II

THE EFFECTS OF DYNAMITE EXPLOSIONS ON FISH LIFE.

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In issuing his announcement of the opening of the Dominion Biological Station for the season of 1901, the director, Professor Prince, suggested that some experiments should be undertaken 'on the wastefulness or otherwise of fishing with dynamite.' It was subsequently arranged that this should be my work for the summer, and the requisite permission to use dynamite having been obtained from the Ontario Fishery Department, Toronto, and from the Department of Marine and Fisheries, at Ottawa, experiments were begun the first week of July, 1901.

ACKNOWLEDGEMENTS.

Before beginning this report, I must acknowledge indebtedness to E. Abbot Johnson, Esq., L'Orignal, Ont., for hospitality and assistance, in carrying out experiments on the Ottawa river. Also, to my colleague, Dr. J. C. Connell, for the use of his launch in carrying on the experiments in Kingston harbour, and similar indebtedness to the Messrs. Whitman Bros., for extensive use of the tug 'Vulcan' off Canso harbour. It would have been impossible to carry out this investigation without the assistance given by these gentlemen.

DYNAMITE.

The dynamite used was the variety known as dualin and has the following composition:—

Nitroglycerine.	40 parts.
Fine sawdust or wood flour.	30 "
Potassium nitrate.	20 "

It is usually sold in cylindrical sticks, or cartridges, of two sizes, one being six, the other eight inches long, and about 1½ inches in diameter. The cartridges are encased in oiled paper, and done up in five pound packages. Each package contains 6 small cartridges, and 14 large ones, and costs about \$2; that is, a little over 8 cents per cartridge for the small ones, and about 10 cents for the large. Fuse costs .75 cents per hundred feet, and caps or detonators about 75 cents per hundred.

The dynamite used at Canso was that manufactured by the Acadia Powder Company, Halifax; that used on Lake Ontario was obtained gratis from the Ontario Powder Company, at their head office, Kingston, and Mr. Smith, the general manager, kindly instructed me how to use the explosive, and furnished me with a copy of the pamphlet, which they send out to their customers. The following are extracts from it, so far as they have a bearing upon my work:—

INSTRUCTIONS.

'Dynamite, when properly used, is perfectly safe, but like all compounds of nitro-glycerine, must be handled with care and judgment. Although it will explode, if roasted up to a high temperature, it burns quietly if set fire to. In order to cause the explosion in practical use, therefore, it must be fired by means of an ordinary 'Detonator' with fuse, or by 'Electric Detonators' with a battery.

'For the former, cut off a piece of fuse to a proper length, straight across, shake all the sawdust out of the detonator, and push the fuse into it gently, nearly as far as it will go, and close the edges of the cap down on to the fuse. Then, if to be used under water, cover edges of cap with soap, grease, tar, or a similar substance, to keep charge inside of cap dry.

'Now, with a small punch, like a pointed lead-pencil, make a hole through the paper in the end of a cartridge of dynamite, as deep as the length of the detonator. If cap has been properly fastened to the fuse, the punched-in edges of the paper after cap is inserted will prevent its being pulled out, in lowering into the drill hole.

'CAUTIONS.

'Dynamite freezes at 42° Fahrenheit, and when frozen it is almost impossible to explode by cap, although it is more sensitive to rough handling. In cold weather, therefore, care should be taken to thaw it until it becomes soft. It is dangerous to do this before a fire. The proper method is to thaw the cartridge by means of a 'Thawing Box,' such as we make and sell at cost, or to keep them in a warm room for several hours before using, and to carry them to the work in a sack, wrapped up in a way to prevent chilling before using, as dynamite at the freezing point, is more sensitive to handling than at either a higher or lower temperature.'

All the explosions at the seaside, and half of these at Kingston, were made by means of a fuse and detonator. Some difficulty was at first experienced in producing explosions at depths greater than ten or fifteen fathoms, but by closing the detonators very firmly round the end of the fuse, covering the joint carefully with common soap, and sinking the detonator well into the dynamite, we succeeded in getting explosions in water as deep as 50 fathoms. When these precautions were not taken, the increased pressure at the greater depths forced water into the caps and prevented the fulminate of mercury from exploding. The difficulty in getting explosions along the Ottawa river was due to the fact that the fuse was not water tight.

In water from 18 to 25 feet deep, no sinker were attached to the cartridges; but in 30 to 50 fathoms, stones or old pieces of iron were used to sink the dynamite as quickly as possible.

LAKE ONTARIO EXPERIMENTS.

The first experiments were made in Kingston harbour, in water about 18 feet deep. Two cartridges were used, the detonation striking our boat like a huge sledge hammer. It stirred up a great deal of mud, and discoloured the water to a radius of 6 or 8 feet, gradually widening to 30 or 40 feet. At first we thought that no fish had been killed, but after waiting for about two minutes they began coming to the surface, and inside of 15 or 20 minutes, 130 perch and 1 small black bass had been lifted into the boat. About three dozen more were left floating; all were not dead; some appeared to be only stunned.

Post-mortem examination of a large number of these fish all showed similar effects: great capillary hæmorrhage from branches of the mesenteric arteries, congestion of the liver and spleen, and invariably rupture of the swim bladder. Portions of the intestines were usually forced dorsally into the cavity of the swim bladder, where, of course, there was also much blood. In rare cases, there was rupture of the venous sinuses feeding the auricles.

SESSIONAL PAPER No. 22a

VARIATIONS IN DESTRUCTIVENESS.

The first explosion and its results were typical of all the work done last summer. Of course the results were not constant, for obvious reasons. The destructiveness of the explosive varied according to easily recognizable conditions. It varied with (a) the charge of dynamite used, (b) with the depth of the water, (c) with the number of fish present in the neighbourhood of the explosion, (d) with their distance away, and (e) with the kind of fish.

That the destructiveness varies with the weight of dynamite exploded, needs no demonstration. This is probably true of all explosives. Many different charges were used, usually varying from one cartridge up to eight. The larger charges did not always result in bringing up the larger number of fish. The number killed depended more upon the number of fish in the neighbourhood than upon any other condition. For example, a charge of $1\frac{1}{2}$ lbs. exploded in the Kingston harbour, west of Garden Island, did not bring up a solitary fish, while one cartridge of $\frac{1}{4}$ lb. weight in St. John harbour, New Brunswick, killed over 800 fish.

The depth of the water was another important condition affecting the destructiveness of dynamite. Explosions were effected at depths varying from $1\frac{1}{2}$ to 300 feet. It produced little, if any, destruction of fish life at shallow depths, say, less than 10 to 12 feet. The reason of this probably is, that at slight depths, the pressure resulting from the explosion is not sufficiently great to rupture the swim bladder. One blast at 18 inches under the surface, sent up a column of water about 100 feet high; another blast about 3 feet below the surface sent up a narrow column about 60 or 70 feet high. In neither case were fish killed, though some must have been present. At 10 or 12 feet below the surface, the explosion lifted a broad cone or mound of water 6 or 8 feet high. At increasing depths, the surface disturbance became less and less marked, until at 45 fathoms or thereabouts, the only evidence of the explosion, after the noise and the tremendous blow on the bottom of the boat, was the appearance of a vast number of small bubbles of gas covering a diameter of from 40 to 60 feet. There was no upheaval of water. Evidently the large volume of gas generated at these depths is, on its way towards the surface, broken up into a large number of distinct bubbles, which separate as they ascend.

As regards explosions at increasing depths, a few of our results may be tabulated as follows:—

No. Expt.	Wt. of Dynamite. Lb.	Depth of Water, in feet.	Depth of Cartridge, in feet.	No. of Fish Killed.
1	$\frac{1}{8}$	12	12	0
2	$1\frac{1}{2}$	14	12	0
3	$\frac{1}{2}$	10	10	0
4	$\frac{1}{4}$	26	18	300
5	$\frac{1}{4}$	25	18	160
6	$\frac{3}{8}$	24	18	35

It is difficult to say whether in Nos. 1, 2, and 3 there were no fish present, or the pressure was insufficient to kill them. The probable explanation of the difference between the number killed in No. 4, as compared with those in No. 5, is that many more fish were present in the vicinity in the former case than in the latter.

No. 6 illustrates another variation in the effects of a dynamite explosion. In this instance not a single fish came up where the explosion occurred. About 30 yards away, seven or eight sunfish were killed outright—not a movement in one of them when picked up. A few moments later, a batch of perch and a few rock bass were seen coming to the surface about 60 yards away. Clearly, therefore, the number of fish killed varies directly with the number present, and varies also with their distance away from the site of the explosion.

Lastly the number killed depends upon the kinds of fish. Those with a thin, delicate texture of the swim bladder are more easily killed than fish possessing a thick,

6-7 EDWARD VII., A. 1907

tough membrane. Pollock were very easily killed for this reason; cunner, very difficult.

Stated mathematically, the energy of the exploding dynamite varies directly with the amount exploded, and diminishes with the distance away, according to an undetermined law, which probably depends upon the relative position of the exploding charge to the bounding water surfaces, upon the nature of the bottom, and possibly also upon conformation. So far as fish are concerned its effects upon them were found to vary (a) with the numbers near the site of explosion, (b) apparently with their depth beneath the surface, and (c) with the strength of their tissues, especially the walls of the swim bladder, and the sensitiveness of the nervous system, though this last was difficult to demonstrate.

CAUSE OF DEATH.

As already indicated, the immediate cause of death is rupture of the swim bladder, and internal haemorrhage. The rupture is evidently due to pressure. When an explosion occurs, there is a sudden liberation of gas tending to produce compression of the water at the site of the explosion. The wave of compression travels outwards in all directions—upwards, downwards and sideways. The direction of least resistance is, of course, always towards the surface of the water—hence the upheaval which follows an explosion. Quite frequently we found three other marked injuries, especially in large fish like pollock. Often in these the liver was compressed into fragments, the ribs were detached from the vertebrae along the whole length, and the flesh (temporal muscle) over the skull, after the skin had been cut, could be raised from the surface of the bone, leaving it as smooth and clean as a piece of polished ivory. Here again, the cause of the dislocation of these structures was pressure. The fish is veritably flattened between the compression wave of the explosion on the one side, and the unyielding water on the other; the ribs are torn from their attachments, the liver crushed to pieces and forced backwards into the extra-peritoneal cavity, and the flesh raised clean off the flat bones of the head. The surgeon sometimes meets with a similar experience in accidents due to crushing.

No external marks or injuries were visible on any of the fish, in either fresh or salt water.

SINKING FISH.

Very early in the investigation it became evident that besides those fish which came to the surface and floated, a number were merely stunned, and subsequently escaped, or were killed outright and sank to the bottom. This was important. The destructiveness of dynamite took on a wider aspect than that of merely counting the slain. The wounded and missing had, if possible, to be accounted for. If one could put off a blast in a large pond, count those killed at the surface, drain the pond dry, and then count the living and dead lying on the bottom, the investigation could soon be closed; but this was not the way in which the problem was presented. Accordingly other methods of investigation had to be planned. A simple method, and one likely to throw some light upon these points, was to use the water telescope. This was done in some of the narrow channels off Canso. Cunner abound in the shallow waters along these shores and between the islands, and after some expert knowledge had been gained by using, first a stove pipe and then an old eaves pipe for an aquatic telescope, we put off a blast, and counted our 'spoils.' Twenty-five dead floated belly up: that was one fact, or collection of facts, if you please. Then by the persevering use of our improvised telescope, one observer counted seven, and another of our party counted eleven dead cunner lying on the bottom. We recovered two of these. Port-mortem examination failed to show particularly why they had sunk. There was great visceral congestion, and profuse haemorrhage. In one, the swim bladder was much torn, while in the other, the rupture was so small that no air could be found escaping, except when the whole animal was

SESSIONAL PAPER No. 22a

placed under water and the swim bladder compressed. The smaller animals generally floated; the larger ones sank.

These results were, however, not satisfactory. In shallow water, explosions always stirred up the mud, and our crude telescope was useless. We determined, therefore, to make a tremendous 'slaughter of the innocents,' and with this end in view selected a small bay, nearly west of Grassy island, and there, set off the largest blast of dynamite which was used during the season—ten cartridges. The noise was loud enough to have awakened the spectral inhabitants of the old French island. There was a tremendous upheaval of water and mud, and in ten minutes wind and tide had spread the dirty water all over the little bay. Twenty-eight dead came to the surface. On returning next morning, we could find only three dead fish lying on the bottom, near where this explosion had occurred; that is, less than ten per cent had sunk in this experiment; in the previous one about thirty per cent.

The next attempt that was made to throw fresh light on this important point was in St. John harbour, New Brunswick. As a preliminary to the real test, a visit was made to one of the salmon weirs at low water. In one compartment of the weir were found two full-grown salmon, one 'fiddler' (small salmon), and ten or twelve adult gaspereau. The time was noon of August 10th. That evening, of course, there was a full tide, and next morning another, so that there were these two chances for additional fish to join their fellows in the weir. At 8.30 next morning, the weir was visited in company with the two fishermen who owned it, and one cartridge was exploded in the compartment which we had previously examined. The two salmon at once floated to the top, also six or eight gaspereau. But the deadly effect of the explosive was brought out in another, and rather unexpected way. Almost simultaneously with the occurrence of the explosion, an immense number of young gaspereau leaped from the water, and then fell back almost motionless upon the surface. They varied in size from 2½ to 5 inches in length. They came partly from inside the weir, but chiefly outside the inclosure, stretching away up towards the city. Evidently a school of these young fish was making its way up into the harbour, or they were leaving it. We counted over 800 of them being driven away by the wind and tide, and estimated that as many of them sank as floated; but this was, of course, mere guess-work.

After rowing along the path of these floating fish for half an hour, we returned to the weir, and awaited the falling of the tide. The tide in this harbour goes out so far that the floors of many of the weirs are left almost dry. We had no difficulty, therefore, in determining the exact number of fish which sank. There they were, 27 gaspereau varying from 7 to 12 inches in length, lying dead on the bottom; 7 others somewhat larger on the average were swimming around in the scanty water remaining in the weir, and in company with these, 2 lively dog-fish which seemed to know perfectly well that they were in a trap. Here were the results which we had been looking for—8 or 10 killed and floating, 27 killed and sunk, and 9 alive. If the dynamite killed the young gaspereau in the same proportions outside the weir, as inside, then 2,500 of them lay dead at the bottom of the harbour in addition to the 800 which we had counted at the surface.

CAUSE OF FLOATING.

Nearly all the fish floated belly up; the sunfish lay more upon their side; lake trout on their back, but with the tail end deep in the water and head above it. Rupture of the swim bladder and escape of its gas ventrally so as to displace the centre of gravity, was probably the cause of the fish floating on their back. But a physiologist can scarcely escape the conviction that the nervous mechanism for the maintenance of equilibrium must have been paralyzed in all of them. Fish which die in water from other causes than concussion, say, from suffocation or from poison, lose their power of maintaining the vertical position, and in these cases they lie on their back because of muscular (i.e., nervous) inability to balance themselves.

WOULD IT PAY.

An attempt was made to see whether a large catch of fish could be obtained in the open sea by means of dynamite. The fishermen at Grand Manan were said to have made it pay during the summer of 1900, and better still in 1901. At any rate, a young seaman whose acquaintance I made through Mr. C. H. Whitman at Canso, claimed to have used dynamite at Grand Manan during June and most of July, 1901. He said that 'whereas only half a dozen vessels had used dynamite in 1900, there were about 90 using it in 1901. It was exceedingly effective with pollock, when they were plentiful and following the red shrimp. They used only one stick of dynamite and exploded it by a detonator and fuse two or three inches long. The men lighted the short fuse with a match or the burning tobacco of their pipes, and then threw the cartridge into the sea from the boat. They judged that the explosion took place about six feet below the surface, but could not say exactly to what depth the cartridge sank before exploding. Hundreds of pollock were killed by one explosion. He was of the opinion that from one-half to one-third of the fish sank and were lost. Other fish were killed besides the pollock. When the shrimps are all eaten up or disappear, the pollock begin feeding upon herring and squid, and consequently separate widely from each other. Under these circumstances, it was not found profitable round Grand Manan to continue the practice—too few being killed to pay for the dynamite and the men's time in collecting the scattered fish. Asked upon what grounds he had formed the opinion that from one-half to one-third sank, he answered that he had come to that conclusion on two grounds: first, by watching the fish sinking after an explosion; and secondly, because on one occasion at Digby inlet he had seen a blast put off beside the wharf in order to kill pollock. After the tide went out they counted as many dead fish on the bottom as they had collected at the surface.'

Such was the substance of the man's story. It remained for us to see how far our experience would confirm his. At the outset, let it be said that although there were six men on board the *Vulcan*, two being experienced fishermen, and all watching eagerly for results, it was generally agreed that it was impossible (by merely watching the surface) to form an opinion as to the number of fish that sank, as compared with the number which floated. We all saw one or two fish sink after some of the explosions, but not one of us from our own observations could confirm the young fisherman's opinion that one-half or one-third sank.

Our experience in St. John harbour compared with his in Digby inlet, showed that three times as many lay dead on the bottom, but they were not pollock.

As regards our experiments in the open sea, the following were typical:—

EXPERIMENT No. 1.

Dynamite, No. of sticks.	2
Depth of water, in fathoms.	7
Depth of dynamite down in water, fathoms	2
No. of fish killed. . . . . pollock	20

One or two fish were observed to sink and not come to the surface again.

EXPERIMENT No. 2.

Dynamite, No. of sticks.	4
Depth of water, in fathoms.	7
Depth of dynamite down in water, fathoms.	2
No. of fish killed. . . . . cod	2

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SESSIONAL PAPER No. 22a

EXPERIMENT No. 3.

Dynamite, No. of sticks.	2
Depth of water, in fathoms.	45
Depth of dynamite down in water, fathoms.	3
No. of fish killed. . . . . pollock	7

EXPERIMENT No. 4.

Dynamite, No. of sticks.	4
Depth of water, in fathoms.	45
Depth of dynamite down in water, fathoms.	3
No. of fish killed. . . . . pollock	1

In experiments 3 and 4 the pollock were schooling all around the boat, evidently chasing squid, which could easily be seen in the water. The eight fish taken in experiments 3 and 4 were all very large specimens. It was hoped that as the explosions took place among considerable numbers of fish, a large 'catch' would be obtained, but such was not the case.

EXPERIMENT No. 5.

Dynamite, No. of sticks.	2
Depth of water, in fathoms.	30
Depth of dynamite down in water, fathoms.	Unknown.
No. of fish killed. . . . . pollock	8

In this case the dynamite was simply dropped into the sea, but in most of the experiments it was lowered a fixed distance by line.

EXPERIMENT No. 6.

Dynamite, No. of sticks.	2
Depth of water, in fathoms.	30
Depth of dynamite down in water, fathoms.	30
No. of fish killed.	0

The dynamite was attached to a heavy piece of iron and the explosion took place at the bottom. There was no upheaval of water. The bubbles of gas, already alluded to, came to the surface very quietly, and had to be closely watched for, in order to be seen at all. This was characteristic of all the deep explosions.

EXPERIMENT No. 7.

Dynamite, No. of sticks.	2
Depth of water, in fathoms.	40
Depth of dynamite down in water, fathoms.	Unknown.
No. of fish killed. . . . . pollock	5

In this experiment it was at first supposed that no fish had been killed; but between fifteen and twenty minutes after the explosion, one fish was picked up; five minutes later a second fish; a few minutes afterwards three more fish. They all exhibited the same peculiarity, viz., that they made repeated and successful attempts to descend into the water, but, within a few seconds they were compelled to come again to the surface.

EXPERIMENT No. 8.

Dynamite, No. of sticks.. . . .	2
Depth of water, in fathoms.. . . .	30
Depth of dynamite down in water, fathoms.. . . .	30
No. of fish killed.. . . . pollock	1

This fish came up fifteen or twenty minutes after the explosion.

EXPERIMENT No. 9.

Dynamite, No. of sticks.. . . .	2
Depth of water, in fathoms.. . . .	30
Depth of dynamite down in water, fathoms.. . . .	Unknown.
No. of fish killed.. . . . pollock	2

EXPERIMENT No. 10.

Dynamite, No. of sticks.. . . .	2
Depth of water, in fathoms.. . . .	30
Depth of dynamite down in water, fathoms.. . . .	Unknown.
No. of fish killed.. . . .	0

EXPERIMENT No. 11.

Dynamite, No. of sticks.. . . .	2
Depth of water, in fathoms.. . . .	30
Depth of dynamite down in water, fathoms.. . . .	Unknown.
No. of fish killed.. . . .	0

In 9 the two pollock came to the surface ten or twelve minutes after the explosion.

Judging from our experience on the *Vulcan*, dynamite fishing cannot be made a commercial success out on the open sea. A few cunner were generally killed, but having no market value, were not counted in our results. We saw no young fish come to the surface during the whole day. Nor could it be said in our experience that pollock were frightened away. After the first day we were out on the bay, we heard that the owners of the small fishing boats were protesting against our operations, as likely to frighten away the fish from their usual haunts. But their fears were groundless, because two days afterwards the pollock were back again in greater numbers than before, and notwithstanding continued experiments on our part, the very best harvest of the season was reaped after our experiments had been concluded. Fishing folk, like other people, often cry before they are hurt.

LOBSTER EXPERIMENTS.

The young seaman already referred to, told a doleful tale of a poor lobster fisherman, who suffered a heavy loss through the explosion of a single stick of dynamite. The fisherman had saved up his catches of lobster by confining them in a pound, in anticipation of a rising market. The pound is a cubical box made of wooden slats, just close enough together to prevent the escape of the lobsters. The box is usually anchored out a short distance from shore, and as the water enters freely through the slats, the lobsters get enough aerated water to live on, if there are not too many of them, and if there is enough of a breeze blowing to create a current in the water. The young seaman's story is that when the lobster fisherman had accumulated about 500 animals in his pound, some mischievous or ignorant person put off a dynamite blast about 150 or 200 yards away, and killed every lobster. As he first told the tale, the lobster pound was 500 yards away, but on cross-examination he was compelled to reduce the distance.

SESSIONAL PAPER No. 22a

To test the accuracy of this story, six lobsters were obtained from a local fisherman. They were secured on the plea that the biologists required them for scientific purposes. The open season was over, and many of the lobster pots were lying high and dry along the shores, but on sailing out to the sand bar, or to Bass rock, it was easy to see that some of the fishermen were using lobster traps for 'scientific' purposes as well as ourselves.

The first experiment consisted in putting off a blast of 3 large sticks of dynamite at a distance of 80 feet from a trap containing 2 lobsters, and at a distance of 40 feet from a small lobster that was tethered by a piece of twine. The explosion produced no effect whatever upon any of the lobsters.

In the second experiment 2 large sticks of dynamite were exploded at a distance of 20 feet from the small lobster. The animal was uninjured so far as we could see.

The third experiment consisted in setting off two sticks of dynamite within 10 feet of a medium sized lobster. No result.

Finally, 3 sticks were exploded 15 feet away from a trap which contained 5 lobsters. These animals had all been used in the previous experiments. The explosion overturned the trap, nearly overturned one of the piles on which the wharf was built, but it seemed to have no effect upon the lobsters.

We concluded, therefore, that the 500 lobsters of the sailor's yarn had died—not from the effects of a dynamite explosion, but from suffocation. They had been confined in too small a pound for too great a time, and the explosion was co-incident with the fisherman's discovery of their dying condition.

Further experiments are necessary to determine the effects upon lobsters at considerable depths, ours being at 12 to 15 feet.

ON THE OTTAWA RIVER.

Experiments on the Ottawa river were conducted at only one point, viz., about half a mile below L'Original village wharf. Twenty years ago, this point was considered a fine spot for pickerel, but to our amazement we obtained nothing but bullheads and suckers. The villagers and inhabitants generally claimed that the government dam at Carillon prevented the fish from coming up the river as they used to do, and that the better kinds of fish were decreasing in number.

EFFECTS ON MINUTE LIFE.

After several explosions in fresh water and one or two at sea, a small tow-net was drawn over the site of the explosions and the material collected was examined under the microscope the next day. Many living organisms such as copepods, phyllopods, &c., were found, and also dead ones, but it was impossible to determine whether the latter were dead when caught, or had died during the night.

Are fish eggs and larvæ killed by dynamite explosions? Because, if they are, this is one of the strongest objections that can be urged against the practice. Here again surface netting failed to show that the percentage of dead eggs or larvæ was increased to any appreciable extent. As is well known pelagic ova and fry both live near the surface of the sea, and it is difficult to understand how these, or any other tiny organisms could be killed by dynamite explosions any more than by the waves of a big storm. Of course, eggs which are laid on the bottom would certainly be destroyed, if they were near the site of any explosion, but further investigation is necessary on these points.

EFFECTS ON THE NERVOUS SYSTEM..

The brains of a dozen fish, half of them killed by dynamite, and half caught by hook and line, were preserved and subsequently examined under the microscope, Leitz

6-7 EDWARD VII., A. 1907

objectives 3 and 6, and ocular 3 being used. On comparison with each other no differences could be observed in their minute structure as a result of their different modes of death. One would expect that there should be differences, but none could be discovered by the methods which were employed.

KILLING OF SEAL.

An interesting result was obtained at St. John, N.B., at the instance of the fishermen. They often lose many salmon, through the depredations of sea-lions or seal. These animals regularly frequent weirs and kill numbers of the imprisoned fish. The fishermen naturally wished to know if seals could be killed by dynamite. Fortunately one of these animals happened to come up the harbour just as our other experiments were concluded. The men rowed out, and a blast of two cartridges was thrown towards the seal just as he dived, forty or fifty feet away. After disappearing under water he must have swam towards the impending explosion. When the tide went out, greatly to the delight of the fishermen, he was found dead sixty or seventy yards away. A deep hollow in the mud marked the site of the blast. Blood was oozing from the eyes, ears and nose of the animal. Evidently he had been killed by fracture of the skull.

CONCLUSIONS.

1. A serious result was clearly brought out in many of the experiments. Large numbers of immature fish were killed. Not one-third of those which came to the surface in fresh water could be sold in the market. Of course, immature fish are killed in other ways. Thousands of young fish perish in weirs all along our coast after every outgoing tide. Fishermen frequently leave them to rot upon the shore. The responsibility for this terrible destruction of immature fish rests in the first place upon the apathy and cupidity of the fishermen, and in the second place upon the Dominion government for allowing the slaughter to continue. Fishermen should be compelled to return immature fish to the sea, because so long as this destruction of young fish is permitted in netting, it is manifestly unfair and inconsistent to prohibit dynamite fishing on the score of its wasteful destruction of immature fish.

2. The second serious objection is the great waste due to the numbers which sink. It would be hardly fair to generalize upon the experiments at Canso and St. John. It is much safer to publish the facts, and the facts are that about one-third of the cunner sink, and that three gaspereau sink for every one that floats. As regards pollock, cod, salmon and other marketable fish, further investigation is necessary if a general conclusion is worth having.

3. Further investigation is necessary also to determine more accurately the effects upon the microscopic life of our inland and marine waters, for such microscopic life is a necessary part of the sustenance of the finny tribes.

KINGSTON, August 9, 1902.