34.—REFORMS AND IMPROVEMENTS SUGGESTED FOR THE FISHERIES OF GREAT BRITAIN AND IRELAND.

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[This valuable paper has been abstracted and arranged by the undersigned, with the consent of Dr. J. Lawrence-Hamilton, partly from articles which have appeared in scientific journals and public prints of Great Britain during the past few years, but chiefly from a privately printed and copyrighted pamphlet, issued in 1890, consisting of a "Report upon the fish markets, fish-trade abuses, and fish supply of the metropolis" and a "Supplementary report upon necessary practical reforms in the fish supply of the United Kingdom." While the work of this author is well known in Europe, where his writings have been extensively circulated and read, the fishing interests of the United States have not generally had his papers brought to their attention. With a view to secure this result, the presentation of this paper to the World's Fisheries Congress was suggested to the author. The paper is full of important deductions, useful suggestions, and interesting information having application to the fisheries of the United States, and will doubtless attract much deserved attention.—HUGH M. SMITH.]

GOVERNMENT FISH INSPECTION.

For the safety and protection of the public it is necessary that Parliament should have fish inspection carried out by efficient government officials, to be appointed to guard over and to protect the interests and health of the public or fish-consumers.

Owing to the general ignorance in detecting fish unfit for food by reason of its decomposition, putrefaction, or poisonous qualities from disease, parasites, and other causes, it would, at any rate for a time, be necessary to appoint special fish-inspectors to examine, seize, and condemn all fish unfit for human food. These official inspectors should be duly trained and competent fish experts, fish naturalists, and fish microscopists familiar with fish diseases and fish parasites, and thoroughly acquainted with the chemical and microscopical characteristics of stale, tainted, decomposed, putrid, and poisonous fish, whether such poisons were normal, occasional, or accidental. A knowledge of the various spawning periods and conditions of fish would be desirable.

Fish markets, fish shops, and stores of fresh, cured, or cooked fish, fish vehicles and barrows and their contents should, when necessary, be inspected. Also fish curing, salting, preserving, bottling, potting, canning, and tinning establishments, wharves, warehouses, stores, etc., specially devoted to storing fish. Fishing smacks and vessels, steam and other fish-carriers, including refrigerator vessels, when necessary, should be inspected. It is, of course, in the interest alike of the public and fish-traders that all premises and appliances in which fish are placed or stored should be kept scrupulously clean, so as to avoid bacterial putrefactive infection. As soon as this economical and sanitary lesson has been learned and appreciated by the public and the fisherfolks, it is to be hoped and expected that fish inspection and fish inspectors will be but very rarely required.

PROHIBITION OF UNBLED AND UNGUTTED FISH IN MARKETS.

Parliament should prohibit unbled or ungutted fish entering any market or retail shop or from being offered or exposed for sale. Prohibiting the sale of unbled or ungutted fish which spoil unspoilt fish in their vicinity would be equally advantageous and profitable both to the fisherfolks and to the public. A small fragment of bad putrefying or putrid fish may destroy whole cargoes or loads of fresh dead fish. The products and bacteria of fish putrefaction are preëminently diffusible, as is shown by the smell of bad fish being so long retained and diffused. Exposing unbled and ungutted fish for sale in markets or shops is, or should be, even under the public-health act of 1875, the carrying on of an offensive trade, with a penalty not exceeding £2 for the first offense, whilst a subsequent conviction may even amount to a fine of £200.

In considering the preservation of fish, its red muscular fibers are comparatively so few that for practical purposes the study of the pale fibers is sufficient. Whilst in the higher animals used as food the muscles are arranged in close, thick, firm bundles of long fibers, in fish nearly all the muscles are in the form of loose, short, soft bundles arranged in narrow rings in a zigzag fashion, separated from each other by delicate partitions of thin connective tissue. Except in the eel, salmon, and mackerel, fat is usually absent in fish. The flesh of salmon yields from 63 to 68 per cent of water, whilst that of ordinary whitefish furnishes from 75 to 82 per cent, which are much larger proportions of water than is contained in meat. Not only in the intestinal tract, but also in the blood, lymph, and tissues of healthy living sea and fresh-water fish, active and multiplying bacteria are found. Though fish up to a certain point apparently are able to tolerate the presence of these bacteria in their blood and lymph, yet, should the vitality of their tissues become lowered by confinement, injury, starvation, or disease, the fish will probably be overcome and die. The same applies to external and internal parasites, which almost invariably frequent healthy fish, which, up to a certain point, are also tolerant of these parasites.

On death, fish readily absorb water from moisture, whether naturally in the atmosphere or foolishly supplied by the custom of using melting ice as well as by the continual watering of fish on the fishmongers' slab. How excessively deleterious the absorption of the moisture will be is apparent upon recollecting the filthy state of the fish boxes, barrels, and baskets in the equally filthy fish boats, fish markets, and some fishmongers' shops.

NEED OF A DEPARTMENT OF FISHERIES AND A ROYAL FISH COMMISSION.

Parliament should create a special department of fisheries, to be presided over by a minister of fisheries, to protect, advance, and develop the fishing industries and trades of the United Kingdom. This is necessary and imperative upon commercial, financial, and economic grounds:

(1) To supervise the production and provision of healthy, fresh, cheap, abundant fish food for the poor and the comparatively poor.

(2) To develop a large foreign and colonial export fish trade.

(3) To gain a knowledge of available fishing-grounds.

(4) To secure and maintain the naval supremacy of our empire from gradually falling into the hands of foreigners by recognition of the fishery marine as the recruiting school of the navy.

I maintain that the fishing industries and trades of the United Kingdom are nationally more important than those of agriculture, which has its representative minister in Parliament. In 1882 it was calculated that already, out of the 60,000 square miles of fish-bearing rivers in England, manufactories and town sewage had so polluted these waters that upwards of one-sixth of these rivers were then no longer able to support fish life. This is an additional reason why national compensation to the fishing industries, in order to cheapen the price of fish to the poor, should be effectively undertaken by Parliament.

I strongly urge upon Parliament to grant a special commission upon fish, fish preservation, fisheries, fish-waste products, fish-hatching, and all allied subjects. I suggest that this proposed royal commission on fish should investigate and report upon the legal, administrative, economical, financial, commercial, trade, and scientific reforms relating to the improvement, development, distribution, and cheapening of the fish supply of the United Kingdom, upon the lines indicated in my report.

THE TREATMENT OF FISH WHEN FIRST CAUGHT.

Very great benefit would accrue to the fisheries by the more general possession of knowledge regarding the best methods to follow in caring for the fish as they are caught. Much avoidable loss annually results to the British fishermen through lack of information on this point. To prepare fish properly for consumption in a fresh condition, they should be killed as quickly as possible.

Immediately on capture, where practicable, fish, prior to the coagulation of its blood, should be gashed under the head, just behind the gills, the usual situation of the heart in most fishes, or else above the tail, which has been the practice from time immemorial in Scandinavia and in Holland; nevertheless British fishermen seem still unwilling to listen to and to learn this wise economical practice. Compared with land animals, fish have but very little blood to lose, and hence fish, on being bled, become at once faint and rapidly pass into insensibility. Next, speedily gut the fish so as to remove its entrails, including the liver and roe. Finally, thoroughly clean each fish inside and outside with abundant washing in clean, fresh-flowing water, sea water being for every class of fish better than spring water. Though gutted fish keep better and longer by the addition of salt or brine into the cavity of the body, I recommend peat moss as being cheaper and much more effective. Universally abundant in Ireland, peat moss should be freely used by its fishermen.

Norwegian fishermen roughly estimate that by bleeding, gilling, and gutting flatfish about one-sixth of the total weight is lost, whilst long fish by bleeding and gutting forfeit about one-fourth of their weight. In spawning fish, being full of roe, these proportions would be materially increased. A codfish weighing 21 pounds is said to have furnished 12 pounds of roe. Thus, especially for railway-borne fish, this economy in freight would mean a great saving to the public—the fish-consumers.

The Dutch, introducing the Scandinavian plans of bleeding, before clotting and gutting, herrings on capture, together with the plan of pickling and curing herrings, reinvented by an Englishman, Will Blenkinson, secured for their countrymen from the fourteenth to the eighteenth centuries the virtual monopoly of the marine mastership of the world, including its carrying and export commerce. Though fish is preëminently more prone to early putrefaction than meat, nevertheless the conventional British fish markets and many fishmongers' shops stink from avoidable causes, and

thereby spoil any unspoilt fish in their vicinity. A slaughter-house would be properly objected to in the heart of most towns, nevertheless fish markets and fishmongers' shops, evil-smelling from avoidable putrefactive bacteria, are sanctioned by indolent custom, though I presume that under the health acts of the United Kingdom their present condition is illegal.

Chiefly owing to being bled on capture prior to the clotting of the blood, Swedish and Dutch herrings are abroad gradually excluding Scottish herrings, which are less carefully cured and selected than the Scandinavian and Dutch herrings.

Modern science confirms the view that putrescent changes occur more rapidly in blood and other body fluids than in muscle and fat by the microscope so frequently revealing putrefactive germs or bacteria or microbes in the blood and internal fluids of fish, flesh, and fowl, whilst their muscles and fat may still be quite healthy. When the blood becomes contaminated with these putrefactive germs it is likely to at once infect the sound flesh, muscle, and fat. Indeed, in preserving all animal substances it is advisable to keep them as dry as possible, which is the principal factor in curing, salting, or smoking fish or meat. Handling fish or meats tends always to accelerate and often to invite and start putrefaction. In the frozen-meat trade, not alone is the carcass kept hard-frozen and dry, but it is invariably covered with a stout sack or shirt to prevent dirt, by handling or other means, injuring the meat. Hence fish, freshly captured and placed on their bellies upon the too-frequently filthy board at the bottom of the fishing smack, will often have their bellies rotten whilst their sides and back remain comparatively sound. Other conditions and circumstances being equal, it is found that fish, flesh, and fowl keep in proportion to the length, density, compactness, and hardness of the microscopic fibers which unite together in bundles to form the muscle. Fat, of course, keeps much longer good than muscle, whilst moisture, high temperatures, and exposure to the direct rays of the sun hasten decomposition. Over-driven cattle, and fish drowned in the meshes of the nets, as well as all animals whose strength has been exhausted by the chase or previous privation or disease, are prone to decompose with increased rapidity. This tendency to rapid putrefaction after death has been observed, by army doctors, in troops who have died on the battle-field after long fasting, fatigue, and fighting.

TORTURING AND STARVING FISH.

Fisherfolk waste fish by starving and torturing. In the United Kingdom those professionally and pecuniarily interested and engaged in fish torturing and starving have, in the ignorant thoughtlessness of chronic custom, been alike blinded to the sacred civilizing duties of humanity and Christianity, and have also overlooked and omitted their own material profits and advantages. Fish starving is a domestic sport which diminishes the commercial value of the fish; it ruins the flesh, flavor, and firmness of the fish; it tends to induce parasitic, bacterial, and other diseases in the fish; it diminishes the weight of the fish, and increases its cost both to the professional fish-starver and to the consumer—the general public. Fish so starved are more liable to rapid decomposition soon after death, and in codfish such starved fish are more difficult to crimp, which are additional causes and circumstances tending to enhance the avoidable risks of the present fish trade, and therefore an unfair tax on the consumer. The average absolute loss in weight of codfish by starvation and imprisonment appears to represent 10 per cent of the entire weight of the natural normal healthy fish, a heavy

avoidable commercial loss. The close confinement of codfish in their fish chests sunk in the fish docks causes a rapid increase in the relative number of bacteria alleged to be always present in the blood of living fish. When the proportion of bacteria exceeds that which the blood of living fish can tolerate, then the fish commence to sicken and will often die, even if well and regularly fed in a fair amount of space, as in fish kept in aquaria. Hence these sunk fish trunks become the rapid carriers of contagious disease to any healthy fish which may chance to be in or near the fish chest.

In addition to tolerating in health a certain proportion of bacteria, fish are also, up to a certain point, equally tolerant of various external and internal parasites; and generally every fish dissected shows either some parasites, as tapeworms, in its intestines, or other parasites about its gills, eyes, skin, or elsewhere, and even sometimes as many as fifteen different species of parasites have been discovered in one individual fish. Often these parasites, along with the bacteria, increase so as to gain the battle over the fish, especially when the latter becomes weakened by starvation, confinement, injury, or other causes tending to diminish its vitality. Parasites also promote decomposition the moment the fish dies. These sunk fish chests never err on the side of cleanliness, and are hence favored localities for hatching and breeding bacteria and parasites specially destructive to fish health and fish life. The loss of life in codfish caught in the nets will not average upwards of 5 per cent. Hooked fish on being drawn up are liable to disgorge or vomit, not alone the contents of their stomachs, but also, especially in the case of deep-sea and abyssal fishes, to have their stomach and part of their intestines protruded through their mouths. Having air-bladders, deep-sea and abyssal fish by the rapid altered pressure, together with the influence of shock, get their air-bladders so dilated with evolved gases that they are unable to sink from the surface of the water in welled smacks till the fisherman, passing a long needle through the walls of the fish's abdomen, or the pit of the left pectoral fin, by letting the gases escape, allows the fish to resume its natural habits. Hooked salmon vomit through fright alone. Fish may be sometimes seen with a prolapsed and protruded rectum and lower intestine, which appears to be due to relaxed flabby muscles, and is a sign which very shortly precedes the commencement of decomposition. As a rule hooked fish keep longer fresh than netted fish, which, owing to being injured by having been trawled over rough grounds, together with the sharp prolonged squeezing and banging about they get in the nets, are specially liable to early decomposition.

Much of the so-called best prime "live" codfish at Billingsgate has after capture been transferred into welled smacks which accommodate from about 600 to 1,000 codfish, each weighing from 16 to 20 pounds avoirdupois. Especially in rough weather, after having been subjected for a few days to injury, confinement, and starvation in the welled boats, to prevent these fish from eating one another they are sometimes specially secured by their tails. On arriving in port some 40 of these codfish are tightly crammed into a fish chest, sunk in the fish dock (which in England answers only during the cold weather from about November till April), where the codfish, after further confinement and starvation, all die within a few weeks. If the fish be kept for a shorter interval, say, a fortnight, then on an average only about 10 per cent of such codfish are found dead upon opening the raised chest. All such starved, closely confined codfish lose much of their natural healthy flavor, firmness, weight, and plumpness. The fish, having to support life, consume much of the substance of their own livers, which

appear small and shrunk when compared with the normal liver of a freshly killed healthy fish. This codfish, if not previously dead, is then stunned with a blow from a big mallet, and thus, whilst insensible, crimping is alleged to be carried on. As the sensibility never returns there is practically no cruelty. Skate are said sometimes whilst still alive to be crimped by fishmongers. So long as cod will "crimp" or show muscular contraction it is called in the fish trade "live cod," an intentional misrepresentation. Out of its healthy season, a woolly, watery codfish is often appropriately termed by the fishermen "churchyard" cod. Recollecting these facts, the familiar dry, flabby, cottony taste of the vaunted best prime "live" codfish so often sold at Billingsgate and elsewhere is easily explained. Skinning live eels and gutting live fish, causing avoidable, useless torture, are occasionally practiced.

In welled boats halibuts are hung up by their tails, under the delusion that in these artificial conditions the fish will enjoy longer lives and that their flesh will keep better fresh for the market. These local injuries often actually cut through the soft parts till the bone is exposed. As to the "alleged habits of halibuts at the bottom of the sea, arranged in parallel rows, waiting and watching for small fish and shellfish: when failing such food supplies, the hungry halibut attacks and eats the tail of its nearest neighbor, which explains the frequently injured and absent tail of freshly caught halibut." This tail cannibalism on the part of the halibut is an absurd invention to hide the cruelties practiced in welled smacks.

Lobsters and crabs are often kept alive on wet seaweed or ferns, and live on an average in hampers for a couple of days, starving before they reach the fishmonger, who frequently stores them, if not sold, till they die of starvation. Lobsters and crabs thus starved to death lose weight, firmness, taste, and flavor, and immediately on death tend to decompose rapidly, which in such conditions is but slightly diminished by boiling in salted water. Instead of puncturing with a stiletto, wriggled about so as to break up the animal's brain material, and then plunging the crabs and lobsters into boiling water, out of sheer thoughtlessness and careless custom living lobsters have been placed in cold water which, while it is being heated up to the boiling point, causes the animal prolonged avoidable torture, for if plunged into boiling water it quickly dies. Previously to boiling, to rid them of sand and dirt, crabs and lobsters should be well washed in fresh flowing water. Spanish fishermen catch a coast crab only to cut off the good-eating coveted claws, and then return the mutilated animal to the sea, to be recaptured if possible upon the reappearance of its developed claws.

Immediately before its death fishermen scale the red mullet to induce permanent contraction of its superficial pigment cells, causing the fish to become the intense popular red color of the trade.

Although no fish or shellfish is legally protected against cruelty in this country, and although it is not punishable to boil fish alive, to roast fish alive, to slice fish alive (as turtle used to be in Ceylon, and as some air-breathing fish carried about in earthen pots in China are still), yet it is to be expected that these cruelties will rapidly disappear as soon as fish-traders find that humanity to animals will benefit their own pockets. Codfish will keep in excellent health and condition if placed in artificial ponds or docks, fed with sea water, as was the custom among the ancient Romans and ancient Egyptians. The present St. Petersburg fish farms or ponds, fed by the river Neva, and where each species of fish has a separate compartment, yield profitable rentals. Lobsters and crabs can be fed on almost any fish refuse.

AVOIDABLE FISH-SPOILING THROUGH CARELESSNESS, FILTH, AND BAD PACKING.

Placed upon their bellies on the usually filthy boards at the bottom of the smack, the abdomen of the fish may rot whilst its sides and back remain comparatively sound. In the United Kingdom captured fish are often thrown unbled and ungutted, and always unpithed, into the more or less foul hold of the fishing boat, where they remain exposed to successive alterations of heat, sunshine, moist and melting ice, and putrefactive filth. The fish are frequently ruthlessly crushed, bruised, and cut by the heavy weights of their thoughtless captors standing in sharp-nailed boots, whilst the lower layers of fish may have tons of fish resting upon them. In some parts of England, from about September till April, many of the smacks fish by themselves, and not in a fleet from which a steamer or other carrier takes away each day's fish. As such isolated smacks stay out at sea about a week, it follows that a portion of their catch has been already some six days in ice before landing. Such stale fish by putrefactive contagion damage the fish more recently caught. On reaching the harbor the fish are commonly pressed into filthy fish boxes, barrels, and baskets pregnant with putrefactive bacteria. The fish suffer further shaking, banging, and bruising by being flung about on the pier, where this food lies again exposed to heat, rain, and sunshine. As the fish boxes or trunks have always wide-open apertures, and in the carrying boats and railway and street vans the boxes are closely piled one above the other, it follows that the flowing filth from the upper boxes circulates through the lower ones, whilst the last tier, both from above and below, is surrounded with these putrefactive abominations.

Fish are, again, further damaged by close packing and pressure. To economize space in packing the barrels a sharp sudden wrench or twist bends the fish into a coil, breaking up the animal's softened muscles and structures, thereby inviting and increasing putrefaction. Finally, such fish are tightly crammed into rough, porous, unvarnished, foul boxes and barrels, which are rudely closed by sharp hammering.

The practice of suddenly twisting the tail of the whiting, and passing it through its mouth or through the sockets whence the eyes have been removed, ruptures the soft, flabby, loose, muscular fibers, especially when such fish have been previously skinned. The exposure of dead fish thus wastefully maltreated in fishmonger's shops, pregnant with putrefactive bacteria, accelerates decomposition.

When fish has once become flabby, stale, or tainted no preservative process can possibly restore its lost flavor, freshness, or firmness.

The fish which British fishermen occasionally gut are often to be seen placed in a few inches of stagnant water supersaturated with putrid blood and filth. Frequently handling fish, especially with dirty hands, accelerates putrefaction, as also the time-honored custom of watering fish on the fishmonger's slab. By a statute of Edward I., dated 1272, no fishmonger was allowed to water his fish more than once; no fresh fish was to be kept in London beyond the second day from its capture; nor was any bad fish to be sold. The profit of the London fishmonger was limited by this statute to one penny in the shilling.

Fisherfolk so fully realize the present difficulty of preserving fish that stale and decomposed fish is technically termed "overday" (over-a-day) fish. Fisherfolk say that thunderstorms spoil fish, but as thunderstorms occur chiefly in hot, still weather, associated with rain, the explanation is included in the fact that fish decompose

quicker on a wet windless winter's day than during a dry hot summer's day with a brisk breeze. Others credit the bright rays of a full clear moon with causing rapid decomposition of freshly caught fish; but there seems to be no foundation for this statement.

INEFFICACY AND INJURY OF CHEMICAL PRESERVATIVES.

Common salt, brine, boracic acid, tartaric acid, niter, sugar, burning sulphur and aromatics, boro-glyceride, limewater, shea or vegetable butter, powdered charcoal, flour, sawdust, or antiseptics, as well as forcing under mechanical pressure chemical solutions into fresh fish, alike fail to keep fish from decomposing when applied in the usual commercial proportions. Chemicals which "preserve" fresh food injure digestion. Hence the employment of all such chemicals in fresh food should be illegal.

The medical and chemical professions should unanimously protest against the introduction of chemicals into fresh food. Of course salting, drying, curing, smoking, preserving in oil, pickles, vinegar, mustard, sugar, spices, alcohol, and other familiar methods of household cookery are not to be included in the term chemicals. Practically, "preservatives" like boric acid and a host of other public and secret methods are rarely used till the "fresh" food is more or less "on the go"; that is to say, till the first stage of decomposition has set in. This trade trick is an old dodge to hide the tainted taste of stale provisions.

THE FAILURE OF ICE AS A PRESERVATIVE AGENT.

The thickness of fishes and certain qualities of their skin cause slight variations in the freezing-point of the different kinds. The freezing-point of fish is a few degrees below that of water or the ordinary commercial ice at 32 F., which, even were it used in large excess, could then only superficially and incompletely chill the exterior layers without practically affecting the temperature of the interior of a thick fish's body. In all conditions and circumstances ice spoils the freshness, firmness, and flavor of fish by rendering it, prior to putrefaction, insipid, soft, and flabby.

Supplying moisture, ice circulates the filth contained in the foul fish trunks. In the United Kingdom, by coasting vessels, fishing is seldom carried on during Saturday afternoon or on Sunday; fish caught on Friday night and often days previously, especially during continued storms, fogs, and calms, could not reach Billingsgate till Monday morning, and the consumer late on Monday, when it would never be less than three days old and often more. Trawlers sometimes stay out at sea for ten days or more at a time, icing their fish as they catch it, and only return to land their fish on the exhaustion of their supply of ice. Indeed, much of the best prime trawl-caught fish sold at Billingsgate is from 3 to 10 days old. The London fish trade alone is now (1889) said to consume upwards of 1,000 tons daily of ice during the summer months.

Ice is an expensive, bulky, rapidly perishable, wasteful product. The present (1889) average wholesale winter or minimum price of rough artificial ice is as low as 11*s.* the ton when purchased in quantities of 2 tons or more, and the average price of artificial ice in winter bought by the smaller fishmongers and costermongers is 1*s.* the cwt., or at the rate of £1 the ton. Even in winter, in London the price of natural Norwegian ice is often £1 10*s.* the ton, which is popular in Billingsgate and other fish markets, where also actually crushed natural ice at 1*s.* 9*d.* the cwt., or £1 15*s.* the ton, is customary. Being imported from the metropolis, ice in most fishing districts is,

again, much dearer than in London. Compared with the winter prices, during the summer months, when ice is most used and most wasteful, it is much dearer—sometimes by 50 per cent.

Experience seems to show that the gravest cases of fish poisoning arise more commonly from eating fish which has been iced than from eating fish kept naturally cool and dry. Where fish is iced it appears that the ice only favors putrefaction by furnishing a constant supply of moisture carrying with it the putrefactive bacteria derived from its foul surroundings, so that this iced fish remains covered with fresh solutions of filth pregnant with putrefactive bacteria. Thus large quantities of those subtle complex bodies, the animal alkaloids or ptomaines, are probably elaborated and give rise to marked symptoms of poisoning which sometimes occur from eating iced fish. On the other hand, keeping fish dry and cool can in no way favor putrefaction. And although here cases of poisoning may happen, yet, as far as I can gather, the symptoms are much less serious and go off sooner, the toxic or poisonous effects being usually confined to a passing attack of vomiting and diarrhea; whilst in the case of iced fish the vomiting and diarrhea may be less marked, though the other symptoms may be much more profound and lasting, and sometimes even fatal.

THE ADVANTAGES OF DRY-AIR REFRIGERATION.

Apart from its present high prices, fish is but comparatively little eaten in the United Kingdom, because it seldom reaches the consumer until it is more or less spoilt, whilst English meat is usually of excellent quality and condition.

To obtain an imperishable, cheap, healthy, and abundant supply of fish food, it is necessary to bleed, gut, and clean the fish at once on capture, and forthwith transfer it to the dry-cold-air refrigerator chambers of special steamers at the fishing-grounds. This hard-frozen fresh fish should be distributed to the fish markets, wharves, and stores situated on canals and rivers by dry-air refrigerator barges, or insulated covered barges for shorter distances, whilst seaport towns could receive the fish direct from the refrigerator steamers, as well as towns like London having wide and deep rivers. As far as possible all railways should be avoided. In the United Kingdom their extortionate rates for the carriage of fish have oppressed the fish trades to the special injury of the poor. However, if frozen fish has to be sent long distances by rail to towns unprovided with canals, rivers, or lakes, as in some of the American cities, then special refrigerator railway fish cars are advisable.

Fresh food is kept imperishable and healthy only by regulating the temperature so that the bacteria of putrefaction and their complex products can not exist. Vegetable and animal foods at low temperatures remain imperishable, provided always that all available moisture is excluded. Meat, game, poultry, and fish must be thoroughly bled before blood-clotting, then gutted and cleaned. Before being artificially cooled or refrigerated, flesh must gradually give up its animal heat, its excess of moisture, and complete the rigor mortis. In arctic climates killed animals, if unbled and ungutted and not previously gradually cooled, may be hard frozen outside and putrid internally. Thus, much refrigerated meat, etc., have been spoilt by omitting to let off the excess of its animal heat and its rigor mortis ("setting" or "firming" in meat, "stiffening" in fish) prior to artificial cooling or refrigeration.

In Russian winters fish is naturally frozen for months, and is sawn for the retail customer. Fish is kept frozen naturally by the dry, cold winter air, in the Hudson

Bay territories, in the elevated regions of Thibet, and in Arctic winter climates generally. The frozen-meat ships, for a forty-five days' passage from London to New Zealand, keep fish frozen for their passengers' food, though usually omitting to have such fish previously bled and gutted. For years the Hudson Bay Company shipped frozen salmon (though unbled and ungutted) to London, Australia, New Zealand, etc., but now the Canadians find that it pays them better to deal with the United States. Frozen salmon brought from Labrador in the screw steamer *Diana* kept good for 200 days, whilst in the Canadian Court of the 1883 London Fisheries Exhibition, frozen salmon after eighteen months of such treatment was found to be excellent eating. A frozen-fish trade is carried on between Senegambia, in West Africa, and Marseilles.

By means of a mixture of ice and salt a large, remunerative trade in hard-frozen fresh fish has long been successfully conducted in the United States, where refrigerator steamers fetch fresh fish from the fishing-grounds, freeze it hard, store it as long as required in specially constructed insulated refrigerator wharves and warehouses, and, when necessary, deliver it frozen in specially constructed fish refrigerator railway cars to inland distant districts unprovided with canals, rivers, or lakes. However, this salt and ice process is much dearer than the dry-cold-air methods.

By the introduction of frozen fish, both the fishermen and the fish-venders themselves will be great gainers, as with an extended commerce they will cease to deal in a perishable product, and also no longer require to waste their money on ice. In time every large town or district will require its own refrigerator stores or depots where both frozen fish and meat could be preserved to supply the local traders, who would thus never have to suffer pecuniary loss from overstocking with perishable food.

Excluding the wholesale fresh salmon trade, almost a monopoly, I estimate that, including all freights, costs, and charges, the wholesale selling price of fresh fish in the markets of the United Kingdom now (1889) already exceeds £15,500,000 a year. But by judiciously pushing and developing the dry-air frozen fresh-fish trades this wholesale commerce for home and export consumption could in a few years be made to exceed £100,000,000 a year. It would be a national disaster if foreign competition were to secure such a trade, which, in addition to its financial aspect, includes the best school in which to train sailors for our navy, a fact long recognized by the Dutch and French.

The poor are naturally puzzled, perplexed, and frightened at the present ever varying and fluctuating prices of the same kind of fish under the existing wasteful fish-destroying systems; this is another reason why they will welcome the advent of frozen fish. The total supply of frozen fish will be quite independent of local fogs, storms, calms, and the catch of the preceding twenty-four hours. Frozen fish should therefore remain all through the year at constant prices.

THE APPLICATION OF REFRIGERATION TO BAIT PRESERVATION.

The scarcity and high price of bait at times can doubtless be largely overcome through the use of refrigerators on vessels and on shore. Whether fish and other aquatic animals are to be eaten by man or preserved as bait with which to catch fish, the methods of preserving such animal tissue must be scientifically and industrially the same. Hence, upon the lines I have already explained, dry-air refrigeration is the only rational, reasonable, and economical plan to preserve fish baits. Therefore, except dry cold air, all chemical or other antiseptics, as used in the diluted proportions practi-

cable, have and will always fail, as foreign and home investigations and experiments have conclusively demonstrated.

Where bait has to be used alive, then it must be preserved in the same manner previously herein advocated.

One of the many useful trade functions to be fulfilled by the proposed free technical schools, would be instructions how at all times to provide abundant cheap bait for fisherfolks, who are now often unable to go out fishing because of fresh-bait famines. This is another avoidable factor tending to make our present fish supply dear, scarce, and bad, whilst inflicting an avoidable though severe loss upon too many of our impoverished fisherfolks and their families.

DRY-AIR REFRIGERATORS FOR VESSELS, MARKETS, ETC.

It is only quite recently that the dry-air machinery for ships, wharves, warehouses, and railway cars has been sufficiently perfected to work well, cheaply, and regularly, so as to be commercially remunerative. Hence the first losses of the earlier introducers of the frozen-food trades are now avoidable. It is to be expected that in the near future further improvements in the economy and efficiency of the frozen-food trades will be introduced, though already, at home and abroad, several rival plans and patents compete for business. Setting aside minor details, the best processes for food freezing may be thus briefly summarized. The average temperature of the cold air in the special ships and storehouses is turned on at 70° to 80° below the zero of Fahrenheit, or upwards of 100° F. of frost. For meat the cold in these refrigerator chambers can be accurately regulated by the machinery, which usually keeps the chamber at 16° to 22° F., though in the case of fish a less amount of cold is necessary. For this purpose the air to be cooled is so greatly compressed that its temperature becomes elevated to about 240° F. The heated air then passes through a long series of pipes, surrounded by cold water, which absorbs the heat of the compressed air, bringing this air down to the temperature of the cool water. This air is next let into another vessel surrounded with cold air, where it deposits all its moisture, for it is essential that the air for freezing food should be freed from every trace of water or moisture. By this time the doctored and dried air has become cooled to about 70° F., when it is suddenly and rapidly expanded, and thereby becomes so intensely cold that the air passes out of the machine at a temperature between 70° and 80° below zero, Fahrenheit, or upwards of 100 degrees of frost. This dry cold air circulates through the refrigerator chambers, and afterwards returns to the compressor machinery, to be again further dried and cooled down to 70° or 80° below zero.

The refrigerator chambers have walls, floors, and ceilings, composed of several layers of nonconducting or insulating materials, generally charcoal, with specially constructed massive insulated doors, so as to hermetically seal the refrigerator compartments. Here the substitution of peat moss for charcoal would be an economy.

Some frozen meat removed from the refrigerator ship *Tainui* to a covered insulated barge maintained 3° of frost after 55 hours, although after the first 24 hours had elapsed about half the frozen carcasses were withdrawn.

For carrying fish from the fishing fleets at the fishing-grounds, specially constructed coal-saving refrigerator swift steel steamers, of about 200 to 300 tons each, would be advisable. The present frozen-meat ships have chambers insulated with thick layers of charcoal, though peat moss would be more economical and efficient,

whilst in case of repairs from accidents, peat moss is much cleaner and weighs less than charcoal. In storing hard-frozen fish, as far as practicable leave an air space around each big fish, whilst large valuable fish, like meat carcasses, are best kept clean and undamaged by a separate canvas shirt or sack. Small fish can be packed in layers of peat moss.

REQUIREMENTS FOR A SANITARY FISH MARKET.

It is essential that the entire premises used for fish-storing should be constructed of glazed, polished, or enameled, level-faced, non-absorbent, non-porous structures and materials; marble, granite, or artificial "stones," highly polished; glazed bricks or glazed tiles; stout, hard, smooth glass; enameled slate or enameled metals for walls, ceilings, fittings, and fish slabs. Fish markets should have roofs of glass and metal only. Supports for the stands can be made of highly-polished or enameled metal, best circular or tubular in form, so as to avoid edges, ridges, and corners, which act as traps or dust bins to collect dirt and dust and breed therein contagious putrefactive bacteria to spoil unspoilt fish. The flooring or pavement should be even, non-porous, non-absorbent, hard, but not too slippery. In public markets a good gradient or fall towards the gutters and outlets is necessary for cleansing and disinfecting purposes.

To exclude contagious putrefactive bacteria, absolute cleanliness, dryness, and low temperature are imperative. If fish were bled before blood-clotting, immediately gutted, cleaned inside and outside with abundant water, especially sea water, and then dry-cold-air refrigerated, these processes would dispense with the expense of ice and disinfectants. Ungutted fish degrades a fish market or fish shop into an offal or filth store. It is as unjustifiable an abomination as an "uncleaned" or ungutted meat carcass, which no "butcher" would tolerate in his shop. By butcher I mean meat vender, who always keeps his slaughter and offal house apart and away from his shop. Fishmongers and fish salesmen should do likewise.

Besides the avoidable Billingsgate bouquet, the number of flies and blue-bottles in warm weather found in fish stores often roughly indicate the amount of avoidable filth and decomposing fish stored in and about the premises. The penetrating odor of bad fish and fish refuse usually prevents the fishmonger being able to let off profitably, if at all, the upper unused parts of his house. Being a local nuisance to the immediate neighbors, some landlords decline to let to fishmongers, while other landlords make many a poor fishmonger pay increased rent, which entails increased rates and taxes on the struggling tenant.

For economical advantages cold dry air and electric light are used in many large wholesale meat stores and shops. Such conditions are alike applicable for storing fish at sea or on land. The burning of gas evolves moisture, heat, and carbonic acid, besides some carbonic oxide, sulphurous acid, sulphureted hydrogen, ammonia, etc., which in crowded market-places, added to the impure products given off by continual excessive respiration and perspiration, contaminate and vitiate a limited supply of air, especially damp air and fogs. These, together with the dirt brought in from the streets and stables sticking to the boots of the market crowds, which mud and filth necessarily adheres to its pavement, are all united conditions and circumstances further favoring the rapid decomposition of unspoilt, spoiling, and spoilt fish. Hence to diminish these evils large public fish markets should be supplied with electric light. Gas should be in readiness in event of the electric light being out of order or during the engineer's accidental absence, etc.

UTILIZATION OF WASTE FISH AND FISH PRODUCTS.

The alarming, augmenting, and avoidable waste of fish and of products made or derivable from fish and fish refuse, together with the waste of immature and of unsalable fish, are questions of national importance. Confirmed by chronic conventional careless custom, these causes combined increase the cost and charges paid for by the consumer and inflict a cruel commercial loss upon the fish-catchers. In trawling, the net is often brought up without containing a single salable fish. Whether the unsalable fish amounts to 50 or 500 per cent, or even more, as compared with the salable fish is a subject upon which fishermen are proverbially reticent. When they do give information on this point their evidence is so opposite and contradictory that the solution of this topic is not thereby advanced. However, when coasting smacks unavoidably catch nothing better than immature and other unmarketable fish, under a rational economic system this fish should be used up for the manufacture of waste products, which in the United States of America represent upwards of 14 per cent of the total value of their fisheries. Excluding the waste of immature and unmarketable fish, I estimate that upwards of £2,156,900 a year is wasted in the United Kingdom by omitting to work up the waste products of fish after the American methods.

Owing to pressure and other causes, almost all fish caught in the nets are either dying or dead before they are landed into the smacks. British fishermen frequently throw immature and unsalable fish and fish refuse into the sea. From time immemorial the Chinese and Japanese have profitably worked up and economized the waste products of fish. The Americans boil fish to extract the oil useless for manure, while the bones are made into glue and other commercial products, and the remainder is used as manure. The Americans bone and skin their codfish and pack it in tins; while thus making a higher-priced article, they derive extra profit by working up the skins and bones for by-products.

In the United Kingdom valuable waste products derivable from fish refuse are usually ignored in every household. Excellent stock or basis for soups can be made from the heads, bones, skins of fish, and of filleted fish, a familiar economy in China, where to make gelatine soup even sharks' fins often fetch thirteen pence a pound. The fins of sharks, rays, and dogfish yield good isinglass—a product universally neglected by our fishermen. A bread of fish "flour" is popular in some countries. English rays are imported into France for making soup; bone earth from fish refuse for manure; albumen from fish blood. A "meat" extract is made from fish; it has no fishy flavor and is alleged to be better and cheaper than beef extracts. This fish extract mixed up with pea food, flavored with herbs and salt, makes a good food sausage. Herring meal, mixed with starchy food, affords an economical and excellent food for cows, without giving any fishy flavor to their milk. In some foreign countries domestic animals and poultry are fattened on fish.

The heads, fins, entrails, blood, etc., give good guano. The skins and bones of fish supply strong adhesive cement. The dried skins of the shark, dogfish, ray, etc., are useful for polishing wood and ivory, and in Egypt serve for the soles of shoes. These fish skins furnish a kind of leather called shagreen. The dried skins of flatfish can be used for gloves, for "leather" purses, for clarifying coffee, as a substitute for isinglass, and for artificial baits. The Chinese use painted and varnished fish skins as ornamental lanterns. In Japan, wax is made from the skins and intestines of fish. Eel skins serve for whip thongs, and when dressed and dried make braces. In America,

cusk and torsk skins have been patented for shoe leather. Siberian peasants clean, stretch, and dry the skin of the fresh-water burbot for leather bags and as a substitute for glass window panes. In some parts of Asia the tanned salmon skin supplies a prettily marked scale-like leather and ray skins a good imitation of morocco. Sham porpoise leather is made from the skins of the seal, walrus, and white whale. The American whitefish yield large good upper leather. India ink is obtained from the cuttle or sepia fish. The mullet's roe provides the botargo of Italy and is an ingredient in Indian curries. Besides the sturgeon, the roes of many other fish furnish caviares.

On capturing fish, the fishermen should squeeze the ripe roes and milts of the same species of fish into a clean bucket of fresh sea water. Thus fertilization of the eggs would be cheaply secured. The bucket would then have its contents returned into the ocean. By technical education, as soon as the fisherfolks realized the advantages of thus adding largely to their marine animal populations, it is to be anticipated that such ready and rapid egg fertilization might in time become a usual practice. Especially about the middle of February the decks of boats where codfish are killed are actually milk-white with cod spawn, which should be used for artificially rearing codfish, as in Norway. Russian scientists have been specially successful in rearing fish from the roes of recently dead male and female fish.

Mussels, one of the best baits for sea fish, have often been destroyed to serve as a cheap manure.

Oyster shells are reported to make good "metal" for roads, and have been used to fill up the foundations of buildings and railway embankments; also as ballast for vessels, manure, food for poultry, and as lime in certain cements. However, oyster shells are most profitably employed in the cultivated oyster farms, so that the oyster spat or eggs can attach themselves to the ready-made attractive home of the old oyster shell. In Russia a brilliant white-wash paint is made from oyster shells. It is said that from these shells the ancient Japanese formerly made luminous pictures to appear at night time, and which mysteriously disappeared during daylight. I am informed that this is one of the many lost arts of past history, and, like that of manufacturing the famous Tyrian purple from the murex or purple-snail, has unfortunately been allowed to die out, perhaps because aniline dyes are cheaper.

FREE TECHNICAL SCHOOLS FOR FISHERFOLKS.

Occasional trade or technical free educational and training schools for fishermen, fisherfolks, and fish-curers should be provided by the legislature in suitable situations. These schools would be a national economy and prevent or check wasting fish food and fish products, tending thus to diminish the price of fish to the consumer, and remove much of the fisherfolks' chronic financial distress. Fish would soon become a uniformly fresh, healthy, cheap, abundant food, and, being sold in a frozen condition, it would practically be an imperishable article, as I shall subsequently show.

Within the last twenty years the construction of fishing boats has much improved, as well as the appliances for catching fish. Since about 1850 the varied combined applications of chemistry, engineering, and mechanics have revolutionized and advanced agriculture. Nevertheless the average fisherman of the United Kingdom seems generally to be a mere primitive fish-catcher, like the savage of present and bygone times, ignorant how to treat and store caught fish. This is not the fault of the British fisherman, but is owing to his political and social misery and misfortune.

In fishing districts and villages he has no opportunities afforded him to learn the practical technical rudiments of his own calling, any more than his means would enable him to study physiology, zoölogy, chemistry, and mechanics at the distant universities.

As regards the first experimental technical free school for fisherfolks, some suitable site or sites in or near Brighton appear to be one of the most desirable localities in England. Its vicinity to the harbors of Newhaven and Shoreham (whilst at least one of its piers could be transformed into a good fish market), its own resident population of upwards of 150,000 persons, its unequaled, easy, and cheap approach by rail or road to London, preëminently recommend Brighton as a fit center for training and educating fisherfolks and fish-curers. The Brighton aquarium—built, as I am informed, at an expense of upwards of £130,000, and being the largest in the kingdom—offers unequaled opportunities for the study and observation of living aquatic animals, including experimental artificial fish-hatching. The Brighton Museum contains already numerous appropriate marine specimens, whilst its adjoining free public library and reading rooms would afford technical facilities.

The legislature should supply some suitable steam trawlers of about 200 to 300 tons each, with dry-air refrigerator machinery fitted with dry-air stores, to be at the disposal of the proposed Fisherfolks' Free Technical School. Thus fisherfolks, including fish-curers, could be practically taught and trained at sea the varied work of their callings. At least one vessel arranged for carrying on practical industrial technical laboratory work in reference to live-fish preservation, fish-hatching, dredging for marine specimens, and allied topics should be also provided and equipped by the legislature. Such a vessel, by means of electric lights and divers, might obtain much valuable information as to many marine problems connected with the food, habits, and breeding of marine animals.

In reference to these subjects and investigations, at a truly trifling cost, the stationary light-house ships would often make admirable marine laboratories where fisherfolks could learn many useful matters. The proposed Fisherfolks' Free Technical Schools for the United Kingdom, acting in coöperation with the Marine Biological Associations, with the Scottish and Irish Fishery Boards, and similar institutions, would, doubtless, with sufficient funds, do great and good work, so as to improve, increase, and cheapen the fish supply and to commercially develop the now decaying fishing trades and industries of the United Kingdom, India, and our colonies.

Among the lines of study and practical instruction suggested for the curriculum of the training schools, are the following:

1. Course in swimming, floating, diving; resuscitation of apparently drowned persons; best means to extinguish fire and to save life from suffocation, burns, and scalds; the use of life-saving apparatus; the use of oil in rough, stormy seas.

2. The management, breeding, and training of carrier pigeons for postal purposes between sea and land, to save life and property and for commercial purposes.

3. The manufacture, preservation, drying, and mending of fishing appliances; the repairing of sails, oars, boats, and vessels at sea, in harbor, and on shore; the use of signals, lights, buoys, fog-horns, etc.

4. The preservation of fish at sea, by immediate bleeding, gutting, and washing; the treatment and utilization on board ship of fish refuse; dry-air refrigeration; packing; cleanliness and inspection of fishing vessels; preservation and transportation of live fish and other aquatic animals for food and bait.

5. Elementary practical teaching of deep-sea dredging and specimen collecting; sounding, to determine nature of sea bottom and probable character of fish; use of collecting tanks for live and museum specimens; preservation of fish and other aquatic animals and plants for local museums; observations of the habits and growth of fishes, etc., in nature and in aquaria.

6. Preparation of fish by drying, smoking, salting, canning, etc.; preparation of oils, extracts, fish meal, manures, etc.; cooking of fish; determination of edible qualities of fishery products now little used or neglected.

7. Fish-culture; mutual relations of inland fishing, farming, and forestry; studies of methods in other countries.

8. Storing, transportation, and distribution of fish; construction of fish markets, stores, vehicles; construction of refrigerators, refrigerator cars.

9. Comparative rudimentary anatomy and physiology of typical aquatic animals and plants; their diseases and parasites.

10. Consideration of questions concerning the fisheries.

11. Fish inspection; naked eye, chemical and microscopical detection of unwholesome fish; detection of trade frauds, substitutions, and adulterations.

CARRIER-PIGEON AND TELEGRAPHIC SERVICE FOR THE SEA FISHERIES.

Fishing fleets should signal by means of carrier pigeons for the refrigerator steamers to come out from the harbors to remove the catch. These carrier pigeons, dispatched at intervals, especially if repeated to allow for accidents, would be useful to the smacks in case of accident and distress, and could also be employed by the fishermen to send messages, weighing up to 2 ounces, to the steamers, as giving orders to bring out any articles required by the fishermen, including food, medicines, fishing nets, tackle, bait, and other requisites.

Alighting on the platform of the pigeon-house, connected with an electric bell for day and uncovering a colored light for night work, the pigeon announces its own arrival. At a trifling cost fishermen and sailors would soon learn to train and breed these carrier pigeons. After a while, probably, no fishing smack would put to sea without a few carrier pigeons.

To effectively encourage fishermen to carefully and extensively rear, train, and breed these carrier pigeons, the Admiralty and the Board of Trade should offer a series of local prizes for the best birds at the various fishing districts and villages of the United Kingdom, in which contests the local coastguards and naval reserve should be allowed also to compete.

Night and day, along the chief Norwegian fishing fiords and grounds, special local telegrams inform the fishing fleets as to the location, the probable destination, and expected time of arrival of observed shoals of fish. Doubtless much might be done on our own coasts by combining and collecting information for telegraphic purposes brought by these carrier pigeons as to the probable course of various migratory shoals of fish. Like the Chinese, the Norwegians, through centuries of acquired observation, are shrewd, trained experts in noticing the habits of fish. In 1888, while visiting the Norwegian fishing towns from Christiania to the North Cape and back, I was informed that the Norwegian Government gratuitously circulated these trade messages for the benefit and advantage of their fishermen. The Government of the United Kingdom should initiate similar plans on behalf of our neglected fishermen, as,

setting aside the just claims of our brave fishermen for such trade information, this would also cheapen fish and thus relieve some of the burdens of tax-payers.*

Telegraphic communication between the light-houses and light-house ships and the shore is of inestimable value in case of many shipwrecks as well as for sea-fishery observations.

OVERFISHING BY MAN, BIRDS, AND FISH.

In 1376 Parliament was petitioned to stop, by immediate legislative interference, the increasing damage done by alleged excessive local sea-fishing by British fishermen. This agitation arose against the further employment of a new engine or instrument, "conceitedly and cunningly contrived," called a "wondy-choun," which was accused of destroying the spawn of fish and the spat of oysters and mussels. Introduced about 1369, the "wondy-choun" was probably an English invention of the original beam trawl or trail net for deep-sea fishing. The present successors of these fourteenth century grievance-mongers are well-meaning but ill-informed fish-trade quacks who publicly pose as the promulgators of the so-styled "immature fish questions." They ignore the elements of the natural history of marine fish life; they apparently sanction the eating of whitebait (a generic term for immature fish, chiefly herrings and sprats); they raise no objection to the use of lobster eggs (though almost tasteless) in sauces for fish; they permit the caviare or sturgeon-egg trade and the eating of the roes or eggs of herrings, cod, perch, pike, red mullet, etc.

Daily sea birds eat myriads of millions of fish eggs, of fish fry, of baby fish, and of sexually immature fish, besides multitudes of the fattest and finest mature table fish, often filled with ripe roes. At the mouths of salmon rivers sea gulls feast on salmon and sea trout of all ages, from the egg upward. In every twenty-four hours these winged anglers probably do more injury to the sea fisheries than all the united fish-catching engines and instruments of man in a whole century. Such evils are augmented and aggravated by these winged fish-poachers, feeding only upon the best food-fishes and eggs, leaving untouched predatory fish and their eggs, especially those of the dogfish and shark. An excess of sea birds would first exhaust and exterminate marine food-fishes. These hungry birds would next eat up the predatory fishes and their eggs and other fishes considered at present too coarse for table or market. Taken in time, man could restore the "balance in nature" by destroying marine birds and their eggs. Sinking only when dying or dead, the living and fertilized eggs of most sea-water fish float about or near the surface. Hence deep-sea trawling can not injure such living floating eggs, but it does injure many aquatic plants at the sea's bottom, on which certain fish feed.

Marine food-fishes are preyed upon by birds and predatory fishes, including the ever hungry dogfish and shark tribes. Troops of dogfish will encircle and devour shoals of herrings, whiting, haddock, young cod, etc. To protect our marine food-fishes, the extermination of the dogfish and shark species is advisable. The bodies of dogfishes and sharks yield commercial fish-oils. Their skeletons are rich in phos-

*A fisheries intelligence service, such as is here referred to, has been in operation in the various coast provinces of eastern Canada for several years. It is maintained by the Government at the remarkably low annual expenditure of $2,000. It has proved of much benefit to the boat and vessel fishermen of Canada, and would doubtless be of equally great value to all other countries having important coast fisheries.—HUGH M. SMITH.

phorous and lime, which, with their bodies, rich in nitrogen, worked up as fish flour, make excellent agricultural manure. Their dried skins can be manufactured into leather for special purposes, or else be used to polish wood and ivory. An excessive increase of predatory sea fishes might practically extinguish the marine food-fishes. Then the predatory sea fish would be forced to devour their own eggs and young. Especially when pushed for food, fish are cannibals.

DEVELOPMENT OF IRISH FISHERIES DEMANDED.

The coast and inland fisheries of Ireland should be properly developed by parliamentary grants and assistance. Ireland has a seacoast of 2,337 miles, and inland waters covering 574,887 acres, which supply chiefly a few salmon and eels. Nevertheless Ireland, for home consumption, actually largely *imports cured* fish. Where Irish railways exist, their stations are generally distant from the harbors; the result is, much fish is spoiled, and the cost of distribution of that which is saved is much enhanced. Besides refrigerator stores on shore, Ireland requires dry-air refrigerator steamers for its export fish trade, and refrigerator barges and insulated covered barges for its inland navigable waters.

Probably no better ground exists for the artificial propagation and rearing of lobsters for commercial purposes than the west and rocky coasts of Ireland. Oyster farming, such as is successfully carried on in Holland, France, and the United States of America, might also be attempted, by introducing young oysters into ponds and inclosed areas of water in salt-marshy districts bordering on the seacoast, where the transplanted oysters can be bred and reared for market purposes.

The pike, bleak, tench, and bastard carp thrive marvelously well, in number and size, in peat waters. This is a further source of wealth, industry, and food for Ireland, whose almost universal peat-moss litter makes excellent packing for dry-air-frozen fish.

The inland fisheries of Ireland at a trifling primary outlay should be made sources of national wealth and industry. Many of the Irish inland waters would answer admirably for breeding the sole, the female often supplying from 100,000 to 200,000 eggs at a time. The sole is justly considered the most digestible and palatable fish, and its flavor seems almost always acceptable. Unlike salmon, mackerel, whiting, eel, trout, cod, and other fish, including the herring, the palate even of the fastidious invalid does not get tired of the sole, which has also the merit of being cooked quickly and easily. I believe that, unless the sole is extensively artificially cultivated, within a comparatively short period it will become, as a food-fish, extinct. For reasons hitherto undiscovered, its already limited geographical area of natural production is gradually decreasing. In the battle of life and struggle for existence the sole will slowly but surely die out unless largely reared and farmed by man.

By gradual acclimatization sea fish can thrive and breed in fresh water if by degrees the proportions of saline matter be reduced to those of fresh water. Artificially cultivated in Irish inland fresh waters, soles, bled prior to the clotting of their blood, gutted, well-washed in fresh flowing water, and then immediately hard-frozen in dry cold air, could be profitably exported in colossal quantities to England, Europe, America, and elsewhere. Probably the American sturgeon would thrive in Irish inland waters. The American shad and alewife, both large herrings, which leave the sea to spawn in fresh water, should be experimentally introduced into Ireland.