmon. In these western hatcheries ground liver, liver and mush mixed, and canned salmon have been chiefly used. The last fouled the troughs with a greasy scum, said to affect also the gills of the little fish, hence it was pressed until of the consistency of damp earth and proved as satisfactory as liver, and liver and shorts, so far as the growth of the fish is concerned.

A very prominent English pisciculturist has recently recommended dessicated haddock ground up coarse, bones and all, as the ideal trout food. The dried stuff contains only about 20 per cent of moisture and is fed to the fish in a stiff paste. Three to three and a half pounds of the concentrated meal will, it is claimed, produce one pound of healthy trout.

Before the yolk is gone, trout fry will pick up minute particles of food, but they may be fed on hard roe of flat fishes, of mackerel, or of other fish with very small eggs, which are easily scattered amongst the hungry alevins. Liver and rock-mussels finely minced form good food; but very little should be given at a time as fragments falling on the floor of the tank pollute the water. Opinions are divided as to the advantages of planting young fry, or of keeping them until a year old.

During their early stages and later in life various diseases attack fishes, especially vegetable parasites such as the well-known fungus *Saprolegnia ferax* and *Achyla racemosa*, and psorosperms and bacteria. Dr. E. J. M'Weney, made a most interesting study of some diseased salmon alevins about 1½ inches long, hatched at Ballisodare hatchery, which had died.* The eggs came from the Rhine and were German salmon. The young fish were found to be suffering from *Saprolegnia*, but in the culture on the 4th day of the experiment the other vegetable parasite *Achyla* was found amongst the hyphal filaments of the original fungus. The rapid spread of *Achyla* amongst eggs in hatching trays renders necessary constant picking out of dead or diseased eggs. On some smolts of salmon the same authority found ulcers on different parts of the body from the size of a pin's head to that of a ten cent piece, and they showed no traces of the mycelium threads of a fungus (*Saprolegnia*), but round and oval refractive granular bodies belonging to the protozoan myxosporidia resembling superficially the microsporidia of barbel and pike found diseased in the Rhine. Further, a large salmon with abraded spots on the skin and fins was shown to be infected with *Saprolegnia*, which so weakened the fish as to render it favourable for the attacks of bacteria found abundantly in the liver, &c. This fungus, which attacks eggs during incubation, is most pernicious. What is called 'dropsy' in the yolk-sac is not com-

* See Dr. M'Weney's Report, Irish Fisheries Office, Dublin, 1892.

mon, inflammation or clogging of the gills is frequent, but fungus is an epidemic that often carries off entire batches of eggs and fry.

The commonest remedy is common salt, of which a saturated solution is made, practically strong brine, and this is poured into the tanks containing the infected fish. It is a good plan to turn off the supply tap so as to leave 2 or 3 inches of water in the tank, and it is easy then to convert the contained water into a fluid not quite the strength of sea-water. It must be thoroughly mixed and the fry left in for about half an hour. Usually the bath has no ill-effect; but if the fry appear to be becoming weak or discomforted, the fresh water should be turned on again. A bath of this kind has been found beneficial, though it requires care, as young salmon immersed in sea-water too long die from hardening of the yolk-sac, which becomes dense as stated above. Recently another remedy has been advocated, viz., permanganate of potash, which sweetens the water and destroys organic germs. The *Revue Scientifique* notes that at the Geneva Exhibition, 1896, permanganate of potash was used to clean the aquarium, and it is claimed that it prevented the specimens of the salmonidæ from being attacked by *Saprolegnia*. It is a matter, however, of experiment as yet, and further trials are necessary to establish its success.

I have always recommended, however, bichloride of mercury as a remedy, though it requires more trouble in application and some little skill. It is successful as is shown by a recent writer who says:—

‘While visiting a friend who has a fish pond stocked with gold fish, I learned the fish had been attacked by a fungoid disease, or a growth of a white fluffy appearance on their scales which is common to fish in vivaria. He cured his fish in the following singularly successful manner: He first caught the fish thus affected, and, with a small painter’s brush or the thumb and finger, removed the fungus, and then with a solution of 18 grains of bichloride of mercury diluted in a 6 ounce bottle, he applied with a camel-hair brush this solution over the parts affected, holding the fish a few seconds before returning them to the water, which was changed daily. The result, he states, is that after one application his fish have entirely recovered, with but a few exceptions, which, however, he states have been cured by a second application.’

Discretion is not always shown in the planting of fish suited to the waters selected. Carp have been a questionable benefit, black bass in some waters have been far from a blessing, and that splendid game fish, the maskinonge, proves to be a veritable fresh-water shark in some lakes. ‘If planted in many of the small inland lakes says Mr. Annin, jr., Superintendent of N.Y. State Hatcheries) the result will be that perch, pickerel and bass fishing would be greatly damaged.’ If predacious fish abound, it is useless to attempt stocking with a better class fish. The fry are inevitably exterminated. In Chautauqua Lake, N.Y., the U.S. authorities wisely decided to clean out that voracious ganoid, the bill fish (*Lepidosteus*), and in two seasons over 4,000 of these useless fish were captured in seines, pounds and traps, such extermination being often necessary before stocking begins. For some years the pike-perch or doré (*Lucioperca* or *Stizostedion*) were hatched at Sandwich and at Ottawa. The first batch, about one million, were hatched in 1881, but partly on account of difficulties in securing ample supplies, this species was, after ten or eleven years, no longer embraced in the government operations. Black bass too, for a time, were hatched at Newcastle, and German carp were also included, for one or two seasons, under the mistaken idea that it would introduce ‘into ponds and waters (to quote Mr. S. Wilmot’s report) now depleted a highly esteemed description of food fish hitherto unknown in our country.’ A thousand young carp were, with the late Prof. Baird’s consent, brought from Washington to Newcastle in December, 1880. Some were planted in ponds in Manitoba, but apparently without result. Pacific salmon have also been introduced into the waters of the eastern provinces. In October, 1874, 20,000 Quinnat or spring salmon eggs were generously donated to the Newcastle hatchery by Prof. Spencer Baird; they hatched out in December, and were planted in April following. In 1874 a second lot was sent, and in October, 1875

a third consignment of 80,000 (of which half were sent to Tadousac Hatchery), and in 1876, a further batch of 40,000, and in November a further shipment of 80,000. Other lots of many thousands were kindly given by the U.S. authorities, but the results appear to be decidedly inconclusive. A fish, 15 inches long, was described by Mr. Wilmot as being captured near the Newcastle hatchery, in 1876, in the creek there and regarded as a Quinnat. 'It was totally unlike the ordinary grilse or smolt of the stream, and was a male with matured milt,' said Mr. Wilmot, and he added, 'The first lot of California eggs was received at this place in the fall of 1874; this salmon must, therefore, have been two years old from the egg.' In July, 1877, several more, it said, were taken. The officer in charge of the St. John river hatchery, N.B., reported, in 1885, that there were grounds for regarding the planting of Pacific salmon (Quinnat) in 1881, as a success. He reported: 'Just as soon as the fishermen set their nets in spring they began to capture a strange, and to them, peculiar species of salmon with which they were unacquainted. This gave rise to inquiries and investigations, which resulted in the fact that they were California salmon, averaging some seven or eight lbs. in weight. Consequently they must have been some of identical salmon that were hatched in the Rapide des Femmes hatchery, and put into the St. John river, four years ago last March.' In March and April, 1881, 35,000 young California salmon had been sent to this hatchery.

It is difficult to say, in most cases what have been the results of transplantation. We know that in New Zealand the results have been most unexpected. On the one hand the results have been grievously disappointing; on the other hand they have exceeded all anticipations. The planting of salmon has had no result whatever. Salmon were wholly absent from New Zealand waters, and in spite of repeated efforts to establish them, no successful results have yet been seen. With trout it has been wholly different. The small Scottish and English trout (*Salmo fario*) have become most abundant, and have attained dimensions that are almost incredible. A 2 lb. English trout is considered a fine fish, and a Thames trout weighing 14 lbs. was a unique capture, but these fish transplanted to New Zealand run from 7 lbs. to 15 lbs. commonly, and examples are not rare weighing 25 to 27 lbs. The planting of Pacific salmon has had no results practically in the eastern waters of this continent. Nor is there clear evidence of tangible results of attempts for over 30 years to establish Pacific species or even the Atlantic sea salmon in the great lakes such as Lakes Huron, Michigan and Superior.

In 1875 the late Mr. Wilmot reported that: 'Rumours have been circulated that a few strange fish were of late taken in some of the waters of Lake Huron. One in particular was related to me last autumn at Sandwich (when engaged in procuring whitefish eggs), to the effect that a fish weighing several pounds had been caught during the summer in the Detroit river, strongly resembling a salmon trout, but brighter in colour and longer, and more symmetrical in shape. This description would very well answer that of the true salmon, but in the absence of a personal inspection of this specimen it must only end in conjecture. Another case was reported in several of the papers that a specimen of the salmon tribe had been caught during the past year in the American waters of Lake Huron, and forwarded to Prof. Baird, of the Smithsonian Institute, who pronounced it to be a smolt of the true *Salmo salar*.

It would be most gratifying to have close research made into this subject by thoroughly prospecting, at the proper time, the Saugeen river with its estuary fisheries near Southampton.'

Within the last four or five years rumours have been repeatedly circulated that Pacific salmon also have been captured by Canadian and U.S. fishermen in the western waters referred to. Many of these specimens have been pronounced to be the steelhead salmon, the only true Pacific salmon (*Salmo gairdneri*), as that species and quinnat, sockeye, and rainbow trout, as well as the Atlantic species have been planted for many years. Most of the specimens were reported to have rich crimson coloured flesh, very tender and palatable; but Pacific salmon and trout having deep coloured

flesh, cannot be described as either tender or palatable; they are on the contrary dry and insipid, but improve in flavour and texture when canned and over-cooked. The species on the Pacific coast which are really tender and palatable, are very pale in the flesh, and frequently quite white.

It is probable that these stray specimens are really remnants of 'plants' of Atlantic salmon.

Lobster hatching had been tried in Norway by Capt. Dannevig as early as 1885, and three years later Mr. Adolph Nielson commenced operations in Newfoundland. The United States also operated an artificial lobster hatchery. A fine building, 75 feet by 35 feet broad, was erected at Caribou harbour, near Pictou, N.S., and began work in 1891. A duplex pump and twenty horse-power steam engine, draws salt water from the bay, and a wharf running out to 20 feet depth of water, enables tugs to come alongside with supplies of lobster eggs obtained by the hatchery officers at the canneries. The eggs, it may be mentioned, are carried attached to the swimmerets in bunches, under the body of the female lobster. Ripe and well-developed eggs are selected, and are known by their paler colour as compared with the deep green or black of the newly extruded eggs. With a spoon, the hatchery operator scrapes off most of the eggs, leaving some still adhering, including some that are unavoidably crushed or burst. Having visited several of the lobster canneries, and picked out egg-bearing lobsters sufficient to give him an adequate supply—the lobsters, of course, being alive and newly brought in from the trapping grounds—the operator at once conveys the eggs in buckets on board a tug to the hatchery, places them in upright jars or vases, slightly wider than whitefish jars, where they are kept rolling about by rapidly circulating sea water until they hatch. At a temperature of 56° or 58°F, they may hatch out in 24 hours; but they frequently take fourteen or fifteen days, if the temperature is lower and the eggs are not advanced in development. At a temperature of 40° or 50°F. lobster eggs take many months for the incubation process, but so favourable are the conditions at the Bay View hatchery, Caribou harbour; that the annual operations are frequently over in five or six weeks in May or June. The young fry like little active shrimps, swimming head foremost in contrast to the adult lobster, are so fiercely cannibalistic that they must be planted at once. They are conveyed in barrels on board a tug, each barrel having a square lid cut out, at the side which is uppermost, for aeration, and the young lobsters are lifted by scoops or dippers, and scattered in the surface waters 3 to 10 miles from land. The method of scattering them by means of a hose pipe at the stern of the tug was not successful, the delicate fry being injured. Lobster fry are never found close inshore, but are pelagic in habit, and frequent the surface of the sea many miles from land. The methods in vogue at the Canadian lobster hatcheries* appear admirable, and should ensure in due time, beneficial results for the lobster fisheries along the Atlantic coast.

Another effort to increase the supply of lobsters on the Atlantic coast has been a matter of experiment for three years at Fourchu on the Cape Breton coast. The lobster commission, 1898, had in their report (p. 33) favoured the reservation of lagoons where seed lobsters might be impounded, after purchase from the fishermen or the canneries, and liberated when the close season commenced. In 1903, the department arranged with Mr. H. E. Baker, the well-known lobster packer, to have an experiment made, and an inclosure 380 feet by 167 feet, divided into smaller pounds, was secured on the south side of Fourchu harbour. The bottom consists of gravel, sand and rock, while through the walls 9 feet high, small apertures, 1 or 2 inches diameter, permit the ingress and outflow of abundant sea-water. Fifty thousand lobsters bearing eggs have been purchased and placed in these ponds and fed every third day upon chopped herring. After being impounded in May, June and July, they were replaced in the sea one and a half to two miles from shore. It is estimated that nearly a thousand

* Five lobster hatcheries are in operation in Canada, viz. Pictou, Canso, N.S., Shemogue and Shippegan, N.B., and Charlottetown, P.E.I.

millions of young lobsters would be hatched out from these 'berried' female lobsters, lobsters which would otherwise have been canned, and their eggs and fry destroyed. Such a method involves a serious expenditure especially if it be extended to all parts of the coast; but of its effectiveness there can be no doubt. Mr. Baker has adopted the method of confining lobster fry in a floating inclosure in which a mechanical arrangement keeps the water actively moving as previously tried by some U.S. experts.

For the sake of clearness a brief summary of some of the features of fish-culture in Canada may be referred to in a concluding paragraph:—

(1) Fish of supreme commercial importance are mainly hatched, hence species, which are chiefly valued for sport only, have a subordinate place in Dominion fish-culture.

(2) Eggs, the hatching of which is difficult or hazardous, e.g. maskinonge, sturgeons, &c., are not included. Results, commensurate with the expenditure of public money, are problematical in the case of such species.

(3) As far as possible all parent fish are returned alive to the water after spawning.

(4) Salmon are impounded in tidal ponds for many months prior to the breeding period in the fall. They cease to feed on entering the mouths of rivers, and the sea water keeps them free from fungus and disease. Lake trout and whitefish also, are kept in pens or pounds for a few days before being artificially spawned, while black bass are kept in nesting ponds and hatch their young naturally. Lobsters, too, as in Cape Breton, are kept in retaining ponds.

(5) Fry are distributed gratis on the applications being officially approved, and the government bears the expense, wholly or partially, of shipment and planting.

(6) Lastly, the fry are all practically shipped in the recently hatched condition (three days to three weeks old). This is unavoidable when vast quantities, tens of millions, are handled. Retention of the fry would involve great expense and serious loss by death, and all the applications could not be filled.

It is hardly open to dispute that the planting, year after year for over 30 years, of countless numbers of young fry of valuable economic fishes must have vastly benefited the waters of the Dominion.

The hatching of cod, mackerel and other marine fishes has not so far been attempted in Canada. The eggs and fry of these fishes are not so favourable for the methods of artificial culture, and the vast numbers produced by each spawning female (a single cod shedding 9 to 10 millions of eggs each season), the extremely delicate pelagic character of the eggs, and the futility of handling successfully the fry, are the reasons which have deterred the government from taking up this work. The public, frequently, do not realize the conditions necessary for successful results. Hatch plenty of fish and plant them, is the course too frequently regarded as necessary. Not long ago, indeed, the view was widely circulated that a great salmon canning industry might be created in Prince Edward Island, parallel to that on the British Columbia waters, if only the government would plant salmon on a sufficiently large scale.

'The chief resources of Prince Edward Island,' said one authority 'are agriculture and fishing. Our inland fisheries have hitherto been neglected. But with our bays, rivers and lakes teeming with salmon and trout, the resources of our province would be materially increased. There is no reason why salmon canning cannot be successfully carried on in this province. British Columbia is reaping a fortune from this industry. And it is an undisputed fact that our waters, too, are adapted for the thriving of the salmon if proper steps were taken to foster the industry. Our provincial laws for the regulation of fishing should be improved. Hundreds of thousands of salmon fry have already been deposited in Vernon river, Murray river, Morrell river, Wheatley river, Naufrage river, and in streams in the vicinity of Kensington and Cape Traverse. And all this is but a stepping stone to the development of an industry which might give employment to hundreds of our people and rich returns to the province.' This

was much too sanguine an outlook. Fish culture might, in time, help the fresh fish trade in salmon and trout, but it is altogether too much to expect that it can build up a business requiring such a wholesale slaughter of fish as canning. If Canadian fish-culture is doing anything to keep up the supplies of fish in our salmon rivers, our great lakes and inland streams, it is doing much. By introducing western species into eastern waters and *vice versa*, it may do more, and we may therefore be content to permit the illimitable ocean, open to all the fishing fleets of the world, to be recuperated by the unassisted methods of Nature herself.

III.

THE SCOTTISH HERRING CURING SCHEME, 1905.

By JOHN J. COWIE, LOSSIEMOUTH, SCOTLAND.

*With Explanatory Preface**By Professor E. E. Prince, Dominion Commissioner of Fisheries, Ottawa.*

PREFACE.

In an article which I contributed to the *Pacific Fisherman*, January, 1906, on the Canadian fishery resources of the Pacific coast, I pointed out that no reason exists why Canadian fishermen and packers 'should not put up as large a pack of the best herring as Scotland, which yields annually 250,000 to 350,000 tons of herring, valued, when pickled and ready for market, at no less than \$5,000,000 to \$6,000,000 per annum.' My remarks would apply to the Dominion herring fisheries generally, though I was referring to British Columbia at the time. I remarked that previous attempts to produce the best grade of pickled herring had resulted in partial success only as the fish packed in most excellent barrels brought, as a rule, \$4 per barrel, whereas Scottish and Norwegian herring sold in the same markets for \$11 or \$12. I have known on the Atlantic coast instances of the sale of large quantities of pickled herring at \$1.50 to \$2 per barrel, and for this very low price there are good reasons, as any one who has knowledge of the great herring industries of other countries is well aware. A New Brunswick fisherman nearly twenty years ago expressed the matter strongly, though unfortunately his criticism was well-founded, when he said:—

'Our fish are put up in a most shameful way. Most of the fishermen use more salt than is needed. One object is to cheat; the other is careless neglect. The fish remain so long out of the water before they go in the salt that it is impossible to cure them. Then the fishermen will fill the barrel half full of salt, under the mistaken idea that the injury done in this way will be remedied, and that the fish will be all right. Our barrels are got up cheap—45 cents for large and 25 cents for half barrels. They are made of poor stuff—staves too thin, with poor hoops. There is not much money in the herring trade for the honest fisherman, as bad fish bring the same price as the good. For that reason the fisherman is careless. We put up a lot of fish last year (1888) well cleaned, washed, good and sweet, 100 lbs. in each half barrel, with half a bushel of salt, and we only received 5 cents a barrel more for them than those who put up bad fish. In fact, the fisherman is not encouraged. The fish merchant buys of the fisherman in large packages; then he re-packs into half barrels, making a gain in quantity, and so the consumer is cheated right and left.*

The reputation of Scottish, Norwegian and Dutch herring has only been secured and retained by a scrupulous adherence to certain rules, neglect of which would seriously injure the whole industry. As is well known the bulk of the European herrings are cleaned and cured on shore, only about one in one hundred barrels being cured on board vessels, and then chiefly when the vessels are fishing in sheltered inlets or lochs

* Report of Dep. of Mar. and Fish. (Fisheries) 1889 Part IV. p. 7.

along the shore, while of the total catch of herring the returns show that over 80 per cent are put up as pickled herring, only about 3 per cent being prepared as split and smoked or 'kippered' herring, about 1 per cent being packed in tins or canned, while only $\frac{1}{4}$ per cent were sold as bloaters or as 'red herring.'

Mr. Cowie referred to the different kinds of herring recognized in the markets of the world in his special report last year. Under the system of official inspection and branding carried out in Scotland five different grades or qualities of cured herring are distinguished. The 'matties' or 'matjes,' which are fat, well flavoured fish, having the roe and milt not developed, bring the highest prices in the coveted Russian markets, these, lightly salted, being in great demand. The German and Austrian markets have a preference for more heavily salted, harder, firmer herring. On the average probably one-tenth of the enormous British herring pack consists of 'matjes,' while one-third consists of 'fulls,' or herring with the roe and milt very large, only one-third of the pack are 'mat. full'; about one-twelfth is of the special grade branded 'La full,' whereas about one-fifth are 'spent' or the inferior spawned herring. Of course the proportion varies from year to year and there has been a notable increase in the quantity of barrels of herring not bearing the government brand. But whether branded or not, the demand for herring of good quality properly cured and packed is increasing and in most seasons is far in excess of the supply.

An inferior fish, however, is preferred in some of the markets as, for instance, the West Indies. 'A large trade is carried on in lean fish' reported one of the department's experienced inspectors (Mr. Hockin) some years ago, 'which being devoid of fat, keep well in hot climates, and the fat July herring are not sold for the same trade. While under government inspection, the lean fish would be branded inferior, it is, for its particular trade, a No. 1 fish.'

Mr. Cowie and his staff have now put up all the various classes or grades of herring recognized by the trade and these Canadian fish, Scotch cured, have been placed on the market, and have gained the approval of the best authorities on this continent. The main object of the scheme has therefore been abundantly fulfilled. It has been proved beyond question that Canadian herring, handled and cured according to the best Scotch methods are not inferior to the fish taken off the British coasts and, indeed, have gained the first place in the best markets of the world. The herring were mainly caught by the Steam Drifter No. 33, purchased by the government for the purpose of this scheme, but a proportion of the fish were bought from fishermen (about 200 barrels) in the locality where the staff was at work. The chief difficulties with the locally bought fish was that they had the scales, as a rule, largely removed by careless handling, and were often too long before being placed in the hands of the staff. The Nova Scotia 'matjes' realized the highest prices obtainable. As a rule they sell for more than 'fulls'; but the demand for the latter is vastly larger and more general. The barrels of 'fulls' were highly approved by the fish buyers who saw them. They were the first N.S. 'full' herring eured in the Scotch way that had ever been placed on the United States' markets, and they created a most favourable impression and brought the following prices:—'Ex. lar. fulls,' \$9 to \$10; 'lar. fulls' and 'fulls' brought \$8.50 to \$10 (\$4.25 to \$5 per half barrel); and 'medium full' and small realized \$8 per barrel.

The object lesson has been given; the aim of the experiment, to prove that Canadian herring are equal to any other herring in the world, and will bring the highest market prices, has been achieved, and the result has exceeded the most sanguine hopes of those who initiated and supported the experiment. As the government official responsible for recommending, arranging and supervising the scheme, I confess that my anticipations have been realized. I felt that if Canadian cured herring have ranked lowest in the scale in the great markets the fault lay, not with the fish, but with the methods of handling, curing and packing them. It remains now to apply the lesson taught by the experiment and to circulate as widely as possible full instructions to the fishermen and others on both the Atlantic and Pacific coasts. The herring put up by the staff under Mr. Cowie on the B.C. coast surprised all qualified judges by their

splendid qualities. It is necessary therefore that in addition to printed instructions there should be brief practical lessons by the staff at as many points as possible on both coasts. Thus the fishing population and the curing firms may be, without loss of time, induced to cure herring which has realized not 75c. to \$2 per half barrel, but \$5 to \$6. Our herring fishermen would find their earnings rapidly increase if the cured herring of Canada were thus improved by the methods adopted by Mr. Cowie. It is stated, on authority, that the earnings of the fishermen from Mr. Cowie's own town, Lossiemouth, in Scotland, exceeded \$2,000 for each crew during the short herring season on the English coast, after their own Scottish fishery was over.

On the Pacific coast the greatest interest has been aroused and a leading B. C. journal, calling attention to the presence at Nanaimo of the Scottish staff said:— 'An industrial movement of prime magnitude in connection with the exploitation of the wonderful resources of this magnificent province is now in progress at Nanaimo, where Mr. Cowie, the Scottish herring expert, assisted by some lassies from Auld Scotia, skilled in the art of handling fish, is giving demonstrations of what may be done in the matter of improved methods in packing and curing. With the knowledge that the annual 'run' of herrings in Nanaimo harbour and vicinity is of tremendous size, and the fish of prime quality, it will be readily seen that with the adoption of improved methods in packing and handling the fish, a great industry will be launched, one, in fact, which will be only of slightly lesser importance than the salmon canning industry. A great market for herring in its cured form exists in Germany, France and Russia, not to mention the growing markets in Australia and the Orient; and if it can be demonstrated that the Nanaimo herring can be cured in as attractive a fashion as the Nova Scotia variety, it would appear that birth will be given very shortly to another very important provincial industry.'

Indeed the packing of Scottish cured herring on the B. C. coast has been so rapidly advanced that the Nanaimo Fisheries Co. recently shipped 150 barrels to the eastern states, upon which a local newspaper remarks:—

'In a few days now Nanaimo herring will be tickling the palates of the connoisseurs in the aesthetic homes of New York.

To-day the Nanaimo Fisheries Company shipped a carload of its famous pickled herring to the metropolis.

The fish, some 150 barrels in all, or approximately 50,000 pounds, is being taken by the steamer *Squid* to Vancouver to be loaded on train there.

The shipment is the famous Scottish brand, put out by this company and which, although it has only been in the market a short time, is being much sought after, and commands a very good price.

The firm originally put up the Viking and the Thistle brands, but it was found that the Viking brand was put up by a New York firm also, and that the Thistle brand was the name of a brand prepared by a Scottish firm.

The brands that they have adopted now are the Sea King, and the Scottish brand mark, which was designed by expert Cowie, when he was here.

It speaks well for the standard of the fish as prepared by this Nanaimo company when they can ship clear to the Atlantic coast and in point of quality compete with Atlantic herring.'

The details of Mr. Cowie's season's work are given in his report which follows these remarks; but it may be stated that owing to a slight break-down on the liner, on which the staff sailed to Halifax, that city was not reached until May 17. About a week later the steam drifter was in full operation taking on May 25 her first catch of 40 barrels of herring at Canso. From that date until July 12, the staff were at work at Canso. On July 15 preparations were made to move to western Nova Scotia, and on August 1 the nets were put into the water off Clark's harbour, and catches of 'full' herring were made until the end of the month. On August 14, the steam drifter No. 33 went to Clark's harbour, where part of the staff, including three of the Scottish girls and Mr. Wm. McBean, of Halifax, formerly of Aberdeen, was temporarily authorized to super-

wise the work. On September 13, Mr. Cowie, Mr. Cumming, the cooper, and three of the girls attended the annual Halifax exhibition, and demonstrated to large crowds the Scotch mode of handling and curing herring. On October 25, the same staff, Mr. Cowie, the cooper, and three girls, left Yarmouth for British Columbia, and early in November were busily engaged with the curing of B. C. herring at Nanaimo. Two firms were already making trial efforts to put up a superior class of cured herring, and Mr. Cowie received much aid and encouragement in the course of his experimental pack, and a number of capitalists and interested persons connected with the fisheries watched with interest the details of the work, as it proceeded in the curing sheds on the Nanaimo wharfs. The Nova Scotia herring were declared by the experienced representative of the *N.Y. Fishing Gazette* to be 'firm, fat and a good colour, with the peculiar sheen of the Scottish pack, well-graded and uniform.' The British Columbia herring handled by Mr. Cowie at Nanaimo were also of most excellent character being, as he points out, 'of the "full" variety, equal to the "full" grade of the Atlantic coast, and not exceeding 11 inches long.' On the Pacific coast the herring industry is not scattered as on the Atlantic coast, but centres at certain important points. This is an immense advantage, and facilitates the success of such an experiment as that in Mr. Cowie's charge. Further, the fishermen, unlike the Maritime Province men, confine themselves to actual herring fishing. In Scotland and in Norway the fishermen devote their time to capturing the fish and delivering them to the curing staffs on shore, and if this system is carried out on all our coasts the herring industry will assume the character of this great fishery in other countries. To be landed in the best and most satisfactory conditions for curing, speed and care are necessary. Some of the herring brought to Mr. Cowie, as he points out, were not landed in a satisfactory condition, 'many of the fish were landed minus scales thereby losing that silvery sheen which they should have even after they are cured.'

Systematic curing on shore not by fishermen, but by curing firms, employing qualified 'gutters,' 'curers,' 'packers' and 'coopers' will ensure the necessary care and skill, and secure ready sale for Canadian herring in the best markets. The processes of cleaning, salting and packing cannot be done by inexperienced persons. The processes, as Mr. Cowie states, are: first salting when the fish are brought in fresh from the fishing grounds: gutting or removal of the 'gib' and part of the entrails; grading the fish; rousing; packing in neat tiers in barrels; dating or branding; first filling; second filling up; repickling. The quality of salt and the right quantity and proper mode of salting are fully referred to in Mr. Cowie's report.

If the experiment carried out under government auspices, with signal success, acts as a stimulant to firms engaged in the fishing industry to raise the standard of Canadian pickled herring it will have achieved more than can be estimated.

Over one hundred years ago a Scottish author said:—

'From the irregular manner of curing herrings at that time on the Scottish coast, no progress of any importance had hitherto been made. Although abundance of fish might have been caught, the ignorance or dishonesty of curers in preparing inferior fish, put up in unfit, inferior packages, with inferior salt, prevented herrings from being received with favour either at home or abroad.

'At that time Scotch herring were generally cured by the fishermen themselves, and that being the case, it could not be expected that the work would be well done.'

There are, of course, special conditions in different markets which cannot be ignored by herring curing firms. As already pointed out, the West Indies have demanded a cured lean or 'poor' fish, owing to its superior keeping qualities as compared with cured fat herring. In some cases the description of package adopted is important. The Mexican market, one very accessible to Canadians, requires fish to be put up, not in large barrels, but in quarter barrels, or even in small kits. For these small packages there is a great and increasing demand. But in such markets as those

of New York and Boston, the demand is, above all, for the best Scotch-cured herring from Britain. This month (January) the following quantities were imported into the two cities named:—

	New York.		Boston.	
	Lbs.	Value.	Lbs.	Value.
Herring from Great Britain	587,040	\$19,147	154,000	\$5,720
“ Norway	116,324	2,974	28,660	1,010
“ Netherlands	444,109	21,256	8,000	438
“ Nova Scotia	108,955	2,082	328,300	2,954

It has now been demonstrated that improved methods have given Canadian herring a status equal to the best cured herring in the markets; but the whole history of the herring industry of Scotland, in its earlier struggles, and its later successes, shows that well cured herring will always find a market, and that stagnation in the trade is generally due to the action of careless, indifferent, ignorant, or dishonest curers.

So it will inevitably be in Canada, and it is open to our fishing population to excel in this great and remunerative industry

E. E. PRINCE,
Dominion Commissioner of Fisheries.

THE SCOTTISH HERRING CURING EXPERIMENT IN CANADA, 1905.

By MR. J. J. COWIE, LOSSIEMOUTH, SCOTLAND.

I have the honour to submit my report upon the operations of the Scottish herring curing staff, under my charge during the past season. Following up the initial experiment authorized by the Department of Marine and Fisheries, the work of capturing and curing herring was not restricted to one portion of the coast, but was extended to include other areas on both the Atlantic and Pacific coasts of Canada during the year 1905.

Operations were commenced at Canso and continued at Yarmouth and Clark's harbour, Nova Scotia, and Nanaimo, British Columbia.

The staff consisting of three fishermen, one cooper and six girls, left Scotland on May 7. A slight breakdown in the machinery of the steamer on which the staff sailed, was the cause of some delay at Glasgow till repairs could be effected.

Halifax was reached on May 17, and Canso on the 19th, and steps at once taken to put the drifter 'Thirty-Three' into fishing order, and to have things in readiness for curing on shore.

In addition to the three fishermen from Scotland, an engineer, a fireman, and three other Canadian fishermen were engaged at Canso, N.S., to complete the crew of the 'drifter' for fishing.

All the necessary preparations having been completed a start was made for the fishing grounds on May 25, and the next day the 'drifter' returned to port with 40 barrels of herring.

Operations were continued at Canso, from that date until July 12.

The fishing grounds tried being those from 10 to 40 miles off the coast, ranging from Isaac's harbour, N.S., to Louisburg, C.B.

The highest single night's catch at Canso was 84 barrels and the total, 166.

As last year, dog-fish once more struck in very plentifully about June 20 and practically took possession of all the fishing grounds.

The herring caught this year again on that part of the coast proved to be of the 'matje' class, unfortunately a large proportion of these were of a small size and had to be disposed of for bait to Lunenburg and local fishermen.

The Canso 'matjes' were well received in the New York market last year, and the

reputation they then gained has been more than maintained this year, for, as you will observe, by the account sales, the first consignment sold for \$7 per half barrel, and the next at \$7.50.

The following is a report by Messrs. Woodward & Son, herring merchants, New York, on receipt of the first consignment of Nova Scotia 'matjes' for 1905:—

'We have to report to you on first consignment of 26 half barrels of matje herring. They look to us to be very well packed, and we do not see how any improvement could be made on the cure or the pack.

'We are endeavouring to sell these to a number of our customers as we want the general trade to become acquainted with them. We are trying to get \$7 a half barrel for them, but we may possibly have to take less. The only fault the trade finds with them, is that the packages do not seem to be quite so full as they might be. One or two of the buyers expressed themselves as being afraid that they would get soft on the bellies, but we ourselves do not see how you could have improved very much on the pack or on the cure, and we call them a choice parcel.

The entire trade generally are much prejudiced against any herrings that are cured in Nova Scotia in the Scotch way. We want to overcome this prejudice and for this reason we want to have enough of the buyers have your goods, as we feel sanguine that they will give satisfaction.'

The prices obtained, namely: \$7 to \$7.50 per half barrel, and the requests made for more of those 'matjes' abundantly prove that the trade is satisfied with the quality, and wants fish of that character.

By the end of July the demand for 'matje' herring practically ceases, after which time the more keepable 'full' herring is in demand.

The 'matje' herring is a fat herring having no milt or roe. 'Full' herring are herring in good condition, though not very fat, with the milt or roe almost fully developed.

It was decided therefore to move the staff to a point on the Bay of Fundy, where I was assured 'full' herring could be got in abundance. After making all due inquiries when visiting the spot, I concluded that Yarmouth, with its central position and its facilities for shipping to the United States, would make the best headquarters for operating from on that part of the coast, with a branch at Clark's harbour.

On July 15, I therefore made a start to move the curing stock and fishing gear from Canso to Yarmouth, two trips of the drifter being necessary to accomplish this, and by the end of the month the whole staff and outfit were in order for work at Yarmouth.

To take charge of the work at Clark's harbour I employed, with your permission, Mr. McBean, a Scotch cooper, who happened to be in Hal. at this time. He arrived in Yarmouth on August 4, and after receiving instruction proceeded to Clark's harbour next day.

As the staff of girls was now to be divided, and to cope with the expected increased work at Yarmouth, I also added to the staff the Scotch woman who remained in Canso last year. I further engaged a pilot belonging to Clark's harbour to insure the safe navigation of the steam drifter amongst the fogs of the Bay of Fundy.

On August 14 I sent the drifter to Clark's harbour with three of the girls and a supply of barrels and salt, retaining four at Yarmouth. A continuous week of fog had prevented me from sending them along sooner.

On the night of August 1, the nets were put in these waters for the first time, and next day 24 barrels were landed.

Part of this catch consisted of small fish, but the very next day 10 barrels of very fine 'full' herring were landed, and on August 8 another 20 barrels of the same quality were got. There was then a scarcity of fish until August 24, when another 20 barrels were caught, and again on August 29 another 12 barrels, after which only small lots were landed, making in all 100 barrels.

All through the season on this part of the coast, operations were considerably hampered by the occasional dense fogs, for which the Bay of Fundy is famous, and also by harassing hordes of dog-fish, not to mention sharks, 14 of which were tangled up in the nets one night.

The fishing was all done on the off-shore grounds at a distance of from 16 to 30 miles. After September 1, the herring seemed to move very close in amongst the rocks, and into places where it was impossible to drift with a large vessel, so that the local fishermen began now to get herring in fair quantities.

It must be pointed out, however, that these herring when they move in to the shore, are seeking the shallow waters to spawn, and by this time, have the roe and milt in a pretty ripe condition, which deteriorates the quality of the fish very much indeed.

For the purpose of augmenting the catches of the drifter you instructed me to purchase the herring catches of the local fishermen, and out of 20 boats I managed to secure 186 barrels between the two places, during the month of September.

I may here mention that the herring received from the local fishermen were not landed in an entirely satisfactory condition. Owing to the want of room in their small boats for the proper handling of their catches, many of the fish were landed minus their scales, thereby losing that silvery sheen which they should have even after they are cured. As was anticipated, the herring caught in and around the Bay of Fundy were of the 'full' class, and of the quality then wanted. All the various classes of 'fulls' recognized by the trade were represented in the catches, namely:— 'Medium full,' 'full,' and 'large full,' that is, herring containing milt or roe, and of not less than $9\frac{1}{2}$, $10\frac{1}{2}$ or $11\frac{1}{2}$ inches respectively, as measured from the point of the nose to the tip of the tail. There was also quite a large proportion of the herring over 13 inches in length, and which were designated 'extra large full,' making in all four distinct grades.

Of the total quantity of full fish cured $\frac{9}{16}$ Extra Large Fulls, $\frac{4}{16}$ Large Fulls, $\frac{5}{16}$ Fulls, and $\frac{2}{16}$ Medium Fulls, were sent to New York, $\frac{2}{16}$ Fulls to Halifax, 97 kits to Yarmouth, and 200 kits and 5 quarter barrels to Montreal.

The prices made in New York were, for 'Ex. Lar. Fulls,' \$9 to \$10 per barrel, 'Lar. Fulls and Fulls,' \$4.25 to \$5 per half barrel, and 'Medium Full,'—a very small herring—\$8 per barrel.

The 'Fulls' in Halifax brought \$3 per half barrel on the spot, and in Montreal, \$1.50 for quarter barrels and 60c. for kits. In Yarmouth the kits made 50c. and 70c. each. The herring which were packed in kits were 'spent' fish *i.e.* herring which had shed the milt or roe.

It will be observed that the price obtained for the 'full' fish is not so great as that received for 'matjes,' but this is also the case with 'fulls' and matjes sent into the markets from Scotland.

The supply of, and the demand for matjes is comparatively limited, whereas the supply of 'full' fish just before spawning time is greater and surer, and the demand almost unlimited, at a figure naturally lower than that given for the less plentiful matje.

These being the first Scotch cured Nova Scotia 'fulls' to be placed upon the American market, it is highly gratifying to be able to say that they as well as Nova Scotian 'matjes' have been well received, and especially so when compared with the price of Scotch cured Newfoundland 'fulls' in the same market.

The following report, taken from the *New York Fishing Gazette* of September 2 speaks for itself:—

'There has been an arrival the past week in the metropolis of an experimental consignment of Lar. Full. Scotch cured Nova Scotia herring to the order of a well-known importing firm. In order that there might be no possible misunderstanding relative to the landing of these fish, of which so much comment has been made, a repre-

representative of the 'Gazette' attended the examination made by the consignees, and a well-known expert, from the Hebrew quarter, was also present. The statement given out for publication is as follows:—

A careful examination has been made by us of the sample consignment of Scotch cure forwarded us from the Yarmouth, N.S., fishery staff. We previously had received a consignment of 'matjes' from Canso which made a very favourable impression on us and were taken up by the trade at an equivalent parity to that ruling on Shetland fish although they were detected as of Canadian production. We can of course say nothing as to the market on the Lar. Fulls. now in question, but the quality of the stock is excellent.

The herring are firm, fat, and of good colour. In the pickle in which they were entered the peculiar sheen of the Scotch pack was noticed and the appearance of the top layers gave a most favourable impression. Removing entire staves and hoops after drawing pickle the pack held to formation denoting good care and understanding in barrelling same.

The stock was uniform and well graded throughout. The herring should command a good market in the United States if produced according to the sample sent us, but the trade is most particular and the consumer is the only party who can inform us as to whether the goods are acceptable.

These people want the best, nothing else suits their requirements and they are willing to pay for just what they get.'

In the beginning of September I was instructed to send part of the staff to give demonstrations in herring curing at the Halifax Provincial Exhibition which was to be held from September 13 to 21.

I, accordingly, with Mr. Cumming, cooper, and three of the girls, from Yarmouth, proceeded to Halifax on September 13—a supply of barrels and salt having been previously sent there.

Sufficient space was reserved in the fisheries building in which the staff demonstrated before large and interested crowds. Some difficulty was experienced in obtaining fresh herring for the purpose of 'gutting and packing,' however, Mr. Boutillier, of Halifax, was able to secure a few for us on two occasions.

Having anticipated this difficulty I brought along from Yarmouth a few half barrels of herring, already gutted and packed, so that in the event of fresh herring being unobtainable we, at least, could show how the barrels were finally filled up and finished off for market. As it turned out, however, we were in a position to show both the process of gutting and packing and that of filling up.

In the beginning of October it was decided to discontinue operations, as the herring were then spawning and getting into rather an unfit condition for curing.

By your instructions, therefore, the drifter was sent to Canso, there to be utilized in the collection of dog-fish for the government reduction works, and the staff paid off, with the exception of those required for the British Columbia herring curing scheme referred to in the department's fishery report last year, and who were employed in repacking the kits of herring for distribution in Yarmouth and Montreal, till the time of departure for the west.

Two of the Scotch fishermen and one of the girls went back to Scotland. The other Scotch fisherman took employment on the drifter at Canso. Two of the girls found husbands and homes in Canso and settled there.

On October 25, Mr. Cumming, the Scotch cooper, three girls and myself left Yarmouth for British Columbia via Montreal and Ottawa, and reached Nanaimo, B.C., on November 4.

The system of conducting the herring business on the Pacific coast is altogether different from that on the Atlantic seaboard. On the Atlantic coast each fisherman cures his own catch of herring, afterwards disposing of them to some local fish merchant. On the Pacific the fishermen simply catch the fish and sell them in a fresh state to local curers who have curing places on shore where the curing takes place.

The curing firms own boats and nets and employ men to do the fishing. There are also a number of independent fishermen, however, fishing on their own account who, besides selling to the local buyers, send fresh herring direct to Vancouver and New Westminster each morning by steamer, but in no case do fishermen cure their own herring.

On arriving at Nanaimo, B.C., I found only two firms engaged in herring curing. As the season advanced, however, a 'kipper house,' and a wharf and shed for dry salting herring for the Chinese market, were erected, besides another curing place under construction for a Fraser river firm.

Herring were reported plentiful outside the harbour at Nanaimo about the beginning of November, but it was the middle of the month before they were got inside, and even then only on occasional nights.

Herring in phenomenally large quantities come right into the harbour about the end of November, and stay there for some months. It seems, however, that their movements during the latter half of November are somewhat erratic. They will come into the harbour quite plentifully for a night and then disappear for a few nights in succession, coming and going in this way until they finally come in to stay about the end of the month, although their flitting out and in has been known to continue till near Christmas.

The herring caught at Nanaimo are of the 'full' variety, the largest of which are equal to the 'full' grade of the Atlantic and never exceed 11 inches in length.

When herring began to come in fair quantities the local curing establishments were visited by the staff, where practical lessons in gutting, packing, salting and filling up, were given to the staffs of the local curers, each day on which herring were to be had.

The Scotch staff filled, in all, 32 barrels and 234 half barrels, in their demonstrations of the Scotch method.

An extraordinary amount of interest was shown in the work of the staff, not only by Nanaimo people, but by representatives of most of the salmon packing companies of the Fraser river as well, some of whom donned overalls and went to work gutting and packing along with the girls.

The members of the Dominion Fisheries Commission who were holding sittings in British Columbia, under the chairmanship of Professor Prince, visited the curing sheds with Mr. Sloan, M.P. and Mr. Ralph Smith, M.P., on November 24 and 25.

The results of marketing will not, of course, be known for some time yet.

Samples are being sent to Australia, New York, Canadian Northwest, and the Western States.

Besides showing the actual work of curing, I had the following instructions printed and distributed to all those interested in the industry in Nanaimo and Vancouver:—

INSTRUCTIONS FOR CURING HERRING IN THE SCOTTISH STYLE AT NANAIMO, B.C.

Fresh fish indispensable.—In the first place it is necessary to have herring perfectly fresh.

Sprinkling with salt.—As the herring are discharged from the boats they should be sprinkled with salt.

Gutting.—In gutting, the gills and gut must be taken clean away with a sharp knife, cutting just below the two upper fins, and the roe or milt left in the fish.

Grading.—There are two marketable grades amongst the herring caught in Nanaimo harbour, namely: what are known in Scotland as 'Full' and 'Medium Full.'

1st grade.—The first grade, or 'Full' herring consists of herring of not less than 10½ inches, measured from the point of the nose to the tip of the tail, and clearly showing the milt or roe at the throat when the gut has been extracted.

2nd grade.—The second, or 'Medium Full' herring consists of all herring under 10½ inches, but not less than 9½ inches, as measured from the point of the nose to the tip of the tail.

Rousing.—As the fish are gutted they are put into a tub, or any other suitable receptacle, and thoroughly turned over in, and mixed with salt, allowing as much salt to stick to each herring as possible.

Kind of salt.—For this purpose, what is known as 2nd Fishery Liverpool salt should be exclusively used.

Mode of packing.—After having been thoroughly 'roused' the herring are then lifted from the 'rousing tub' and packed in tiers in the barrels.

In packing, the fish are placed back down, kept close together, using three herring to stretch across the barrel, one at each side with their heads to the staves and one in the centre.

When the tier has been completed, two herring are placed on their sides, over the heads of the herring in the tier, with their tails crossed and their backs next the staves. The whole tier is then salted and the next tier packed across the one below it and so on until the barrel is packed full, each tier being salted separately. The gutting and packing takes place simultaneously.

Quantity of salt on tiers.—There is no fixed rule for regulating the quantity of salt to be used to each tier. This varies slightly according to the condition of the fish, the market to be cured for, and the length of time the herring are to be kept, and therefore must be necessarily gauged, accurately, by experience.

A safe guide, however, is to scatter as much salt on each tier as will nearly hide the bellies of the fish in the tier.

Kind of salt.—For the purpose of salting the tiers, California salt may be used, but 2nd Fishery Liverpool, is preferable for use on the tiers as well as for 'rousing.'

Dating and marking.—As each barrel is given to the packer to be filled, the date of filling, and the grade of fish to be packed, must be written, in pencil, on the bottom of the barrel, as for example:—Dec. 1-F. or Dec. 1-M.F., the letter F. denoting that the barrel contains 'Full' herring packed on December 1, while 'M.F.' denotes 'Medium Full' packed on the same date. The necessity for this appears later.

1st filling up.—On the third day after packing, the salt will be found to have dissolved a little and pickle seen almost up to the top tier. The herring will also have sunk two or three inches in the barrel.

On this day each barrel is filled up to the 'croze' with herring of the same day's pack, a little salt being added to the herring used in filling up, the head put in and made light, and the barrel laid to one side until the herring pined and matured the stated number of days before the final filling up and preparation for market.

2nd filling up.—On the twelfth day, counting from the day of first packing, a bung-hole is made in the side of the barrel, about three inches from the centre, that is, nearest the bottom end, the barrel up-ended and the head taken out. It is necessary to have some distinguishing mark, to know the head end of the barrel from the bottom.

The bung is then taken out and the pickle drained off as far down as the bung-hole. It will now be found that the barrel will take from two to three more tiers of herring

to complete it. This is done by taking herring of the same day's pack, and grade, which are readily known by the marks on the bottom, already referred to, and packing them as before until the space is filled up, this time filling the barrel so that the top tier will be quite flush with the 'chime' and laying three herring straight on their backs, across the heads of the top tier, instead of two on their sides as in the case of the other tiers, after which the head is pressed in and made perfectly tight, then, as much of the original pickle as the barrel will now take is inserted through the bung-hole. The herring used for the final filling up, should be washed in pickle and very slightly sprinkled with salt, when in the tiers.

Repickling.—If the herring have to lie for some weeks after being finally filled, they should be supplied with pickle about once in two weeks.

With what has been seen of the actual work of the staff, and by adhering closely to the foregoing instructions, there can be no doubt about the Nanaimo curers carrying on herring curing, in future, in an improved and systematic manner.

While on the coast, I found that a deep and widespread interest was being taken in the work of the staff, and due appreciation of the government's action, in sending the staff to British Columbia to give object-lessons, was manifested on every hand.

On December 11 the staff left Nanaimo for the east, reaching Ottawa on December 16, and after being paid off, left next day for Scotland via Halifax.

GENERAL REMARKS.

The task of improving the system of herring curing in British Columbia was found to be an easy one compared to that of introducing the new system on the Atlantic seaboard.

This, in the first place, is owing to the fact that the herring trade of British Columbia, at present, centres at Nanaimo. Fishermen gather there from Vancouver and other places for the season's work.

In the second place, because curing was being done on lines somewhat similar to the Scotch system, by merchant curers on shore, who, being in direct touch with the markets, are alive to the necessity of exercising that care and skill in curing which will enable them to find larger and more remunerative outlets for the product, and, further, because a most desirable barrel, made of the best of wood and well hooped, is in general use there.

The real reason that the industry started out on lines akin to the Scotch, soon becomes apparent to the visitor to Nanaimo, during the season.

The enterprise in British Columbia is quite a new one, and the fishermen being mostly Scotch, many of whom I knew on the other side of the water, although they know little about curing, have nevertheless given the local curers some idea of how the industry is conducted in Scotland.

On the Atlantic coast, on the other hand, a little curing takes place, more or less, in almost every creek and cove along a coast line of some thousands of miles in extent, in the most deplorable of barrels, by the fishermen who are not in touch with the great cured-herring markets, and do not therefore know how to find an entrance to the best markets. Similar conditions existed in Scotland 80 or 100 years ago.

Signs are not wanting now, however, of an inclination on the part of fish merchants, on the Atlantic coast, to take up the curing of herring on shore.

Fishermen, in the western part of Nova Scotia especially, have expressed to me their desire, time and again, to be relieved of the necessity of curing, so that their time and skill might be devoted more to the catching of the fish.

As an example of the increased energy that fishermen would put into herring catching if relieved of the trouble and expense of curing, I may mention that as soon as

I had started to buy fresh herring from the fishermen of Yarmouth and Clark's harbour, the members of one crew were so eager to get herring that they went to sea one blowy night, and so loaded their boat, that she went under in the choppy sea, the crew escaping in their dories.

The boats used at present, of course, are small, but if curers on shore established curing places, where fishermen could dispose of their catches fresh, larger boats with more nets would be used and the supply of herring be more of a certainty than it now is.

Now that we have had an opportunity of curing and placing on the market all the various classes of herring, detailed instructions similar to those given to the trade in British Columbia, printed in both languages, could be distributed in the Maritime Provinces, by the department. This with flying visits of the staff to all places where it is intended to carry on this style of curing, will cause its adoption to become general and nearly simultaneous. Such instructions must differ somewhat, however, from those issued on the Pacific coast, owing to the greater number of grades of fish to be dealt with. The question of an improved barrel would also be dealt with and details given for its construction.

In curing 'matjes' to obtain the higher price, a very great amount of skill and experience is necessary. Many even of our Scotch coopers, are quite unacquainted with the curing of 'matjes.' The fish have to be mildly cured in such a way that they will retain their soft condition and at the same time be cured enough to keep good for months, and although regulations may be published for the guidance of the trade, I would strongly advise any firm which contemplates engaging in the curing of this class of fish, to obtain the services of a Scotch cooper who has had a thorough experience in 'matje' curing.

OTTAWA, December 23, 1905.

