

11.—THE TRANSPLANTING OF LOBSTERS TO THE PACIFIC COAST OF THE UNITED STATES.

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INTRODUCTION.

This paper has been prepared chiefly for the purpose of recording in convenient form for reference the several attempts that have been made to introduce the American lobster (*Homarus americanus*) on the western coast of the United States. It seems appropriate, however, that the detailed account of the shipments should be preceded by a few general remarks.

The genuine lobsters of the North Atlantic Ocean have no true representatives on the Pacific coast of the North American continent, where the only crustacean north of Point Conception, California, now deemed worthy of commercial recognition is the large crab (*Cancer magister*). South of Point Conception we find the so-called spiny lobster, or salt-water cray-fish (*Panulirus interruptus*), which ranges southward to Mexico. This species, which is very unlike the Eastern lobster, occurs abundantly in some localities, where it is much sought for as an article of food, supplies also being sent to the San Francisco markets. The omission of the true lobster from the aquatic fauna of the Pacific coast has been considered by the inhabitants of that region a great misfortune, and while its absence causes neither suffering nor affliction, it is much desired both as an article of commerce and as an added variety to the food supply. Demands have been made upon the Government to attempt its colonization there, and the State of California has several times lent its aid in the matter, both by independent action and by co-operation with the U. S. Fish Commission. The scheme has received the approval of high authorities, and the benefits to be derived from the introduction of so useful a species is generally admitted.

Before engaging in so difficult and expensive an enterprise it is important that it should have careful consideration both as to its utility and its promises of success, and this it has received, especially since the matter was taken in hand by the General Government. Some persons not acquainted with the facts have deprecated the transplanting of the east-coast species on the assumption that the west coast already has its lobster in the *Panulirus*, already referred to. The so-called spiny lobsters, or *langoustes* of the French, form a large and conspicuous group distributed throughout the warmer parts of the globe. In the North Atlantic we have two well-known species, one inhabiting southern Europe, the other the Southern United States, the West Indies, etc. Both of these are highly prized for food, but the American species

does not, in its range, overlap that of the true lobster, nor compete with the latter in any of our markets. On the Pacific coast the spiny lobster is confined to the southward of Point Conception, which to some extent marks the dividing line between a warmer and a colder fauna. The same influences (temperature mainly) which thus restrict the range of *Panulirus* to the south of Point Conception would limit the distribution of the true lobster to the north of the same point, providing its introduction on the Pacific coast was attended with success. There would be no more conflict between the two species than now occurs on the Atlantic side, but the same condition of affairs would be expected to exist. The comparison may perhaps be strengthened by imagining the extinction of the true lobster on the coasts of the Middle and New England States and the British Provinces. Its place could scarcely be filled by the Southern species.

Admitting the expediency of stocking the Pacific coast with lobsters, the question of their adaptability to that region next requires investigation. The North Atlantic and North Pacific Oceans have much in common with respect both to their physical and their biological characteristics. Identical species of fishes and marine invertebrates inhabit the northern parts of both oceans, and the number of related forms in the two regions is very great. The natural resorts of lobsters on the eastern coast, rocky, gravelly, and sandy bottoms, covered in places with kelp and rock-weed, and with an abundance of aquatic life suitable for food, occur throughout the North Pacific region from California to Alaska. Temperature, however, is probably to be regarded as the most important factor determining the fitness of the region for this new food product, and it is the only one which we can now pretend to measure although we have little data respecting it for the western coast.

On the Atlantic coast the lobster ranges from Delaware to Labrador, being most abundant between the Cape Cod region of Massachusetts and the Gulf of St. Lawrence and Newfoundland. Its bathymetrical distribution is from the littoral zone (in some localities) to depths of probably 50 and 60 fathoms, but the fishery is chiefly carried on inside of a depth of 30 fathoms. It apparently does not migrate up and down the coast to an appreciable extent, but moves off into deeper water with the approach of winter in order to escape the severe cold.

The continuous temperature observations in the possession of the Fish Commission relate mainly to the surface waters, but in the shallow areas where they were taken there is generally not much difference in this respect between the surface and the bottom. Delaware Breakwater, practically the southern point in the range of the American lobster, which occurs here only in small numbers, is located between the light-ships at Winter Quarter Shoal, Virginia, and Five Fathom Bank, New Jersey, the distance between these light-ships being about 56 miles. At the former the annual range of water temperature is from 35° to 76° Fahr., at the latter 37° to 76°, there being practically no difference between the two.* Above Five Fathom Bank light-ship, on the New Jersey coast, lobsters become somewhat more abundant on several off-shore banks, the range of temperature at Sandy Hook light-ship, just to the north of these banks, being from 33° to 74° Fahr. In Long Island Sound, where several important fishing localities exist, the range, as determined at Bartlett's Reef and Stratford Shoal light-ships, is from about 33° to 70° Fahr. The middle portion of Vine-

* In all of these records the observations for January, February, and the first part of March are omitted.

yard Sound, farther to the eastward, has the same range of temperature. The region adjacent to Block Island, the Elizabeth Islands, and Martha's Vineyard, is the most important one for lobsters south of Cape Cod, and here the range of surface temperature as observed at Brenton's Reef and Vineyard Sound light-ships is from about 32° to 69° Fahr.

At Pollock Rip light-ship, off the southern end of Cape Cod, the range is reduced to from 32° to 62° Fahr., and in the Gulf of Maine we find the same range by combining the results of observations at all stations, although in some places the maximum is only 54° Fahr.

For comparison with these observations we have continuous records for only two localities on the Pacific coast; namely, San Francisco, California, and Cape Disappointment, at the mouth of the Columbia River. At the former place the surface range is from about 51° to 61°, the bottom temperature being seldom more than a degree lower at any time; at the latter the surface temperature ranged from 40.5° to 65.75° and the bottom from about 42° to 65°. The higher maximum at Cape Disappointment is due to the fact that the observations were taken in shallower water on the inner side of the cape, in the vicinity of Fort Canby; they are also limited to a period of two years, while at San Francisco the records extend through six years.

The lobsters transplanted to the Pacific coast in 1888 and 1889 were all obtained in the Vineyard Sound region, and chiefly in the vicinity of Vineyard Sound light-ship. The shipment of 1888 was mostly planted at Monterey, California, about 75 miles south of San Francisco, the balance going to the vicinity of Trinidad light-house, in the same State, about 200 miles north of San Francisco. The water temperature at Monterey is probably not very different from that at San Francisco, while Trinidad light-house is intermediate in position between San Francisco and Cape Disappointment. At both of these observing stations the records indicate ranges of temperature falling within those of the New England coast, and therefore presumably favorable to the existence of lobsters.

In order to furnish the means of readily comparing the New England water temperatures with those of northern California we have introduced a graphic chart (Plate LXX) on which the temperature curves for San Francisco and the Vineyard Sound light-ship are plotted conjointly. The description of the chart will be found at the end of this introduction. By reference to the chart it will be seen that the temperature is far more equable at San Francisco than in Vineyard Sound, having a range of only about 10° in the one case and of over 30° in the other. The yearly range at San Francisco corresponds to that in Vineyard Sound from May 20 to the last of June and from the first part of October to the middle of November, seasons during which the lobsters are on the in-shore grounds, the former being also the regular hatching season. In case lobsters become colonized on the coast of northern California it will therefore be interesting to observe if the more equable temperature of that region has any influence in bringing about a change in their customary habits. Will their off-shore migrations be less pronounced and their breeding season prolonged? Another matter which this temperature comparison suggests is as to whether the more severe cold of the Eastern winters is essential to their welfare or not. There is nothing to prove the case one way or the other, but the fact that lobsters seek shelter from the extreme cold would rather indicate that they might not suffer from its absence. An additional question of interest to the biologist concerns the effect upon the existing fauna of the intro-

duction of the Eastern lobster upon a large scale. Will it, to any extent, disturb the general balance of life in that region, reducing the prominence of some species and perhaps aiding others in their struggle for existence? Only the future can decide this matter, but in any event the addition of the lobster to the Pacific waters could produce no harm for which the inhabitants would suffer.

An erroneous notion prevails among many persons with respect to the difficulties attending the transplanting of lobsters and the delays incidental to their introduction upon a new coast. It has indeed been a perplexing problem to determine the best methods of shipping them long distances over land, but even with that point decided, if we may so consider it, the task is still far from being accomplished. The lobster is, to the best of our knowledge, a slow-growing species, not attaining a length of 10 inches within at least five or six years from the time of leaving the egg, and by some it has been computed that the growth is even less rapid. The five hundred and sixty-five lobsters recently planted on the coasts of California and Washington can not in themselves be regarded as a direct addition to the food supply. They are only a breeding stock, and any increase in their numbers must be derived from the growth of their progeny, also taking into account the young embryos placed in the water off Monterey in 1888. The number of embryos planted by the Fish Commission was about 100,000. Supposing that they all lived, we could not at the end of five or six years have an addition of more than that number of adult lobsters in the Monterey region, and until that time there would be no additions to the original stock of breeding lobsters. At the end of the first year, or during the first breeding season following their introduction, a maximum of 1,800,000 eggs and embryos would be all that could be expected from the original lot of females planted, under the most favorable circumstances, and providing they all lived that long. Prolonging these conditions, the maximum number of eggs would not be increased from year to year before the fifth or sixth year. It is probable, however, that the original stock of adult lobsters will not keep entirely together, and some will undoubtedly become the prey of fishes. Moreover, lobster embryos are subject to great mortality, and only a very small percentage reach maturity. If at the end of six or even ten years a few thousand only compose the colony off Monterey, the experiment may be considered as successful, but when once it has been firmly established on so large a basis the annual increase will be much more rapid.

The above remarks, perhaps at the first sight discouraging to some of the promoters of the scheme of introducing this important crustacean in the Pacific Ocean, but not appearing so to the Fish Commission, have been written with a special object in view. The General Government has, at considerable expense, made several plants of breeding lobsters in excellent condition upon favorable parts of the Pacific coast. Other shipments may be made in the future, but here the power of the Government ceases, and it rests entirely with the people in whose districts the plantings have been made to give the experiment a fair trial. The grounds which the lobsters are observed to inhabit for the purposes of feeding and spawning should not, under any circumstances, be molested. The taking of lobsters purposely by any fishing method should be prohibited not simply for a specified term of years, but until there are positive indications that they have become firmly established upon the coast, and all lobsters accidentally captured should be returned to the water at once. It is incumbent upon the authorities not only to enact laws covering this matter, but also to provide that they be executed promptly and impartially. Without such co-operation

on the part of those whose interests are most at stake it can not be expected that the transplanting will result successfully.

Information received from Monterey since this report was first written indicates, however, that the fishermen of that region thoroughly appreciate the necessity of protecting the lobsters to the full extent of their ability, and we feel assured that the experiment is receiving their earnest support. A few of the adult lobsters deposited there have been observed during 1889, crawling upon the bottom in shallow water, but none have been captured in any of the nets. Young lobsters, measuring about 4 inches long, have also been reported from time to time, but until specimens have been examined by some one competent to identify the species, we can not give full credence to the statements concerning them, as other kinds of crustaceans resembling small lobsters occur on the California coast.

The relative merits of the several methods of shipping live lobsters across the continent which have been followed up to the present time can best be decided after reading the accounts of the different trials given in the following pages. The subject has to be considered from at least two stand-points. While one method may insure safe transportation it may, at the same time, be too cumbersome to permit of the carrying of a sufficient number of individuals to do any good. On the other hand, any method that allows too large a percentage of loss must be uneconomical and unprofitable. The successful planting of a region must depend upon the bringing together of large colonies of individuals in favorable localities, and large cargoes must therefore be provided for.

In comparing the different shipments we are obliged to omit the first one, made in 1873, which ended in a railroad accident near the middle of the continent. On the second trial the lobsters were packed with straw and sponges in narrow box compartments, and were constantly sprinkled with sea water. Some were transferred, however, during the journey, to a large tank of sea water. Out of the one hundred and fifty lobsters with which the car started, only four survived the journey. The published accounts of the trip are too meager to explain the causes of the failure in all particulars. The packing about the lobsters in the compartments was probably too dense, and the temperature of their surroundings may have been at fault, while fresh water entered the boxes from the melting ice. The packing materials were also probably not suitable for the purpose, the straw tending rapidly to decay.

On the third trial the lobsters—twenty-two females with eggs—were carried in three large tanks of sea water, maintained at a low temperature. No record has been left us of the amount of space taken up by the tanks and by the 1,000 surplus gallons of water carried along to make changes on the way, but it must have been considerable. Only one lobster died during the journey and the remaining twenty-one were planted in the vicinity of Bonito light-house, off San Francisco. It is curious to note, however, that only female lobsters were included in this, as well as in the two former shipments, and unless some of the embryos contained in the eggs planted with them reached maturity, no breeding could subsequently have taken place.

By the time of the fourth and fifth shipments the means of transporting live fish had been greatly improved, and cars were in existence built specially for that purpose. The seasons of the year in which the shipments were made, however, were both unfavorable, but there had been no opportunity for a choice, as at other times the cars were needed for other branches of the work. The methods of packing followed

proved entirely satisfactory, and the results of both trials were eminently successful. A loose packing of moist rock-weed was placed about the lobsters, which were carried in open trays, and the temperature of their surroundings was kept as nearly as possible between 42° and 45° Fahr. The shipment consisted of both males and females, and both sexes were planted in each locality. The lobsters were in excellent condition when returned to the sea, and unless some mishap shall befall them, they will probably be heard from again. In addition to the adult lobsters, 102,000 active embryos were planted off Monterey and 2,000 in San Francisco Bay.

The accounts of the five shipments are given below.

EXPLANATION OF THE CHART COMPARING THE TEMPERATURE AT SAN FRANCISCO, CALIFORNIA, AND VINEYARD SOUND, MASSACHUSETTS.

This chart represents by curved lines the average surface and bottom temperature at San Francisco, California, for six years (1878, and 1882 to 1886, inclusive) and the surface temperature at Vineyard Sound light-ship, Massachusetts, for seven years (1881 to 1887, inclusive). The San Francisco temperatures are shown by the continuous lines, the heavier line corresponding to the surface temperature and the lighter one to the bottom temperature. Only surface temperatures were taken at the Vineyard Sound light-ship, as indicated by the line composed of dashes.

The construction of the chart scarcely requires explanation. It is divided by the heavy vertical lines into ten-day periods, with the exception of one fifteen-day period at the end of the year. The interspaces between the horizontal lines represent, each, one degree Fahrenheit. The temperature curves are drawn with reference to the lighter vertical lines in the middle of each ten-day period, and are based upon the mean reductions of ten days' observations in each year. At San Francisco one observation was taken daily, so that each point with reference to which the curves are drawn represents sixty observations for the six years. In the case of Vineyard Sound light-ship, however, where two observations were taken daily for the seven years, each point is the equivalent of one hundred and forty observations.

The temperatures at Vineyard Sound light-ship for January, February, and the first part of March are omitted on account of the occasional erroneous reading of the thermometer during that period.

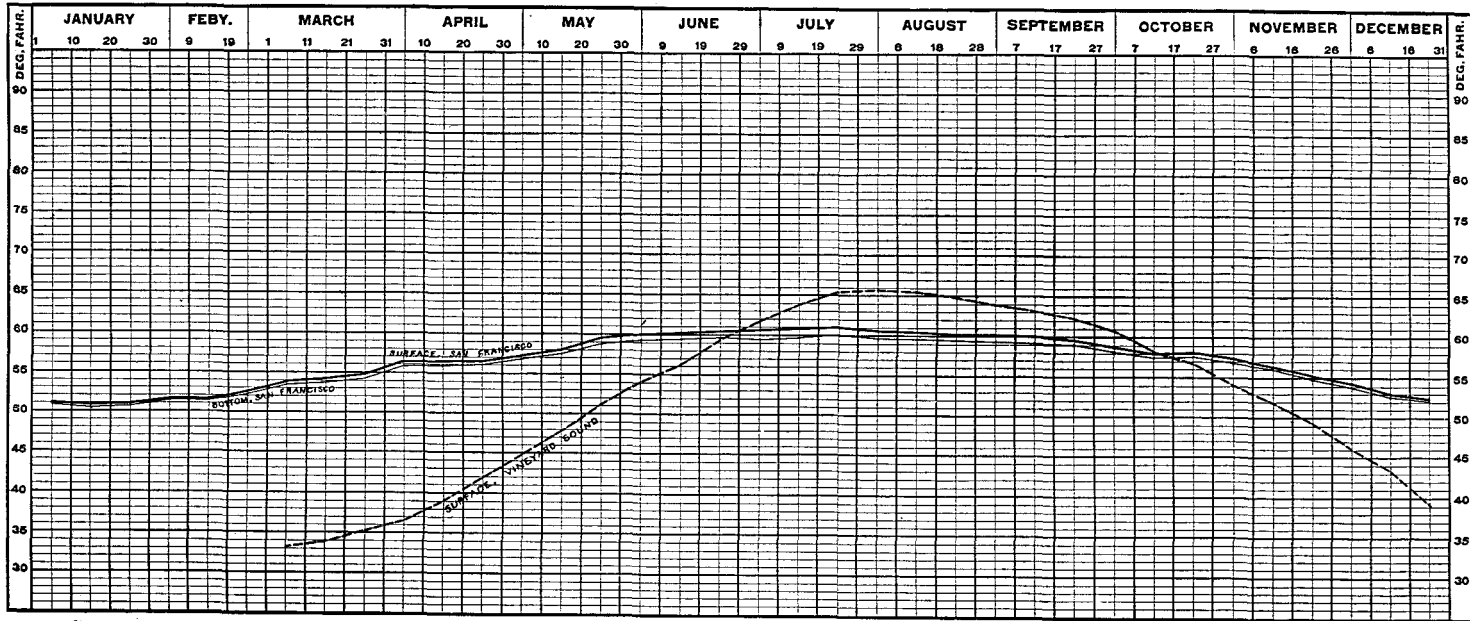
Vineyard Sound light-ship is anchored on the western side of the southern entrance to Vineyard Sound, Massachusetts, about 2½ miles southwest by west of Cuttyhunk Island, in a depth of 15 fathoms. The temperature observations were taken by the light-house keepers. Important lobster fisheries have been carried on in this region for many years. At San Francisco the observations were made by an observer of the Signal Service at different wharves along the bay front, as follows: Foot of Vallejo street, foot of Washington street, foot of Jackson street, and foot of Broadway, the depth of water varying from 15 to 42 feet according to the locality and the state of the tide.

FIRST TRIAL—JUNE, 1873.

The first attempt to carry live lobsters to the Pacific coast was made in June, 1873, under the supervision of Mr. Livingston Stone, and in the joint interests of the State of California and the United States. The lobsters, one hundred and sixty-two in number, formed but a small part of the shipment, which consisted of several species of fresh-water and marine fishes from the eastern side of the continent. A fruit car, furnished by the Central Pacific Railroad Company, was specially fitted up for the purpose with a large stationary fresh-water tank, a large ice chest, and the means of carrying an abundance of salt-water. The lobsters were contained in six large cases at one end of the car, but the manner of storing and caring for them is not described in Mr. Stone's report. The specimens were obtained partly at the Boston market and partly at Wood's Holl, Massachusetts. The car left Charlestown, New Hampshire, where most of the fish had been brought together for convenience of shipment, June 3.

UNITED STATES COMMISSION OF FISH AND FISHERIES.
COMPARISON OF THE OCEAN TEMPERATURES
 AT
SAN FRANCISCO, CAL., AND VINEYARD SOUND, MASS.

TO ACCOMPANY A REPORT ON THE TRANSPLANTING OF LOBSTERS TO THE PACIFIC COAST.



*The heavier continuous line represents the average surface temperature at San Francisco, based upon daily observations for six years, 1879, and 1882 to 1886, inclusive.
 The fainter continuous line represents the average bottom temperature for the same place and period.
 The broken line represents the average surface temperature at the southern entrance to Vineyard Sound, based upon two observations daily during seven years, 1881 to 1887, inclusive.*

It had on board 180 gallons of ocean water, but this was to be used only in part for the lobsters, there being also several other species of salt-water fish. Omaha was reached on the sixth day out, at which time only forty lobsters remained alive. Just after leaving Omaha, however, a serious accident happened to the train, and the special car with its contents was precipitated into the Elkhorn River. The first attempt, therefore, ended in misfortune, but even with the crude method of handling the lobsters which was followed, one-fourth of the total number was carried safely during a period of time which in the present days of rapid travel would have taken the car nearly to San Francisco.

SECOND TRIAL—JUNE, 1874.

The second trial took place just a year subsequent to the first one, the car leaving Charlestown, New Hampshire, June 4, 1874. This shipment was made by Mr. Stone under the sole auspices of the California State Fish Commission. As in the first instance, the consignment consisted of a number of Eastern species, from both salt and fresh water, there being one hundred and fifty specimens of lobsters, all of which were adult females, bearing eggs. Two lobsters were planted in Great Salt Lake, on the way, and only four reached San Francisco alive. The following account of the manner in which the lobsters were cared for is abstracted from the report of Mr. M. L. Perrin, assistant to Mr. Stone: *

The lobsters were obtained in Boston, of Messrs. Johnson & Young, and were shipped to Charlestown, New Hampshire, June 3, on a special car. They were packed in seven pine boxes, each of which measured $3\frac{1}{2}$ feet long, 15 inches wide, and 15 inches deep. A horizontal partition divided the boxes into two compartments, an upper and a lower, making two tiers, in each of which, except one, eleven lobsters were stored, being laid directly upon the wooden bottoms, with a packing of sponges over and around them. The ocean water was transported from Boston to Charlestown in six casks, containing 149 gallons each, or 894 gallons in all. This water was obtained outside of Boston Harbor, and upon arriving at Charlestown was mostly transferred to two salt-water tanks on board the aquarium car. These tanks were made of hard wood and were smeared with a mixture of resin and tallow in order to render them water-tight. During a part of the journey they were used for salt-water fishes, and one of the original casks of sea-water was therefore carried on the car intact, to serve for the lobsters during the latter part of the journey.

In preparing for the trip to Charlestown the sponges were wet with salt-water, and then so packed around the lobsters that the latter were completely hidden. During the trip salt-water was poured upon the lobsters and the sponges were again saturated. At Charlestown, on the morning of June 4, the day of starting on the long journey, the lobsters were all repacked in twelve boxes, subdivided into twelve compartments, each of which was just large enough to admit one lobster, and about 6 inches deep. There were no covers to the boxes, and each compartment had an auger hole bored in the bottom to furnish drainage. Wet straw was laid upon the bottom under the lobsters, which were then covered with sponges as in the first instance. The boxes were stacked against the side of the car in two piles of six boxes each.

The lobsters were examined twice a day. The sponges were removed and squeezed

* Report U. S. Fish Commissioner, Part III, 1873, '74, 1874-'75, p. 259.

out over them, and then, being soaked again with the sea-water, were arranged about them as before. Broken ice was also placed over each compartment to reduce the temperature, and pailfuls of salt-water were often poured over the boxes as they lay piled against the side of the car. No lobster died during the trip from Boston to Charlestown, but during the first two or three days after leaving the latter place a few were found dead at each examination.

June 6, sixty lobsters were put into one of the large tanks with marine fishes, the water being continually aerated by a stream of air forced through a hose, and kept at a low temperature by ice piled upon the top of the tank. The next afternoon the lid of the tank was found to have fallen in, and all the lobsters and other fish it contained were dead, but the precise cause of the mortality was not discovered.

From this time on, a large quantity of ice was kept piled upon the boxes containing the remainder of the lobsters, but the mortality was very great, being generally equal to one-third or one-half the number at each examination. On June 8, the fifth day of the trip, only twenty-five out of the one hundred and fifty with which the trip began were living. The reserve cask of 149 gallons of water was opened on this day, and they began to use the water from it instead of from the tank. June 9, the straw was taken from beneath the lobsters and they were packed entirely with sponges. This appeared to have a beneficial effect upon the few surviving specimens, and Mr. Perrin thinks that had this change not been made no lobsters would have reached San Francisco alive. June 11, when the water brought with them had become exhausted, a large supply of salt-water reached them from the Pacific coast, and gave them the means of treating the eight specimens then living with liberal doses and frequent changes. Two specimens were planted in Great Salt Lake, at Salt Lake City, and four specimens were put into the sea at Oakland Wharf, San Francisco Bay, June 12, just nine days after they had been taken from the water at Boston. These lobsters were all females and two were said to have been well supplied with spawn.

Mr. Perrin's report is full of useful suggestions, and it is interesting to note that some of the most important desiderata which he mentions in connection with his trip were supplied in the case of shipments four and five described below, and undoubtedly conduced to their successful issue. Mr. Perrin was obliged to place his ice partly inside and partly on top of the lobster crates, in order to keep the temperature sufficiently reduced, but in these positions more or less of the fresh water resulting from the melting was absorbed by the sponges, and the lobsters were not constantly surrounded by the denser salt-water, which seems to be essential to their welfare, as proved by subsequent experiences. Mr. Perrin also refers to the currents of warm air which struck the sides of the boxes, especially when the car doors were open, and made it difficult to maintain a uniform temperature. A serious mistake noted by Mr. Perrin was the subdividing of the boxes into narrow compartments, which entirely restricted the movements of the lobsters. A still more serious error, probably, was the use of straw and sponges for packing. While the latter is undoubtedly preferable to the former, in view of Mr. Perrin's experiments, it packs too closely and prevents the circulation of air, which is now deemed necessary. Had rock-weed been used upon this trip instead of sponges it is probable that the results would have been much more gratifying. It is unfortunate that we have no record of temperatures in connection with this experiment, but it probably would have been difficult to have taken reliable temperature observations in boxes exposed as these were.

THIRD TRIAL—JUNE, 1879.

The third attempt was also made under the direction and personal supervision of Mr. Stone, and was more successful than either of the preceding ones. A special car was not provided, but the specimens were carried in the ordinary baggage cars, making it necessary to transfer the lobsters at the termination of each railroad. The expedition left Albany, New York, which had been made the point of rendezvous for the different kinds of fishes, at midnight of June 12, 1879, with twenty-two female lobsters carrying about 400,000 eggs nearly ready to hatch. In fact, about 40,000 eggs hatched on the road between Boston and Albany, giving that number of embryos to be cared for on the way. In order to test the efficacy of the methods that were followed, before beginning the trip a number of lobsters were subjected, during about a fortnight previous, to practically the same conditions which they would encounter on the journey. The salt-water taken along was also obtained sometime in advance, and allowed to stand until the microscopic organisms it contained had died and they and all the other impurities had settled to the bottom. The clear water was then decanted and remained pure during the entire journey.

The lobsters were carried in three large open tanks of water, and every effort was made to keep the water clear and cold in the manner described below. This was a radical departure from the methods followed in 1873 and 1874, and although the shipment was attended with much greater proportionate success, there was this disadvantage that comparatively few lobsters could be carried in the same or in even a much greater space. Frequent changes of water were also required, necessitating the taking of a large reserve stock, the expedition starting with nearly a thousand gallons, some of which, however, was early spoiled, due to its having been stored in unclean casks.

For reducing the temperature of the water three methods were employed, as follows: (1) Putting ice and salt in large stone jugs and hanging the jugs in the tanks; (2) Putting the freezing mixture in a vessel surrounding another vessel containing the water to be cooled, this water being afterwards transferred to the tanks; (3) Filling a large earthen drain-tile with the freezing mixture and keeping it in a reserve tank of water from which the water, when sufficiently cool, could be exchanged for the warmer water in the lobster tanks. The second method described was found to work best in actual practice. Aeration was produced by dipping up the water and allowing it to fall back into the tank, this operation having to be kept up without intermission.

Respecting the temperature in the lobster tanks, Mr. Stone wrote as follows: "It was easy enough to manage the temperatures of all the tanks except those containing the lobsters; but these gave us a good deal of trouble, because they could only be cooled by exchanging the water on the lobsters with the water in the coolers, and by using the stone jugs containing the freezing mixture. On very warm days it was extremely difficult to reduce the temperature in the lobster tanks as fast as the heat of the day raised it. With great pains, however, we succeeded in preventing it from rising high enough to do any mischief." The temperature in the lobster tanks was maintained during the entire journey at between 45° and 56° Fahr., never rising above 49° on the last three days.

Only one lobster died during the trip. It was taken out at Omaha, and was found to be the same whose spawn had hatched between Boston and Albany. It was evidently not in good condition at the start. The remaining twenty-one reached the west

coast alive, the trip having consumed about six days from Albany. "The lobsters were carried to Oakland Wharf by the writer," says Mr. Stone, "where they were met by a steamer chartered for the purpose, which took them to the Bonito light-house, under the shadow of which, in a sheltered bay a few miles outside the Golden Gate, I had the pleasure of placing them with my own hands—the first lobsters ever introduced into the Pacific Ocean. They were all in splendid condition except one, and had with them over a million eggs nearly ready to hatch."

EXPERIMENTS PRECEDING THE FOURTH SHIPMENT.

In accordance with instructions from Professor Baird, Capt. H. C. Chester, then superintendent of the Wood's Holl station of the Fish Commission, made a series of experiments during the spring of 1886, with the view of devising some means of transporting live lobsters long distances without the use of a large supply of sea-water. His experiments were directed mainly in one line, that of packing them in moist rock-weed, and reducing the temperature of their surroundings. It is needless to describe his experiences in detail, but the following method was found to give the most satisfactory results :

A zinc box (tin or galvanized iron would answer as well), measuring 22 inches long by 18 inches wide and 13 inches deep, was inserted in a wooden box of sufficiently large size to allow an interspace between the two all around of about 5 inches. Each of these boxes was separately drained at the bottom by means of a small pipe, and the inner one had a central opening above large enough to afford ventilation and facilitate the packing. The interspace between the boxes was completely filled with powdered ice. The lobsters were packed in the zinc box in one layer between two layers of rock-weed. The temperature was maintained as nearly as possible between 42° and 44° Fahr. The rock-weed was moistened in the beginning, and on the third, sixth, and ninth days a quart of sea water was sprinkled over it. This was all the wetting the lobsters received, but on the eleventh day, when they were removed, they were apparently in as good condition as when taken from the water. A second lot was kept in the box nine days, with only a single wetting and without injury, seeming to require only moist air for respiration when the temperature is low. The eggs adherent to the swimmerets of the female also remained that length of time in good condition.

It was Captain Chester's idea that in making a distant shipment a number of these cases should be used. The facilities for shipping offered by the special cars of the Fish Commission, however, rendered it unnecessary to make use of these somewhat complicated appliances, as explained farther on. One of the most interesting results of his experiments was the information that rock-weed could be kept fresh, by slight wetting, a long period of time, remaining as sweet and elastic as when first cut from the rocks.

FOURTH TRIAL—JUNE, 1888.

Fish Commission car No. 3, in charge of Mr. J. F. Ellis, with the Commissioner, Col. Marshall McDonald, and the writer on board, reached Wood's Holl, Massachusetts, on the afternoon of June 14, 1888, for the purpose of beginning the fourth shipment of lobsters to the California coast. The superintendent of the Fish Commission station at that place had previously been advised of the proposed shipment and was instructed

to have everything in readiness. Upon our arrival we found that about nine hundred medium-sized lobsters of both sexes were being cared for in floating cars, while a large quantity of the common rock-weed (*Fucus*) had been collected from the neighboring shores. The next day being Saturday it was decided to begin the packing and loading early in the morning, in order to start the car westward before Sunday.

In car No. 3 the compartments for carrying live fish consist of two large tanks or refrigerators under the floor of the car and extending its entire length between the trucks. Access to these tanks is had through large openings in the floor, separated only by the width of the floor timbers, and furnished with trap-doors, closing them completely.

The method of shipping the lobsters, as determined by the Commissioner, was to pack them in shallow trays or crates which could easily be handled, and in which the lobsters could be examined in small lots at a time during the progress of the journey. The dimensions of the trays were regulated in part by the size of the openings to the tanks, through which they would have to be passed for storage. They were made of rough boards, and measured on the outside 22 inches long by 17 inches wide and 6 inches deep. The bottoms consisted of five or six narrow slats, separated by comparatively wide interspaces to permit of circulation and free drainage. No covers were provided. A tray of these dimensions would hold six lobsters of the average size without undue crowding, and it was estimated that one hundred of the trays could be conveniently accommodated in the car.

The packing was done at the Fish Commission wharf, whence the trays were carried by water in two lots to the railroad station, about a quarter of a mile distant, and immediately placed in the large car tanks. The lobsters were transferred from the floating cars to the trays with as short an exposure as possible to the open air, and none but active and apparently hardy individuals were selected. First a layer of the moist rock-weed of sufficient thickness to form a soft and yielding cushion was spread over the bottom of the tray, and upon this six lobsters were laid in two rows facing the ends of the trays, their backs being upward, and no precautions being taken to fasten the claws or restrain their movements. They very rarely attack one another, and to plug the claws, as was done on all or nearly all of the former shipments, causes serious injuries, from which they may not recover. Over the lobsters a second, loose layer of rock-weed was placed, but care was taken that it should not be thick enough to reach above the level of the top, in order that it might not pack solidly when the trays were piled one upon the other. No attempt was made to separate the males from the females, but an accurate record of the sexes was kept during the packing. The lobsters were not fed during the journey, and it is doubtful if they would have eaten much under the peculiar conditions of their imprisonment. The introduction of food would, moreover, have resulted in the accumulation of decayed matter among the rock-weed, doing more harm than good.

The total number of lobsters packed in the one hundred trays was 610, of which 250 were males and 360 females, eight of the latter having spawn attached to the swimmerets. In size they ranged mainly from 8 to 12 inches in length, a few only being slightly over 12 inches long. About one-half were under 10 inches long, and one-half over 10 inches. Four lobsters were also placed in a large tin pail with a small amount of rock-weed, and carried in the ice box.

In addition to the lobsters, about 150,000 loose eggs cut from the swimmerets were

arranged on twelve small cloth-bottom trays, which were tied together in one package and stored in the ice-box close by the ice, being sprinkled twice daily with salt-water during the trip. The eight egg lobsters mentioned above died before reaching San Francisco, and their eggs were taken from them and added to those on the trays, making about 196,000 loose eggs that were carried across.

On the evening of June 15, the day on which the car reached Wood's Holl, a quantity of ice was placed in the carrying tanks to reduce its temperature. The first of the trays were packed in the tanks about noon on the 16th, but by that time the temperature was not as low as was desired. The second and final lot of trays was placed in the tanks about the middle of the afternoon of the same day. Fifty trays were arranged on each side of the car in piles of two and three, open spaces being left at the ends and in the middle of the tanks for the storage of ice. These spaces were completely filled with ice, and several thermometers were inserted at different places to record the temperature. The covers to the tanks were then lowered, and were only opened thereafter for the purposes of inspection or for wetting the lobsters. The tanks, however, received some ventilation from the ends, especially when the car was in motion.

The following necessary supplies were taken along: About 200 gallons of sea-water that had been filtered through raw cotton to remove all impurities. It was contained in twelve acid carboys and two large milk-cans, and remained pure to the end of the journey. A large quantity of coarse salt for making a freezing mixture with the ice, and also for preparing a brine to be used upon the lobsters in case the supply of sea-water became exhausted. The refrigerator was filled with ice before starting, and this necessary commodity had to be replenished at frequent intervals during the journey.

Mr. John Jansen, of the Fish Commission station at Wood's Holl, whose long experience in the handling of lobsters made his services invaluable in that particular, was detailed to accompany the car to San Francisco. The writer also made the journey as far as Chicago. The shipment was in charge of Mr. J. F. Ellis, assisted by Mr. R. S. Johnson and Mr. J. D. Trenholm, and to their unremitting labors is due the success of the undertaking.

All the arrangements having been completed in time, the car left Wood's Holl with the 4.10 p. m. train for Boston, where it arrived about 7.30 p. m. At Boston the car was attached to the Chicago express leaving at 9 p. m., and proceeding via the Boston and Albany, New York Central, Lake Shore and Michigan Southern Railroads. At the time of departure everything seemed auspicious, although the weather was rather warm. The lobsters had been thoroughly sprinkled with water just before leaving Wood's Holl. There appeared to be an abundance of ice in the tanks, but no salt was mixed with it, as it was thought that the temperature could be kept sufficiently low without its use. This proved to be not the case, however. The bottom of the carrying tanks being only a few inches above the bed of the railroad, which had been greatly heated during the day, was too much influenced by the temperature outside, especially as some of the superheated air entered through the ends of the tanks in the manner already explained.

The first inspection of the lobsters was made immediately after breakfast on the morning of June 17, between Syracuse and Rochester, New York. It occupied about two hours, a much longer time than had been anticipated, and the fact was soon recognized that the overhauling had been left until too late in the day, on account of

the extreme heat the thermometer already recording over 80° Fahr. in the shady parts of the car. Subsequently all examinations were begun at day-break, and the tanks were never opened later in the day excepting to add water, ice, or salt.

About half a dozen trays were lifted out at a time, that being the number stored in each compartment, the rock-weed was partly removed, and each lobster was examined to ascertain its condition. The dead lobsters were removed, the rock-weed was replaced, and the trays were sprinkled with water and returned to the tanks as rapidly as possible. The water used for moistening the trays on this and all subsequent occasions was first kept in the ice-chest for several hours in order to reduce its temperature to near the freezing-point of fresh water. It was exceedingly interesting to note its revivifying effect upon the lobsters, which seemed to recognize instinctively their native element even though it was doled out to them in such small quantities. Some of the lobsters which appeared to be lifeless on a first examination were entirely restored by plunging them into the nearly ice-cold sea-water and allowing them to remain there several minutes. The wetting of the trays was done by means of an ordinary garden sprinkler, and although the precise quantity of water used on each tray was not measured, the supply was so apportioned that there was no danger of its becoming exhausted before the end of the journey. In order also that the water might reach as far as possible, the trays were generally returned to the tanks before wetting, so that the drippings from the upper ones might serve to moisten the lower ones. The two wettings a day were sufficient to maintain the rock-weed constantly moist, and it remained sweet and fresh during the entire trip.

At the first inspection, the mortality was found to be forty-five lobsters, of which twenty-two were males and twenty-three females; twenty-four were under 10 inches long and twenty-one over 10 inches,—showing that the mortality was about equally distributed with respect to sex and size. This high death-rate—between 7 and 8 per cent. of the entire number—was undoubtedly due directly to the high temperature of the tanks during the night. No salt had been used upon the ice, it being supposed that the large quantity of ice employed was sufficient to bring the temperature down to about 45°, when, in fact, it never fell below 50°, and was sometimes as high as 60°. Judging from subsequent inspections, however, it is certain that the heat alone can not be held accountable for the heavy losses which occurred from day to day. The condition of the lobsters, moreover, furnishes sufficient proof of this. All the dead lobsters taken out on the first two days were carefully examined, and there is no doubt that a large percentage of them were far advanced toward shedding, the new shell in some being fully formed and of the dark color which it assumes just before the old shell breaks away. Of the twenty-three females which died the first night fourteen also showed traces of recently hatched eggs, and it is now generally considered by naturalists that the crustacea molt soon after losing their spawn. Lobsters about to shed are always regarded by the fishermen as in poor condition for the market, as they will not stand handling. The great mortality on the present trip was therefore probably due primarily to the weak condition of the lobsters, although at the time of packing they were certainly very hardy in appearance. It would, moreover, be impossible to obtain a better supply at this season of the year, and future shipment should preferably be made in the spring or fall. Some deaths also occurred among the lobsters which were in contact with the ice or close to it, due probably to the

intense cold, although the fresh water formed by the melting of the ice may have had something to do with it. However, the less hardy individuals were weeded out during the journey, and those which survived at San Francisco were in excellent condition for planting.

It was found to be injudicious to attempt the taking of frequent temperature observations in the tanks, for every time the tanks were opened the temperature was sensibly increased. Before closing them on the morning of June 17 large quantities of salt were thrown among the powdered ice. At Buffalo, which was reached about noon on the same day, the temperature was 48° in the bottom of the tanks and 65° at the top. More ice and salt were added at Buffalo and Cleveland, and the ice was broken into much finer pieces than before. At 8 p. m. the trays were again thoroughly sprinkled with water at 32°, and three dead lobsters were removed from the upper tiers.

On the morning of June 18 the second inspection was made between 4 and 6 a. m., and the mortality was found to have been greater than on the first day. The total number of dead lobsters was fifty-four, as follows: Under 10 inches long, thirty-four; 10 inches long and over, twenty; males, twenty-four; females, thirty. The condition of this lot with respect to shedding was the same as the previous one. The temperature in the bottom of the tanks had, however, been lowered to 44°, and the live lobsters remaining seemed to be in much better shape than on the day before. They were more active, and, after receiving a thorough wetting, appeared not to have suffered from the journey.

At Chicago a much larger supply of ice than usual was procured, and every large interspace between the trays was closely packed with small pieces mixed with salt. Several pieces of galvanized sheet-iron were also obtained, and being laid upon the upper trays were covered with ice and salt. The four lobsters carried in the ice-chest were still alive, although they had received only one bath of sea-water since leaving Wood's Holl, and the loose eggs on the cloth trays had apparently suffered no injury up to this time. The writer left the car at Chicago and returned to Washington.

From Chicago the car proceeded to Omaha and thence by the fast express on the Union Pacific Railroad to Oakland, California, where it arrived June 23. On the morning of June 19 only forty dead lobsters were found, and the thermometers placed in the upper trays registered 42°. From this time forward no difficulty was experienced in maintaining the temperature of the tanks at between 40° and 42°, the sheet-iron covers furnishing the means of reducing the temperature around the upper trays.

Near Rawlins, Wyoming, June 20, forty-six dead lobsters were removed, the thermometers registering 40°. When the tanks were opened, near Elko, Nevada, June 21, thirty-nine dead lobsters were found, the temperature being 42°. The car reached Sacramento in the evening of June 22, and was met there by Mr. J. D. Redding and Dr. H. M. Harkness, of San Francisco, both of whom were much interested in the success of the experiment.

The disposition of the lobsters was left to the discretion of Prof. Leslie A. Lee, naturalist, and Lieut. Commander Z. L. Tanner, U. S. Navy, commander of the Fish Commission steamer *Albatross*, then at San Francisco, who were to act in conjunction with Mr. Redding in the matter. By direction of Captain Tanner, observations were

made at several places in San Francisco Bay, to determine the salinity of the water. The results reduced to 60° Fahr., according to the Hubbard table, were as follows:

Locality.	Density at surface.	Density at bottom.
One-fourth mile west of Yerba Buena Island.....	1. 019887	1. 021487
One-fourth mile west southwest of Saucilito Wharf.....	1. 019887	1. 021487
One-eighth mile off Yellow Bluff.....	1. 018687	1. 021687
One-fourth mile south by west of Alontraz Island.....	1. 019887	1. 021487

The average specific gravity of the water of the ocean being about 1.0274, it was decided, leaving the impurities of these localities out of consideration, that the low salinity of the water alone would not warrant the planting of the lobsters in the bay, and that some other place must be selected. The neighborhood of Monterey appeared to offer good advantages for the purpose, and the car, after going to Oakland, was, therefore, dispatched to that place, where it arrived on the evening of June 23, just seven days after leaving Wood's Holl. After leaving Elko, Nevada, fifty-five lobsters had died, making a total loss of two hundred and eighty-two lobsters during the trip. The number remaining on hand was three hundred and thirty-two, and all seemed to be in good condition. Of the 196,000 loose eggs carried on the trays, it was estimated that about 75 per cent. were also in fair shape, only those on the two or three upper trays having died.

It had been intended to place all the lobsters in floating cars for a few days' time before consigning them to the ocean, in order to make sure of their condition, but as these commodities of the Eastern fishermen were unknown in the vicinity of Monterey, none had been provided, and it was considered prudent to plant a part of the shipment without delay. On the evening of arrival, therefore, one hundred and sixty-two lobsters were taken out in a fisherman's boat and dropped into the sea, about three-fourths of a mile off shore, between Pacific Grove and Chinatown, in a depth of 12 fathoms, rocky bottom. Observations made at the same time showed the temperature of the water to be 64°, and its density about 1.025. The remaining lobsters, one hundred and seventy in number, were placed the same evening in several boxes that were floated in the bay. The next day Mr. Ellis had a car constructed, measuring 12 feet long, by 6 feet wide, and 3 feet deep, and to this the lobsters were then transferred. A second plant of ninety-five lobsters was made July 1, 1 mile off Point Lobos, to the south of Carmel Bay, in a depth of 30 fathoms, rocky bottom. Only two had died since they were taken from the railroad car, the remainder being active and feeding well. Seventy-three lobsters were, therefore, left in the car, and of these it had been arranged to send fifty of the best and most hardy by the steamer *Albatross* to the northern part of the California coast. An attempt was made to remove these from the car July 4, while it was still floating, but the lobsters were so active as to elude all efforts with the dip-net. The car was then hauled part way out on the beach, but a heavy swell carried away one of the bottom boards, and through the opening thus formed the lobsters began to beat a hasty and unceremonious retreat. Only thirty were captured, the balance making for the deeper water and getting safely away to sea. Their actions forcibly demonstrated the fact that they were in the very best condition for planting, and their escape at this place can not be regarded as a mishap, although it was somewhat tantalizing to have them assume the initiative.

The *Albatross* left San Francisco July 4, with the thirty lobsters, of which thirteen were males and seventeen females. They were planted the next day in 13 fathoms of water, $1\frac{1}{2}$ miles S. $\frac{3}{4}$ W. (magnetic) from Trinidad light-house, California, (about 41° north latitude). They were all active but one. The place was selected on the recommendation of Prof. George Davidson, who considered that the conditions of the natural home of the lobster were more nearly realized here than elsewhere on the California Coast. The shore is bold and rocky, the bottom consisting of alternating kelp-covered ledges and sandy patches, and the water being very pure.

The loose eggs were transferred to hatching boxes June 24; they began hatching slowly June 28, and more rapidly July 2. Operations ceased July 7, up to which time 104,000 embryos had been obtained. They were planted in seven lots, as explained below, off Monterey, in Monterey Bay, and in San Francisco Bay, only 2,000 going to the last mentioned locality.

SUMMARY OF RESULTS.

Of the six hundred and fourteen lobsters with which the car left Wood's Holl, June 16, three hundred and thirty-two were carried through safely, two hundred and eighty-two dying on the way. After arriving at Monterey the casualties amounted to only two or three.

One hundred and sixty-two lobsters were planted June 23, directly off Pacific Grove, Monterey.

Ninety-five lobsters were planted July 1, off Point Lobos, to the south of Carmel Bay.

Forty-five lobsters escaped from the floating car, July 4, in Monterey Bay.

Thirty lobsters were planted by the steamer *Albatross*, July 5, off Trinidad light-house on the northern part of the California coast.

One hundred and ninety-six thousand loose eggs were carried across, affording 104,000 embryos, which were planted between July 1 and 7, as explained in the following table:

Deposits of lobster embryos.

Body of water.	Point of deposit.	No. planted.	Condition.	Date of deposit.
Monterey Bay.....	Off Monterey, California.....	1,000	Good.....	July 1.
Pacific Ocean.....	.....do.....	18,000	...do.....	July 2.
Do.....	.....do.....	20,000	...do.....	July 3.
San Francisco Bay.....	Off San Francisco, California.....	2,000	...do.....	July 4.
Pacific Ocean.....	Off Monterey, California.....	25,000	...do.....	July 5.
Do.....	.....do.....	30,000	...do.....	July 6.
Monterey Bay.....	.....do.....	8,000	...do.....	July 7.
		104,000		

This first successful large shipment of lobsters across the continent elicited many favorable comments from the press, especially in California. The desirability of making the attempt to establish this useful food species on the Pacific coast was acknowledged by all, and only a few ventured to criticise, in advance, the methods to be pursued in caring for the lobsters. It is now considered, however, that the manner of packing followed in the present case can scarcely be improved upon. The proper

regulation of the temperature still presents a difficult problem for experimentation, and, as shown further on, too low a temperature is as much to be dreaded as too high a one. A solution may be found, however, by making the shipments in the spring or autumn.

THE RETURN TRIP.

Arrangements were made through Prof. Leslie A. Lee, of the steamer *Albatross*, to transport a quantity of the large edible California crab (*Cancer magister*) and also of one or more species of California clams to the Atlantic coast, the former species especially being regarded as a desirable one for introduction in New England waters. Much difficulty was experienced in procuring the crabs, as it was not then the season in which they are generally brought to market. A lot of three hundred was finally obtained, however, from one of the fishermen, but the specimens were not in good condition, having been kept too long before they were delivered at the car. They were packed in the crates from which the lobsters had been taken, the rock-weed for the packing and the sea-water for the journey having been collected at a point outside of San Francisco Bay. The car left San Francisco for the East July 14, via the Central Pacific Railroad, with a full load, as follows: Three hundred crabs, 15 bushels of clams, six California terrapin, fourteen Galapagos tortoises, and several cases of specimens obtained on a recent cruise of the steamer *Albatross*. July 15, Mr. Ellis telegraphed from Truckee California, that all the crabs except forty had died. Such a result was not unexpected, in view of their condition when received; but with this report the experiment ended, for on the next morning, at about 5 o'clock, the train to which the Fish Commission car was attached was badly wrecked, some 5 miles east of Humboldt, Nevada, car No. 3 being thrown upon its side and dragged some distance. The contents of the car were scattered over the ground, and the car itself was in no condition to continue the journey. Mr. Jansen was severely injured, but the other occupants escaped with only bruises and a thorough shaking up. The Galapagos tortoises and the *Albatross* collections suffered comparatively little damage, and were subsequently brought to Washington on the same car.

THE FIFTH TRIAL—JANUARY, 1889.

The fifth and last trial so far attempted was made during January, 1889, with the same methods followed the previous summer. The destination of the shipment was the coasts of Oregon and Washington, by way of the Northern Pacific Railroad. Car No. 3 was again selected for the work, being in charge, as before, of Mr. J. F. Ellis, assisted by Mr. R. S. Johnson and Mr. Trenholm. The shipment consisted of seven hundred and ten lobsters, as follows: Males, two hundred and seventy-nine; females, with eggs, sixty-three; females without eggs, three hundred and sixty-eight. The crates were made in the same manner and of the same size as on the previous trip, an additional number being required, however, to accommodate the extra quantity of lobsters taken. The car tanks were filled to the very tops, and it is probable that they were over-crowded, preventing a sufficient circulation of air. One hundred and seventy gallons of sea-water were provided in ten carboys, and this quantity met all demands.

The packing was done at Wood's Holl, Massachusetts, January 14, and the car left at 4 p. m. the same afternoon, the thermometer registering 38° at the bottom of

the tanks and 48° at the top. Leaving Boston at 9 p. m., the weather grew cold during the night, the thermometer falling to about 20°, the temperature in the tanks reaching 36° at the bottom and 42° at the top. Albany was reached at 4 a. m., January 15, and at 8 a. m. the lobsters were overhauled; this operation requiring three hours. Only two females and one male had died during the night. The temperature in the tanks during this day ranged from 37° to 40° at the bottom, and from 41° to 48° at the top.

The car left Chicago at 6.50 a. m. on the 16th, the examination of the lobsters taking place about two hours later. Eleven were found dead, seven being males and four females. The temperature in the tanks during the day varied from 37° to 47° at the bottom, and from 44° to 51° at the top. Up to this time the prospects were exceedingly encouraging, and it looked as though the trip would be made with only a very slight percentage of loss; but disappointment was ahead and it came in a manner entirely unexpected and unprovided for. The previous summer it had been necessary to fight the extreme heat, and it seemed as though the tanks could not be made too cold. On the present occasion, however, the conditions were precisely the reverse, and a very heavy mortality occurred through the low temperatures which prevailed during the middle part of the journey. In giving the temperatures observed from day to day in the tanks, it should be remembered that they are the readings of the thermometers in only a few positions, the temperature probably varying considerably in different parts of the tanks at the same time.

During the night of the 16th the weather grew colder, and some of the trays were taken from the tanks and placed on the floor of the car to warm them up. At 9.30 on the morning of the 17th the temperature of the air outside the car had fallen to 10° below zero, and at that time the trays were overhauled, with the result of finding fifty-five dead lobsters, thirty-seven being males and eighteen females. The trap-doors to the tanks were now left open for the purpose of raising the temperature about the trays, but with no appreciable effect. The car reached St. Paul, Minnesota, at 2 p. m. and left at 4 p. m. At 11.15 the same evening steam was turned into the pipes running through the bottom of the tanks, but the hot air instead of becoming diffused, rose to the top along certain parts of the tanks, superheating some portions and leaving others uninfluenced. A small amount of ice formed during the night on the sides of the tanks toward the wind. During the 17th the thermometer registered from 32° to 37° at the bottom and from 34° to 37° at the top of the tanks.

At 3 a. m., January 18, the temperature outside the car had fallen to 25° below zero. Steam was kept up all night and part of the day, the temperature ranging from 32° to 36° at the bottom of the tanks and from 49° to 52° at the top, this difference between the temperature at the top and bottom resulting from the steam heat. At 8 o'clock in the morning eighty-one dead lobsters were removed, forty-one being males and forty females.

January 19 the outside temperature had risen to 2° below zero, and no steam was used during the day. At 9 o'clock in the morning ninety-seven lobsters, fifty-three females and forty-four males, were found dead, and many of those still living were observed to be in poor condition. The temperature at the bottom of the tanks ranged from 34° to 38°, and at the top from 48° to 52°.

January 20 there was an abundance of snow and the weather was still cold. At

10 a. m., when the trays were overhauled, one hundred and thirteen dead lobsters were discovered, fifty-nine of this number being females and fifty-four males. The car arrived at Spokane Falls at 10.10 a. m., and remained there until 7.10 p. m. About twelve hours were also lost beyond Spokane Falls on account of damage to the railroad track. The temperature during the day ranged from 35° to 38° at the bottom, and from 44° to 47° at the top of the tanks.

January 21 the car arrived at Walla Walla Junction at 10 a. m., the weather being warmer than on the previous day. The number of dead lobsters removed was seventy-six, sixty-one being females and fifteen males. The live lobsters were here re-assorted in the trays, on an average two males and four females being placed in each, to facilitate the handling at the end of the journey. East Portland was reached at 7 p. m. Mr. R. A. Bensell was to meet the car at this place and take charge of a part of the shipment intended for Yaquina Bay, Oregon, but as he did not appear, and delay might be fatal to the balance of the stock, the car was taken on to Portland, where Mr. Johnson was left with twenty-two trays, containing one hundred and ten lobsters, as follows: thirty-two males, twenty-five females with eggs, and fifty-three females without eggs. These were planted, in part, off Cape Disappointment, at the mouth of the Columbia River, and, in part, about 7 miles farther north in Shoalwater Bay.

The car arriving at Tacoma the same day, Mr. Trenholm, together with Judge James G. Swan, who had made arrangements for the northern planting, left at 7 a. m. on the morning of the 22d with the balance of the lot for Port Townsend by steamer. From the latter place the following deposits were made the same afternoon, namely: In Scow Bay, opposite Port Townsend, twenty-four lobsters; off Point Hudson, at the entrance of Port Townsend Bay, twenty-five lobsters; off Wilson's Point, three-fourths of a mile from the light-house, near Port Townsend, seventy-four lobsters, a total of one hundred and twenty-three lobsters. The temperature of the water was 45° Fahr. According to Judge Swan, the summer temperatures in this region range from 50° to 55° Fahr. The places selected for making the plants were rocky and gravelly bottoms, covered with kelp and rock-weed, and with an abundance of animal life.

Nine females with eggs had died on the way over. Their eggs were saved and were deposited in Puget Sound, there being no facilities for hatching them, and the season also being unfavorable for their development.

RÉSUMÉ OF THE TRIP.

Car No. 3 left Wood's Holl, Massachusetts, January 14, 1889, with seven hundred and ten lobsters, destined for the coasts of Washington and Oregon. The trip was made via the Northern Pacific Railroad in seven days, the plants being made on the eighth day after leaving Wood's Holl, namely, January 22. On account of the failure of Mr. Bensell to meet the car at Portland it was impossible to make the proposed planting on the central part of the Oregon coast, but a small number were left at the mouth of the Columbia River, on the north side. The condition of all the lobsters planted was reported good. The results of the shipment are summarized in the following table:

Results of the fifth shipment of lobsters to the Pacific coast.

	Total No. of lobsters.	No. of males.	No. of Females.	Females with spawn.	Females without spawn.
Lobsters taken on board at Wood's Holl	710	279	431	63	368
Lobsters lost during the trip	477	207	270	9	261
Lobsters carried safely through and planted on the coast of Washington	233	72	161	54	107
Plant made—					
Off Cape Disappointment	88	25	63		
In Shoalwater Bay	22	7	15		
In Scow Bay, Puget Sound	24	8	16		
Off Hudson's Point, Puget Sound	25	8	17		
Off Wilson's Point, Puget Sound	74	24	50		

Recapitulation of the five shipments.

Number and date of shipments.	No. of Lobsters taken.	No. of Lobsters lost during journey.	No. of Lobsters planted.	Place of deposit.
First, June, 1873	162	162		
Second, June, 1874	150	146	4	California.
Third, June, 1879	22	1	21	Do.
Fourth, June, 1888*	614	232	332	Do.
Fifth, January, 1889	710	477	233	Washington.
Total	1,658	1,008	590	

* Also, 102,000 embryos planted off Monterey, and 2,000 in San Francisco Bay.

