

## THE PROTECTION OF THE LOBSTER FISHERY.

By FRANCIS H. HERRICK, PH. D.,  
*Professor of Biology, Adelbert College.*

In the lobster fisheries we have an example of an industry which has increased rapidly in value in a very few years. In 1869 the Canadian fishery was valued at \$15,275; in 1891, at \$2,250,000.<sup>1</sup> In twenty-two years its value increased nearly 150 fold. The value of the products of this industry in the United States was nearly half a million dollars in 1880 (\$488,432), and in 1892 over a million dollars (\$1,062,392).<sup>2</sup> In 1896 there were 14,285,157 cans of lobster packed in Canada, having a value of \$2,400,000. The average price per pound in 1883 was 9½ cents; in 1893 it had risen to 14.10 cents, and at the present time it is 18.72 cents.<sup>3</sup>

The decline of the lobster fishery is a well-worn theme. The facts pointing to its gradual but certain decay are too evident to be mistaken, such as the interminable legislation on the subject of protection, the increase in the number of traps, the decrease in the size of the lobsters themselves, and their increase in market value. Twenty-five years ago the lobster was common; now it is generally a luxury.

The cause of the depletion of the fishery is plain. The supply has been unequal to the demand. More lobsters have been annually destroyed than have been annually raised. No number of animals, however large, can stand such a drain. For twenty-five years the law in Canada has been called to the aid of the fishery. It has taken a vacillating course in both the Provinces and the United States, revoking one year what was enacted the year before, adopting this and that suggestion, and jumping from one expedient to another. Regard to personal interests, imperfect knowledge of the habits and needs of the animal itself, and perverted logic have characterized much of the legislation which governments have enacted for the preservation of animal life. There are, indeed, praiseworthy exceptions, and legislation, though it has often failed, may have been animated by the right spirit.

The problem of perpetuating an animal like the lobster, or rather of maintaining the supply, for it is not in the power of man to exterminate this species, is certainly a difficult one. In order to discuss this or any similar question profitably and intelligently, it is necessary to set aside pride and prejudice of every kind, whether personal, sectional, or national, and consider in a judicial spirit the conditions in which this

<sup>1</sup> Report on the lobster industry of Canada, 1892. Supplement to 25th Annual Report of the Department of Marine and Fisheries, 1893.

<sup>2</sup> The American Lobster. Bulletin of the U. S. Fish Commission, 1895, p. 12.

<sup>3</sup> Discoloration in canned lobsters, by Andrew Macphail. Supplement to 29th Annual Report of the Department of Marine and Fisheries, 1897.

problem is involved. We must know the state of the fishery and the principal facts pertaining to the life and habits of this animal.<sup>1</sup>

Until within a few years the life-history of the lobster was very imperfectly known, and this ignorance has nowhere been more clearly reflected than in the attempts to cure existing evils by legislation. Knowing the general facts of the case, we must interpret them in accordance with the principles of science and common sense. The principal facts are these<sup>2</sup>:

(1) The fishery is declining, and this decline is due to the persistence with which it has been conducted during the last 25 years. There is no evidence that the animal is being driven to the wall by any new or unusual disturbance of the forces of nature.

(2) The lobster is migratory only to the extent of moving to and from the shore, and is, therefore, practically a sedentary animal. Its movements are governed chiefly by the abundance of food and the temperature of the water.

(3) The female may be impregnated or provided with a supply of sperm for future use by the male at any time, and the sperm, which is deposited in an external pouch or sperm receptacle, has remarkable vitality. Copulation occurs commonly in spring, and the eggs are fertilized outside the body.

(4) Female lobsters become sexually mature when from 8 to 12 inches long. The majority of all lobsters 10½ inches long are mature. It is rare to find a female less than 8 inches long which has spawned, or one over 12 inches in length which has never borne eggs.

(5) The spawning interval is a biennial one, two years elapsing between each period of egg-laying.

(6) The spawning period for the majority of lobsters is July and August. A few lay eggs at other seasons of the year—in the fall, winter, and probably in the spring.

(7) The period of spawning lasts about six weeks, and fluctuates slightly from year to year. The individual variation in the time of extrusion of ova is explained by the long period during which the eggs attain the limits of growth. Anything which affects the vital condition of the female during this period of two years may affect the time of spawning.

(8) The spawning period in the middle and eastern districts of Maine is two weeks later than in Vineyard Sound, Massachusetts. In 1893 71 per cent of eggs examined from the coast of Maine were extruded in the first half of August.

(9) The number of eggs laid varies with the size of the animal. The law of production can be mathematically expressed as follows: The number of eggs produced at each and is, therefore, practically a sedentary animal. Its movements are governed chiefly by the abundance of food and the temperature of the water.

(3) The female may be impregnated or provided with a supply of sperm for future use by the male at any time, and the sperm, which is deposited in an external pouch or sperm receptacle, has remarkable vitality. Copulation occurs commonly in spring, and the eggs are fertilized outside the body.

(4) Female lobsters become sexually mature when from 8 to 12 inches long. The majority of all lobsters 10½ inches long are mature. It is rare to find a female less than 8 inches long which has spawned, or one over 12 inches in length which has never borne eggs.

(5) The spawning interval is a biennial one, two years elapsing between each period of egg-laying.

(6) The spawning period for the majority of lobsters is July and August. A few lay eggs at other seasons of the year—in the fall, winter, and probably in the spring.

(7) The period of spawning lasts about six weeks, and fluctuates slightly from year to year. The individual variation in the time of extrusion of ova is explained by the long period during which the eggs attain the limits of growth. Anything which affects the vital condition of the female during this period of two years may affect the time of spawning.

(11) The hatching period varies also with the time of egg-laying, lobsters having rarely been known to hatch in November and February.

(12) Taking all things into consideration the sexes appear about equally divided, though the relative numbers caught in certain places at certain times of the year may be remarkably variable.

(13) Molting commonly occurs from June to September, but there is no month of the year in which soft lobsters may not be caught.

(14) The male probably molts oftener than the female.

(15) In the adult female the molting like the spawning period is a biennial one, but the two periods are one year apart. As a rule, the female lays her eggs in July, carries them until the following summer, when they hatch; then she molts. It is possible that a second molt may occur in the fall, winter, or spring, but it is not probable, and molting just before the production of new eggs is a rare occurrence.

(16) The egg-bearing female, with eggs removed, weighs less than the female of the same length without eggs.

(17) The new shell becomes thoroughly hard in the course of from six to eight weeks, the length of time requisite for this varying with the food and other conditions of the animal.

(18) The young, after hatching, cut loose from their mother, rise to the surface of the ocean, and lead a free life as pelagic larvæ. The first larva is about one-third of an inch long (7.84 mm.). The swimming period lasts from six to eight weeks, or until the lobster has molted five or at most six times, and is three-fifths of an inch long, when it sinks to the bottom. It now travels toward the shore, and, if fortunate, establishes itself in the rock piles of inlets of harbors, where it remains until driven out by ice in the fall or early winter. The smallest, now from 1 to 3 inches long, go down among the loose stones which are often exposed at low tides. At a later period, when 3 to 4 inches long, they come out of their retreats and explore the bottom, occasionally hiding or burrowing under stones. Young lobsters have also been found in eelgrass and on sandy bottoms in shallow water.

(19) The food of the larva consists of minute pelagic organisms. The food of the older and adult stages is largely of animal origin with but slight addition of vegetable material, consisting chiefly of fish and invertebrates of various kinds. The large and strong also prey upon the small and weak.

(20) The increase in length at each molt is about 15.3 per cent. During the first year the lobster molts from 14 to 17 times. At 10½ inches the lobster has molted 25 to 26 times and is about five years old.

After reviewing the most important facts concerning the life of this animal we are ready to discuss the methods which have been tried to prevent its destruction, such as: (1) The protection of immature lobsters by establishing a legal-size limit, or by regulating the construction of traps, or by making close seasons—periods of the year when fishing is illegal; (2) protecting the "berried lobster" or females with external eggs; (3) regulating the canning industry; and (4) attempting to increase the supply of lobsters by artificial propagation. It must be admitted that up to the present time all these measures have proved very disappointing.

The desire to protect the immature lobster and allow it to breed at least once in its life is certainly commendable. It is largely because of the failure of efforts to attain this result that the fishery is now in decline. One reason for this is that there are no obvious means of determining whether a live lobster has in every case produced

eggs or not, and another is that the lobster often matures at a much later period than has been generally supposed. The legal-size limit in Canadian waters fluctuated from 9 to 9½ inches between 1874 and 1892. In 1895 the legislature amended the law, making it illegal to take lobsters less than 10½ inches long. In 1895 the legal limit in Maine, Massachusetts, New Hampshire, and New York was 10½ inches; in Rhode Island 10, and in Connecticut 6 inches. The legislature of Massachusetts was ready to reduce the 10½ limit the next year, but its act was vetoed by Governor Wolcott.

Some lobsters are known to produce eggs when 8 inches long; therefore, it is said, a 10½-inch limit is too great. This can not be allowed. While a few female lobsters produce eggs when 8 inches long, the majority at this size do not. The same is probably true of lobsters 9 and 9½ inches long. Some lobsters do not spawn until after reaching the length of 12 inches, and the limit of 10½ inches is none too great. Thus we see how such attempts to protect the lobster have failed through the legalized killing of immature individuals.

The legislation on the subject of close seasons forms a curious piece of reading. Ignorance of the fact that the lobster carries her eggs for the period of ten months has been an element of confusion here. In Canada, almost every combination of the calendar has been tried. Close seasons for canning establishments, for fishermen, and for different sections of the coast have been tried in vain, but no combination has brought good or lasting results.

The object of a close season is to let the animal breed in peace, but there is a peculiar difficulty in the case of the lobster which makes it impossible to confer any protection upon it worth mentioning by a short close season. The difficulty lies in the fact that the animal does not drop its eggs in the sea or deposit them on some foreign substance, as the older naturalists believed, but carries them on its body. Consequently, in order to protect the eggs you have to protect the egg lobster. This has been attempted in the United States and in Canada by making it illegal to sell the "berried lobster." But the object is defeated by the ease with which this law can be evaded. It is only necessary to scrape the eggs from the body. Again, to obviate this, attempts have been made to allow the capture of "berried lobsters" and to buy up the eggs from the canneries and hatch them by artificial means. On this point I shall speak later.

The period of egg-laying on the coast of the United States extends, as we have seen, over the months of July and August. If fishing in these months is closed the spawners are protected.<sup>1</sup> This can be done, and would result in some good, but at either end the spawning females would be subjected to fire. First, there being no way to detect females which are ready to spawn, these would be killed in great numbers up to the beginning of the period; then, after the close in September, if egg lobsters were captured and the eggs removed and destroyed, the good which has been done would be partially neutralized.

Protection to the immature lobster by regulating the construction of traps, making the distance between the lower slats sufficiently great to let out all the lobsters except those of the legal size—10½ inches—is a measure which, if generally carried out, could not fail to be beneficial.

The canning industry is undoubtedly responsible for a large share in the depletion of this fishery. It is operated in the spring, and for years has destroyed large

---

<sup>1</sup> This period is well covered by the close period in Massachusetts, which extends from June 20 to September 20.

numbers of immature lobsters and of mature females nearly ready to spawn. The canneries have been allowed to use smaller lobsters than those which are sent to market, and we are told that if further restricted they could not exist. Whether this is true or not I do not know, but it is surely folly to protect an animal in one direction and allow it to be destroyed in another.

We have now to speak of the artificial propagation of the lobster as a means of maintaining or increasing the supply. In 1893 I tried to point out some of the fundamental errors which rendered the methods of artificial propagation abortive. The objections which were then made have never been answered or removed.<sup>1</sup> The difficulty is that a false logic has dominated the whole subject, not only of the propagation of the lobster, but of many of the true fishes, both in this country and in Europe. This is shown by the fact that the number of eggs hatched has been taken as a direct test of the efficiency of the method. The question of prime importance, which overtops all others, *what is the ratio between the number of eggs hatched and the number of young reared*, has been strangely left in the background or lost sight of. The following sentence, which I quote from a report on the lobster industry in Canada, illustrates the tendency to which I refer:

The fecundity of the lobster is wonderful. Every female reaching the age of maturity emits from 12,000 to 20,000 eggs every season.<sup>2</sup>

What is here implied is that because the lobster produces a large number of eggs there must be a large number of lobsters raised from those eggs. This is a fundamental mistake. In the animal kingdom the production of a large number of eggs points, not to a great number of survivals and consequent abundance of the species, but to the great destruction of young, which makes a large number of eggs a necessity in order to maintain the species even at an equilibrium. A blue crab (*Callinectes hastatus*) of medium or large size produces 4,500,000 eggs, or 157 times the number of eggs laid by a lobster 13 inches long. Does this imply that the ratio of survival in the crab is 157 times greater than that of the lobster or that the crab is 157 times more abundant than the lobster at any point on the coast? Not at all. It rather implies that the crab lays a smaller egg, has a longer larval period, and is subject to far greater destruction by the elements of nature. In order to preserve its equilibrium, this expedient of producing a vastly greater number of eggs than can possibly survive has been tried in nature and has met with success. In the tapeworm we have an animal with individualized segments, capable of producing millions or even hundreds of millions of eggs, and yet it is comparatively rare, since the chances for survival of each of those millions of eggs is very slight, for in order to live the embryo or larva must find its way by chance to the body of two particular and distinct vertebrates.

In the course of the struggle for existence among animals and their evolution this chance of survival has been increased in other ways than by the multiplication of ova, as by asexual reproduction seen in budding, or by acquisition of special habits or instincts. In the vegetable world we are even more familiar with the great destruction of seed; thus in the common elm, how many of the hundreds of thousands of seeds which annually fall to the ground from a single tree are ever raised to maturity?

<sup>1</sup> The habits and development of the lobster, and their bearing upon its artificial propagation. Bull. U. S. Fish Com. 1893, pp. 75-86.

<sup>2</sup> This statement is erroneous in that eggs are laid only every other year.

Is it possible to determine the number of survivals in an animal like the lobster? We can not fix the number positively, but we can fix a maximum limit beyond which we may be sure, reasoning from known facts, the number of survivals can not pass. By *survivals* I mean the number of eggs which develop and grow up to maturity, for death, at whatever point occurring at this period, means evil to the species in exactly the same degree. In order to maintain the species at an equilibrium it is only necessary that each female produce two adults in the course of her life, whether it be long or short. Then there will be neither increase nor diminution, but the species will hold its own. If more than two adults are raised from the eggs of each female in a given period, then the species must increase; if less, it must diminish. Under present conditions it is generally agreed that the lobster is declining, which means that each adult female produces less than two sexually mature individuals to take the place of their parents.

Spawning lobsters may produce as few as 3,000 eggs and as many as 90,000 or 100,000, the number of eggs laid increasing very rapidly in proportion to the increase in size, according to the law given above. While a 10-inch lobster produces on the average 10,000 eggs, a 12-inch lobster bears twice as many, and a 14-inch lobster nearly four times as many, or 40,000. Although sexually mature lobsters can produce eggs only once in two years, many live to hatch several broods and give rise to hundreds of thousands of young. Remembering that females become mature when from 8 to 12 inches long, to be on the safe side we may assume that on the average they mature at the length of 10 inches. A 10-inch lobster produces on the average about 10,000 eggs. Considering all the facts, it is erring on the safe side to assume that the average number of eggs produced by all lobsters which have spawned is 10,000. It is probably much greater than this. It can not certainly be less. Since it is necessary that only two of this number should survive to maintain the species at an equilibrium, we can get some idea of the amount of destruction which is wrought under existing circumstances. A survival of 2 in 10,000 or 1 in 5,000 is probably even greater than actually occurs. The remainder of this large number must be destroyed in one of two ways, by nature and by man, who assists nature in this work after the young are able to be caught in his traps. It can make no difference in the result what the agent of this destruction is, whether it is the ocean current, the storm lashing the rock-bound coast, the codfish, or man, except in so far as the evil wrought by man may be under control. If we award to man one-half of the blame, this would imply that instead of a saving of 2 in 10,000, under nature there might be a survival of 4. But such a survival would lead to a greater increase in the species than could probably ever occur.

What, then, is the ratio of the number of eggs laid to the number of young reared? Allowing that man does one-half of the work of destruction—which he certainly does not—and allowing an average total production of 10,000 eggs to each female that has spawned at all—undoubtedly too small a number—the species would be maintained under nature by a survival of 2 in every 10,000, or 1 in 5,000, if man did not interfere. A survival of 4 in every 10,000, or 2 in 5,000, would keep up the present stock with the added drain which man puts upon it. Considering that the fishery is declining, it can be maintained with a considerable degree of confidence that a survival of 1 in 5,000 is a very liberal allowance.

These considerations have a direct bearing upon the efficiency of the present methods of artificial propagation, which consist of stripping off the eggs from the

berried female, hatching them, and liberating the young larvæ into the sea. Nature does not confer any special favors upon the young lobster thus brought into the world. It is not a case of making two blades of grass grow where but one would have grown before. A delicate, helpless organism, one-fifth of an inch long, it must contend alone with the forces of the world into which it is cast, the ocean, on the surface of which it is destroyed by millions through the indiscriminate forces of nature—the tempest, the tide, the ocean current, and wave-beaten shore—and we must add to this the destruction wrought by surface-feeding animals.

With the liberal allowance of the survival of 2 individuals out of every 10,000 hatched, we would have to hatch 1,000,000 eggs to produce 200 adults, 100,000,000 to get 20,000, and 1,000,000,000 to obtain 200,000 adult animals. To raise 1,000,000 lobsters would involve the hatching of 5,000,000,000 eggs. Since hundreds of thousands of adult lobsters are captured every month during the best of the season, it is evident that the annual supply can not be appreciably affected by this method unless conducted upon an altogether impracticable scale.

The greatest number of lobsters artificially hatched and liberated in a single year in Newfoundland, Canada, and the United States, according to the official reports for 1894, was 702,288,000.<sup>1</sup> This number of young at the rate of survival of 1 in 5,000 would yield 140,457 adults, while in a single year (1892) 68,000,000 lobsters have been captured in Canada alone. In order to put an equivalent number of lobsters back to make good this loss, not half or three quarters of a billion should have been hatched, but 340,000,000, or something less than 500 times as many as were actually liberated. In this case man has attempted by working on a small scale to stem the tide of destruction which nature working on such a vastly greater scale has been unable to do.

The conclusion which we reach is that too much has been expected from the present method of the artificial propagation of the lobster, and that it is totally inadequate to accomplish the task of restocking the depleted waters.

It may properly be asked of one who makes criticisms to suggest remedies, although he is not wholly responsible for the performance of this task. The following suggestions without further discussion seem to me to have a logical basis:

(1) That the coasts of those States in which the lobster fishery is of sufficient importance be divided, after careful consideration, into a number of well-marked areas, and that fishing for this animal be closed in each alternate section for a period of five years; at the end of this time the open areas to be closed, and so on alternately.

(2) That the legal limit be fixed at 10½ inches for all purposes and under all conditions.

(3) That all traps be registered and marked, and that their construction be regulated by law so that the space between the two lower slats be sufficient to allow free passage to all lobsters under 10½ inches in length.

<sup>1</sup> The number of young lobsters hatched and liberated on the Atlantic coast since 1893 is given by the official reports as follows:

Fiscal year.	United States.	Canada.	Newfoundland.
1893.....	8,818,000	153,600,000	517,353,000
1894.....	78,398,000	160,000,000	463,890,000
1895.....	72,253,000	108,200,000	174,840,000
1896.....	97,079,000	100,000,000	.....
1897.....	115,606,000	.....	.....

(4) That the capture of berried lobsters be prohibited at all times. Though a law of this kind is sure to be more or less evaded, it is not expedient to encourage the destruction of eggs under any circumstances.

A series of experiments should be tried in raising the young in spacious inclosures, where crowding in vertical and horizontal limits could be avoided, and where a natural supply of food could be provided, the object being to determine whether it is practicable to raise the young up to the fifth and sixth stages, when they go to the bottom and are able to protect themselves. If then set free, the chances of survival would be many hundred times greater than in the first stages. If we could save 100 instead of 2 out of every 10,000 hatched, every 1,000,000 would give us 10,000 adults, and every 1,000,000,000 would yield 10,000,000 lobsters capable of reproduction. In such attempts to rear the lobster there are serious obstacles to be overcome in isolating the young, and giving them an abundant supply of pure water which shall at the same time yield the proper food, but we can not enter into the discussion of these subjects in this paper.

The close period referred to above should begin about June 20, and extend five years and two months from that time to August 20. To illustrate it, we will say that it begins June 20, 1900, and extends to August 20, 1905. During this period 6 sets of lobsters would spawn; 2 of these sets would spawn three times, 2 sets would spawn twice, and 2 once. Thus the set spawning in 1900 would lay eggs again in 1902, and again in 1904, and so on. Furthermore, the survivors of the broods of 1900 and 1901 would be mature, or nearly so, at the end of this period in 1905.

CLEVELAND, OHIO.