The Commonwealth of Massachusetts.

A REPORT

UPON

THE MOLLUSK FISHERIES

OF

MASSACHUSETTS.

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APPROVED BY

THE STATE BOARD OF PUBLICATION.

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COMMISSIONERS ON FISHERIES AND GAME,
STATE HOUSE, BOSTON, Jan. 15, 1909.

To the Honorable Senate and House of Representatives.

We herewith transmit a special report upon the mollusk fisheries of Massachusetts, as ordered by chapter 49, Resolves of 1905, relative to scallops; chapter 73, Resolves of 1905, relative to oysters; chapter 78, Resolves of 1905, relative to quahaugs; and chapter 93, Resolves of 1905, relative to clams.

Respectfully submitted,

G. W. FIELD,
Chairman.

REPORT ON THE MOLLUSK FISHERIES OF MASSACHUSETTS.

Introduction.

The general plan of the work was outlined by the chairman of the Commission on Fisheries and Game, who has given attention to such details as checking up scientific data, editing, revising, and confirming results, reports, etc. The work has been under the direct charge and personal supervision of the biologist to the commission, Mr. D. L. Belding. The able services of Prof. J. L. Kellogg of Williams College were early enlisted, and many valuable results which we are able to offer are the direct outcome of the practical application of the minute details discovered by Professor Kellogg in his careful study and original investigations of the anatomy and life histories of the lamellibranch mollusks.

Of the other workers who, under the direction of Mr. Belding, have contributed directly, special mention should be made of Mr. J. R. Stevenson of Williams College, W. G. Vinal of Harvard University, F. C. Lane of Boston University, A. A. Perkins of Ipswich and C. L. Savery of Marion. Those who have for a briefer time been identified with the work are R. L. Buffum, W. H. Gates and K. B. Coulter of Williams College, and Anson Handy of Harvard University.

In addition to the results here given, much valuable knowledge has been acquired, particularly upon the life histories of the scallop and of the quahaug, and the practical application of this knowledge to the pursuit of sea farming. It is hoped that the commission will later be enabled to publish these results.

The present report is limited to a statement of the condition of the shellfish in each section of our coast, and to consideration of practical methods for securing increased opportunities for food and livelihood by better utilization of naturally productive lands under water. Since the chief purpose of legislative action under which this work was undertaken was to ascertain how the best economic results could be secured, we have thought it wise to embody the results of our investigation in a plan which is suggested as a basis for appropriate legislation for making possible a suitable system of shellfish cultivation similar to that which already exists in Rhode Island, Connecticut and many other coast States, and which has been carried on for more than two thousand years on the shores of the Mediterranean Sea.

The following tentative outlines are offered, and it is intended to subject each topic to an unprejudiced examination and discussion: —

A Proposed System of Culture for the Tidal Flats and Waters of Massachusetts.

The Purpose. — The proposed system of shellfish culture aims to develop the latent wealth of the tidal waters, to increase the output of tidal flats already productive, and to make possible the reclamation of large portions of the waste shore areas of our Commonwealth. It is further designed to foster dependent and allied industries; to extend the shellfish market, both wholesale and retail; to multiply opportunities for the transient visitors and shore cottagers to fish for clams and quahaugs for family use, and to ensure fishermen a reliable source of bait supply; to increase the earnings of the shore fishermen, and to furnish work to thousands of unemployed; to increase the value of shore property; to add to the taxable property of the shore towns and cities of the State; to secure to all the citizens of the State a proper return from an unutilized State asset; to furnish the consuming public with a greater quantity of sea food of guaranteed purity; and in every way, both in the utilization of present and in the creation of new resources to build up and develop the fast-declining shellfish industries of the Commonwealth.

Private v. Public Ownership of Tidal Flats. — The first difficulty confronting this proposed system is the too frequently accepted fallacy that all lands between the tide marks now are and should be held in common by the inhabitants of the shore communities, to the exclusion of citizens from other sections of the State, — an assumption which is directly contrary to the more ancient law, supported by decisions of the highest courts, that the right of taking shellfish is a public right, freely open to any inhabitant of the State. Such unwarranted assumption of exclusive rights in the shellfisheries by individuals, corporations or towns sacrifices the rights of the majority. The disastrous effect of this policy is plainly demonstrated in the history of the rise and decline of the shellfisheries of Massachusetts.

Secondly, this fallacious assumption is contrary to the fundamental principles of all economic doctrines. It may be safely affirmed that the individual ownership of property has proved not only a success but even is a necessary condition of progress, and has in fact at length become the foundation of all society. It inevitably follows that if the system is justifiable in the case of farm lands it is equally justifiable in the case of the tidal flats, for the same principle is involved in each. It is therefore fair to assume that if private ownership of farm land has proved to be for the best interests of human progress, so private ownership of the tidal flats will also be a benefit to the public.

It is not our purpose to discuss the underlying principle involved in private ownership of property, — it is simply our purpose to call attention to two facts: (1) if individual control of real estate is just, private ownership of tidal flats and waters is likewise just; (2) that individual control of such areas is the only practical system yet devised capable of checking the alarming decline in the shellfisheries and of developing them to a normal state of productiveness, and rendering unnecessary an annually increasing mass of restrictive legislation.

The Present System. — The present system of controlling the shellfisheries is based on the communal ownership of the tidal flats. Ownership by the Commonwealth has degenerated into a system of town control, whereby every coast community has entire jurisdiction over its shellfisheries, to the practical exclusion of citizens of all other towns. Thus at the present time the mollusk fisheries of Massachusetts are divided into a number of separate and disorganized units, which are incapable of working together for the best interests of the towns or of the public. This communistic system is distinctly unsound, and is in direct opposition to the principles of social and economic development. The man who advocates keeping farm lands untilled and in common, for the sake of the few wild blackberries they might produce, would be considered mentally unbalanced; but it is precisely this system which holds sway over our relatively richer sea gardens. With no thought of seed time, but only of harvest, the fertile tidal flats are yearly divested of their fast-decreasing output by reckless and ruthless exploitation, and valuable territories when once exhausted are allowed to become barren. All hopes for the morrow are sacrificed to the clamorous demands of the present. The more the supply decreases, the more insistent becomes the demand; and the greater the demand, the more relentless grows the campaign of spoliation. The entire shore front of the Commonwealth is scoured and combed by irresponsible aliens and by exemplars of the "submerged tenth" who are now but despoilers, but who if opportunity were present might become cultivators of the flats rather than devastators. The thoughtful fisherman, who would control the industry in a measure, is under present conditions overruled by his selfish or short-sighted fellow workers, and is of necessity forced to join their ranks by the clinching argument that if the shellfisheries are to be ruined anyway, he might as well have his share as long as they last. The theory of public ownership of shellfisheries has been weighed in the balance and found wanting. The necessity for some radical change in the present system is becoming more and more apparent, and a system of private control, with certain modifications, is the logical result.

Need of Reform. — The shellfish supply of Massachusetts is steadily declining. So extensive is this decline that it is unnecessary to mention the abundant proofs of almost complete exhaustion in certain localities and of failing output in others. While the apparent cause of this decrease is overfishing and unsystematic digging, the real cause can be readily traced to the present defective system of town control, which has made possible, through inefficiency and neglect, the deplorable condition of this important industry. Unless the decline is at once checked, within a very few years our valuable shellfisheries will be exhausted to the point of commercial extinction. The legislation of former years, essentially restrictive and prohibitory in character, has unfortunately been constructed on a false economic basis. Its aim has been to protect these industries by restricting the demand rather than by increasing the supply. What the future requires is not merely protective or restrictive legislation, but rather constructive laws for developing the shellfisheries. The system of shellfish culture here presented appears to be the only practical method for improving the condition of these industries in such a way as to protect all vested interests of both private and public rights, and at the same time to make possible adequate utilization of the natural productive capacity.

In brief, the proposed system of shellfish culture is based upon a system of leases to individuals. These leases should be divided into two classes: (1) those covering the territory between the tide lines, and consisting of small areas, from 1 to 2 acres; (2) the territory below low-water mark, comprised of two classes of grants, which differ only in size and distance from the shore, — the smaller (*a*), from 1 to 5 acres, to include the shore waters, small bays and inlets, and the larger (*b*), of unrestricted size, to be given in the deeper and more exposed waters. The owners of all grants shall be permitted to plant and grow all species of shellfish, and shall have exclusive control of the fisheries area covered by such lease. The large and more exposed grants, which cannot be economically worked without considerable capital, should be available for companies; while the smaller holdings, for which but small capital is required, are restricted to the use of the individual shore fishermen. For the tidal flats and shore waters but one-half of the whole territory in any one township shall be leased, the other half still remaining public property.

Success of this System. — The system of private control by leased grants is by no means a new and untried theory. In actual operation for many years in this and other States, in spite of lack of protection and other drawbacks which would be eliminated from a perfected system, it has proved an unqualified success. The rapid depletion and even extermination of the native oyster beds necessitated legislative consideration, and for years the oyster industry above and below low-water mark in this and other States has been dealt with by a similar system. The plan here suggested would be but a direct extension of a well-tested principle towards the cultivation of other species of mollusks. The financial value to the fishermen of such a step has been proved beyond all question in this State during the past three years by the demonstrations of the Massachusetts department of fisheries and game. These experiments have proved that tidal flats, with small outlay of capital and labor, will yield, acre for acre, a far more valuable harvest than any upland garden.

This system has the further element of success by being based on individual effort, in contrast to the present communal regulation of shellfisheries. In all business individual initiative and effort furnish the keynote of success, and the future wellfare of the shellfisheries depends upon the application of this principle.

Nature cannot without the aid and co-operation of man repair the ill-advised, untimely and exhaustive inroads made in her resources. This is shown in the thousands of acres of good farm lands made unproductive by unwise treatment, and by the wasteful destruction of our forests. It is as strikingly shown in the decline of our shellfisheries. The fisherman exhausts the wealth of the flats by destroying both young and adults, and returns nothing. The result is decrease and ultimate extermination. The farmer prepares his land carefully and intelligently, plants his seed and in due time reaps a harvest. If the fisherman could have similar rights over the tidal areas, he could with far less labor and capital and with far greater certainty year by year reap a continuous harvest at all seasons. The success of the leasing system in other States, notably Louisiana, Rhode Island and others, is definite and conspicuous.

The Obstacles to this Proposed System. — Before the proposed system of titles to shellfish ground can be put in actual operation, it is absolutely necessary to have all rights and special privileges pertaining to shore areas revested in State control by repeal of certain laws. In this centralization of authority four main factors must be carefully considered: (1) communal rights to fisheries in tidal areas, as in the colonial beach law of 1641-47; (2) the theory, practice and results of town supervision and control; (3) the rights of riparian owners; (4) the rights of the fishermen and of all other inhabitants of the State. So important are all four that it is necessary to discuss each in turn.

(1) *Communal Fishery Rights of the Public.* — The fundamental principle upon which the shellfish laws of the State are founded is the so-called beach or free fishing right of the public. While in other States shore property extends only to mean high water, in Massachusetts, Maine and Virginia, the earliest States to enact colonial laws, the riparian property holders own to mean low-water mark. But by specific exception and according to further provisions of this same ancient law the right of fishing (which includes the shellfisheries) below high-water mark is free to any inhabitant of the Commonwealth. The act reads as follows: —

> SECTION 2. Every inhabitant who is an householder shall have free fishing and fowling in any great ponds, bays, coves and rivers, so far as the sea ebbs and flows within the precincts of the town where they dwell, unless the freemen of the same town or the General Court have otherwise appropriated them.

It is necessary that some change be made in this law, which at present offers no protection to the planters. Its repeal is by no means necessary, as the matter can be adjusted by merely adding "except for the taking of mollusks from the areas set apart and leased for the cultivation of mollusks."

(2) *Results of Town Administration of Mollusk Fisheries.* — All authority to control mollusk privileges was originally vested in the State. The towns, as the ancient statutes will show, derived this authority from the higher State authority, developed their systems of local regulations or by-laws only with the State permission, and even now they enjoy the fruits of these concessions solely with the active consent of the Legislature. Thus the State has ever been, and is at present, the source of town control. The towns have no rights of supervision and control over shellfisheries except as derived from the General Court.

The State gave them this authority in the beginning. It follows, therefore, that the Legislature can withdraw this delegated authority at any time when it is convinced that it is for the benefit of the State so to do. To those few who are directly profiting at the expense of the many, this resumption of authority by the State may seem at first sight a high-handed proceeding, but a brief survey of the facts will prove it to be justly warranted and eminently desirable. The present system of town control has had a sufficient trial. It is in its very essentials an unbusiness-like proceeding. A large number of towns acting in this matter as disorganized units working independently of one another could not in the nature of things evolve any co-ordinated and unified system which would be to the advantage of all. The problems involved are too complicated, requiring both broad and special knowledge, which cannot be acquired in a short term of experience. Lastly, the temptations of local politics have been found to be too insistent to guarantee completely fair allotment of valuable privileges.

The Legislature has not only acted unwisely in allowing the towns in this respect thus to mismanage their affairs, but it has not fulfilled its duty to the Commonwealth as a whole. The Legislature has unwittingly delegated valuable sources of wealth and revenue, the fruits of which should have been enjoyed at least in some degree, directly or indirectly, by all citizens of the Commonwealth alike as well as by those of the coast towns. Many of the coast cities and towns have dealt with this opportunity very unwisely, and few have developed or even maintained unimpaired this extremely valuable asset of the State. It cannot be too strongly emphasized that such important sources of wealth as the shellfisheries are not the property of the coast towns alone; they are the property of the whole Commonwealth, and the whole Commonwealth should share in these benefits. In allowing these valuable resources to be mismanaged and dissipated by the shore towns, the Legislature has done a great injury to all the inland communities, and, indeed, even to those very coast towns for whose benefit such legislation was enacted. The Legislature was not justified, in the first place, in granting jurisdiction over these important industries belonging equally to the whole Commonwealth and to the coast towns.

It was but an experiment. Inasmuch as these towns have grossly mismanaged the trust placed in them, the Legislature is doubly under the obligation to take advantage of the knowledge gained by this experimental delegation of the State authority to cities and towns. The completely obvious obligation of the Legislature is to remove what is either tacitly or frankly acknowledged by many city and town authorities to be an impossible burden upon the city or town, and to restore to State officers the general administrative control and supervision of the public rights in the shellfisheries.

(3) *Riparian Ownership does not include Exclusive Fishing Rights.* — The third objection is that in the assumption of State control is involved the much-discussed and vaguely understood question of riparian ownership. To make plain the conditions relative to the fisheries, including the shellfisheries on the tidal flats, it should be borne in mind that in only four States, Virginia and Maryland, Massachusetts and Maine, does the title of the riparian owner extend to low-water mark, but in these States the right of fishing, fowling and boating are specifically mentioned as not included in the title. Under the existing laws owners of seashore property in Massachusetts possess certain rights (though perhaps not in all cases clearly defined) over the tidal areas within 100 rods of the mean high-water mark. As the proposed system of shellfish grants deals with this territory between high and low water marks, it is necessary to see in what manner, if any, the rights at present possessed by riparian owners would be impaired by the leasing of certain rights of fishing. While the riparian owner has in a measure authority over the territory which borders his upland, there are certain specific limitations to this authority. He does not have exclusive rights of hunting, boating and fishing between the tide lines on his own property, but participates in these rights equally with every citizen of this Commonwealth. The courts have distinctly held that shellfish are fish, and that a man may fish — *i.e.*, dig clams — on the tidal flats adjoining the shore without the consent of the riparian owner.

(4) *Rights of the Fishermen and of All Citizens.* — The fishermen as a class are best located to benefit most from an opportunity to lease exclusive fishing rights, whether they chance

to be riparian owners or not, though every other citizen of this Commonwealth who so desired would not be excluded from an opportunity to secure a similar lease. The personnel of the fisher class has vastly changed in the past decade. There are to-day two distinct types: The permanent resident, usually native born, bound to a definite locality by ties of home and kin and of long association, — a most useful type of citizen. Contrasted with this is the other, a more rapidly increasing class, — foreign born, unnaturalized, nomadic, a humble soldier of fortune, a hanger-on in the outskirts of urban civilization, eking out an existence by selling or eating the shellfish from the public fishing grounds. Too ignorant to appreciate the importance of sanitary precaution, the alien clammer haunts the proscribed territory polluted by sewage, and does much to keep the dangerous typhoid germ in active circulation in the community.

The public mollusk fisheries only foster such types of non-producers, and prevent them from becoming desirable citizens. The best class of fishermen and citizens has no advantage over the worst, but is practically compelled to engage in the same sort of petty buccaneering and wilfully destructive digging, in order to prevent that portion and privilege of fishing which the law says shall belong to every householder and freeman of the Commonwealth from being appropriated by these humble freebooters, who are at once the annoyance, the terror and the despair of cottagers and shore dwellers.

All these conditions would be almost completely corrected by the lease of the flats to individuals, thus removing from the fishermen stultifying competition and compelling these irresponsible wandering aliens to acquire definite location. But most particularly a system of leasing would permit each person to profit according to his industry, perseverance, thrift and foresight.

The Grants. — As previously stated, the grants should be made into two divisions: (1) including suitable areas between the high and low water marks; (2) territory below mean low-water mark. The privilege of planting and growing all shellfish should be given for both classes of grants. Class 1 would be primarily for the planting of clams, with additional rights over oysters and quahaugs; class 2 would be primarily for the planting of quahaugs and oysters, with possible rights over clams and scallops.

The grants should be leased for a limited period of years, with the privilege of renewal provided the owner had fulfilled the stipulated requirements of the lease. In order, however, that these leases should not degenerate into deeds, to be handed down from father to son, it might be necessary to assign a maximum time limit during which a man might remain in control of any particular lease. This would be merely fair play to all concerned, for it would not be just to allow one man to monopolize a particularly fine piece of property, while his equally deserving neighbor had land of far less productive value. In connection with this clause should follow some provisions for payment of the value of improvements. Should there be more than one claimant for lease of any particular area, some principle of selection, such as priority of application, highest bid, etc., should be established.

That there may be no holding of grants for purposes other than those stipulated in the agreement, there should be a certain cultural standard of excellence to be decided upon relative to the use made of the granted areas. A clause of this kind is necessary in order to keep the system in a proper state of efficiency, and to insure the development of the shellfish industries.

All taxes on the capital invested in these grants and taxes upon the income should go to the town in which the leasehold is situated. In addition, there should be a just and equable revenue assessed by the State on every grant, as rent for the same. This rent should be apportioned according to a fixed scale in determining the relative values of the grants, and should be paid annually, under penalty of forfeiture. The revenue might be divided into two parts: one part to go to the State department having the control of the shellfisheries, for the maintenance of a survey, control and protection of property on leased areas, and other work; the second part to go to the town treasury of the community in which the grant is located, to be expended under the direction and control of responsible State officials in restocking barren flats and otherwise developing the shellfish upon its unleased territory which is open for free public use.

Grants to be Nontransferable. — These grants, while designed for the use of all citizens of the Commonwealth, should be made especially available for the poor man with little capital. In order to assure the poor man of the enjoyment of his privilege, it is necessary to guard against the possibility of undue monopolization. Leases must, therefore, be strictly nontransferable. Neither should areas be rented to another individual under any consideration whatever. Every grant must be for the benefit of its individual owner. He should be at liberty to hire laborers to assist him in working his grant, but not to transfer it in any way. Any attempt on his part to do so should not only immediately result in the forfeiture of his grant, but should also subject him to a heavy penalty.

Survey. — In order to guard against confusion and to maintain an orderly system, an accurate survey of all granted areas should be made. The ranges of every grant should be determined and recorded. The plots should be numbered and properly staked or buoyed, and a record of the same, giving the name of the owner, yearly rental and value, should be kept on file at the proper town and State offices. The same system which is now in operation in the oyster industry of other States should be applied to all the mollusk fisheries of Massachusetts.

Administration. — The department of the State government under whose jurisdiction this system of leases may come should be indued with full authority, properly defined, to supervise the grants, furnish them with adequate protection by the employment of State or town police, oversee the survey, allot the grants, and to exercise such other powers as may be necessary to develop the system, remedy its defects and strengthen its efficiency.

Protection of Property and of the Rights granted by the Lease. — No system of shellfish grants is possible without absolute protection. The lessee must be permitted to cultivate his grant free from outside interference, and thus, with reasonably good fortune, he can enjoy the fruits of his labors. This protection, which is the greatest and most vital need of the entire system, and the foundation upon which depends its whole success, must be insured by proper legislation rigorously enforced, and accompanied by severe penalties.

Leasing of the Grants. — Every citizen of the Commonwealth is entitled to participate in this system, but for obvious reasons an inhabitant of any coast town should be given first choice of grants within the boundary of his particular town. The first grants might be given by allotment, but after the system had become well established, they could be issued in the order of their application.

Water Pollution. — The sanitary condition of the marketed shellfish taken from contaminated waters is not only at present to some extent endangering the public health, but is placing an undeserved stigma upon a most reputable and valuable source of food supply for the public. The public should demand laws closing, after proper scientific investigation, these polluted areas, and conferring the power to thoroughly enforce such laws. The danger arising from contamination should be reduced to a minimum by prescribing some definite regulations for transferring shellfish from these polluted waters to places free from contamination, where the shellfish may in brief season be rendered fit for the market.

It should be unlawful to use any brand, label or other device for designation, intended to give the impression that certain oysters offered for sale were grown at specified places, *e.g.,* Cotuit, Wellfleet, Wareham, etc., unless such oysters were actually planted, grown or cultivated within the towns or waters designated, for a period of at least three months immediately previous to the date of marketing. Furthermore, there should be appointed proper inspectors, whose duties would be to guarantee by certificates, labels and stamps the purity of shellfish placed upon the market, and likewise have the power of enforcing severe penalties on violators.

THE SHELLFISHERIES OF MASSACHUSETTS: THEIR PRESENT CONDITION AND EXTENT.

By D. L. Belding, assisted by F. C. Lane.

Dr. George W. Field, *Chairman, Commission on Fisheries and Game.*

Sir: — I herewith submit the following report upon the present extent and condition of the shellfish industries of Massachusetts. The following biological survey was made in connection with the work done under chapters 49, 73, 78 and 93, Resolves of 1905, and chapter 74, Resolves of 1906. The statistics and survey records which furnish the basis of the report were obtained by D. L. Belding and F. C. Lane.

Respectfully submitted,

David L. Belding,
Biologist.

Introduction.

When money was first appropriated in 1905 for a three-year investigation of the life, habits and methods of culture of the clam, quahaug, oyster and scallop, provision was made for a survey of the present productive and non-productive areas suitable for the cultivation of these four shellfish. The following report embodies the results of this survey.

A. Method of Work. — In making this survey two objects were in view, which permit the grouping of the work under two main heads: —

(1) A survey of the productive and non-productive shellfish areas of the State was undertaken, showing by charts the location, extent and abundance of each of the four shellfish, as well as the biological conditions of the waters and soils of the areas along the entire coast which could be made more productive under proper cultural methods. Wherever possible, information as to the production of certain areas was obtained from the shellfishermen as a supplement to the survey work.

(2) Statistical records of the four shellfish industries were formulated, showing their value and extent as regards (*a*) production, (*b*) capital invested, (*c*) men employed. Data for these records were obtained from town records, from market reports and from the dealers and shellfishermen, both by personal interviews and by tabulated forms of printed questions. Owing to the present chaotic condition of the shellfisheries, it has been impossible to obtain absolutely exact data. The statistics that have been obtained are to all purposes correct, and are the most exact figures ever published on the subject.

B. Value of the Survey. — Before any reform measures of practical value can be advanced, accurate and comprehensive knowledge of the present shellfish situation in Massachusetts is absolutely essential.

Up to this time there have been only vague and inaccurate conjectures as to the value of the shellfisheries, and even the fisherman, outside his own district, has little knowledge of their extent and their economic possibilities. The consumer has far less knowledge. For the first time this problem of the Massachusetts shellfisheries has been approached from the point of view of the economic biologist. This survey is intended to present a concise yet detailed account of the present status of the shellfisheries of Massachusetts, and is therefore the first step towards the preservation of our shellfisheries by providing a workable basis for the restocking of the barren and unproductive areas. It is hoped that it will be of interest both to the fishermen and consumers.

C. Presentation of the Report. — The first part of the report presents the general results of the survey, *i.e.,* the present condition of the shellfisheries, while the second part deals directly with details of the survey. The report is divided into four parts, each shellfish being considered separately. Under each is grouped (1) the industry as a whole; (2) a statistical summary of the industry for the whole State; (3) the towns of the State and their individual industries. A series of charts showing the shellfish areas of the State makes clear the description of the survey.

Geographical Situation. — The peculiar geographical situation of Massachusetts renders possible the production of the four edible shellfish — clam, oyster, quahaug and scallop, — in great abundance. Cape Cod forms the dividing line between the northern and the southern fauna, which furnish the coast of Massachusetts with a diversity of molluscan life. Zoölogically, the Massachusetts coast is the point where the habitats of the northern (the soft clam, *Mya arenaria*) and the southern clam (the quahaug, hard clam or little neck, *Venus mercenaria*) overlap. Nature has favored Massachusetts with a coast indented with bays, estuaries and inlets which are especially adapted for the growth of marine food mollusks.

Former Natural Abundance. — If we compare the natural shellfish areas of to-day with those of former years, we find a great change. All four shellfish formerly throve in large numbers in the numerous bays and indentations of our coast line. The area between tide marks was formerly inhabited by quantities of soft clams, and the muddy patches just below low-water mark produced great numbers of quahaugs. In the estuaries were extensive natural oyster beds. On our shoals it was possible to gather many thousand bushels of scallops. Now thousands of acres once productive lie barren, and we have but a remnant of the former abundant yield.

Historical Wastefulness. — History tells us that the Pilgrims at Plymouth "sucked the abundance of the seas" and found health and wealth. But between the lines of history we can read a tale of wastefulness and prodigality with hardly a parallel, and to-day we find the natural heritage of the shellfisheries almost totally wasted through the careless indifference of our forefathers. Prof. James L. Kellogg, in the introduction to his "Notes on Marine Food Mollusks of Louisiana," gives the following excellent account of the exploiting of natural resources: —

As one looks over the record of the settling of this country, and notes how a continent was reclaimed from a state of nature, he can hardly fail to be impressed with the reckless wastefulness of his ancestors in their use of the treasures which nature, through eons of time, had been collecting. In thousands of cases, natural resources, which, carefully conserved, would have provided comfort and even luxury for generations of men, have been dissipated and destroyed with no substantial benefit to any one. They scattered our inheritance. Such knowledge dulls a feeling of gratitude that may be due to them for their many beneficent acts, — though the truth probably is that few of them ever had a thought of their descendants. Men seldom seem to have a weighty sense of responsibility toward others than those who immediately follow them. The history of the prodigality of our ancestors since their occupation of this great continent has not fully been written, — and it should be, in such a way that the present generation might know it; for sometimes it seems as if the present generation were as criminally careless of the natural resources that remain to it as were any of those that are gone. Perhaps it is hardly that. We have learned some wisdom from the past, because our attention has recently been drawn to the fact of the annihilation of several former sources of subsistence. Rapidly in America, in recent years, the struggle to obtain support for a family has become more severe to the wage earner. In thirty years the increasing fierceness of competition has resulted in a revolution of business methods. In every profession and in every line of business only the most capable are able to obtain what the mediocre received for their honest labor in the last generation.

But it is easier to condemn the past for its failures than to recognize and condemn those of our own generation. The average man really has a blind and unreasoning faith in his own time, and to laud only its successes is to be applauded as an optimist. In the present stage of our national life we certainly have no room for the pessimist, who is merely a dyspeptic faultfinder; nor for the optimist, who blinds his eyes to our faults and mistakes, and so fails to read their priceless lessons. Instead, our intelligence, as a race, has reached that degree of development which should give it the courage to consider "things as they are."

Considering things as they are, we must admit that we are not realizing our obligations to future generations in many of the ways in which we are misusing our natural resources. This waste is often deliberate, though usually due to the notion that nature's supplies, especially of living organisms, are limitless. The waste of 70 or 80 per cent. in lumbering the Oregon "big trees," and the clean sweep of the Louisiana pine, now in progress, is deliberately calculated destruction for present gain, — and the future may take care of itself. In making millionaires of a very few men, most of whom are still living, a large part of the lower peninsula of Michigan was made a hopeless desert. To "cut and come again" is not a part of the moral codes of such men. It seems to mean sacrifice; and yet they are woefully mistaken, even in that.

But most often, no doubt, the extinction of useful animals and plants,

> that we have so often witnessed, has been due to the ignorant assumption that, under any circumstances, the supply would last forever. This idea seems especially to prevail concerning marine food animals. The fact that the sea is vast might naturally give the impression that its inhabitants are numberless. . . . But when a natural food supply nears complete annihilation, men begin to think of the necessity of a method of artificial culture.[1]

Present Unimproved Resources. — In spite of the wastefulness of former generations, many areas can again be made to produce the normal yield if proper and adequate measures are promptly taken to restore to the flats, estuaries and bays of Massachusetts their normal productive capacity. In spite of the fact that some of the natural beds have entirely disappeared, either "fished out" or buried under the débris of civilization, and others are in imminent danger of becoming exhausted, Massachusetts still possesses a sufficient natural supply to restock most of these barren areas.

Possibilities of Development. — Opportunities for development are alluring. The shellfisheries could be increased, in these days of rapid transit and marketing facilities, into industries which would furnish steady employment for thousands of men and women, both directly and indirectly, resulting in a product valued at a minimum of $3,000,000 annually, with possibilities of indefinite expansion. At present the idea of marine farming attracts popular attention. The conditions are parallel to agriculture, except that in the case of marine farming the crops are more certain, — *i.e.,* are not subject to so many fatalities. The experiments of the Department of Fisheries and Game for the past three years have proved that cultivation of shellfish offers great inducements and profit to both individuals and towns. When the present waste areas are again made productive, the value of the annual catch should be increased tenfold.

Statistical Summary of the Shellfisheries for 1907.

Name of Mollusk.	Production.		Area in Acres.	Capital invested.	Men employed.
	Bushels.	Value.			
Clam,	153,865	$150,440	5,111	$18,142	1,361
Oyster,	161,182	176,142	2,400	268,702	159
Quahaug,	144,044	194,687	28,090	94,260	745
Scallop,	103,000	164,436	30,900	121,753	647
Total,	562,091	$685,705	66,501	$502,857	2,912

In the above table the areas for the scallop, clam and quahaug are only approximate. The scallop and quahaug fisheries cover nearly the same areas, and employ to a great extent the same men and capital.

[1] Gulf Biologic Station, Cameron, La., Bulletin No. 3, 1905.

Annual Yields (in Bushels) of the Shellfisheries of Massachusetts since 1879, from United States Fish Commission Reports.

Year.	Clam.	Quahaug.	Oyster.	Scallop.	Totals.
1879,	158,621	11,050	36,000	10,542	216,218
1887,	230,659	35,540	43,183	41,964	351,346
1888,	243,777	26,165	45,631	26,168	341,741
1898,	147,095	63,817	101,225	128,863	441,000
1902,	227,941	106,818	103,386	66,150	504,295
1905,	217,519	166,526	112,580	43,872	540,497
1907,[1]	153,865	144,044	161,182	103,000	562,091

Massachusetts fishermen to-day receive an annual income of $685,705 from the shellfisheries, which approximately cover a productive area of 40,000 acres. Under the present methods of production, the average value per acre is only $17; each acre, if properly farmed, should furnish an annual production of at least $100, or six times the present yield. The shellfish areas of Massachusetts which are at present utilized are giving almost a minimum production, instead of the enormous yield which they are capable of furnishing. All that is necessary to procure the maximum yield is the application of systematic cultural methods, instead of relying on an impoverished natural supply. Not only are the productive areas furnishing far less than they are capable of producing, but also Massachusetts possesses 6,000 acres of barren flats, which should become, under the proper cultural methods, as valuable as the productive areas. (This has been experimentally demonstrated by the commission.) While it is possible to develop, through cultural methods, these latent natural resources, it will take years to bring them to a high degree of development. It can be partially accomplished, at least, in the next few years, and the present production increased several times, *as nature responds to the slightest intelligent effort of man, and gives large returns.*

Decline of the Shellfisheries.

A. Is there a Decline?

(1) So obvious is the general decline of the shellfisheries that almost every one is aware, through the increasing prices and difficulty of supplying the demand, that the natural supply is becoming exhausted.

(2) Statistical figures of the shellfish production not only show a decline, but conceal a rapid diminution of the supply.

[1] Returns of Massachusetts Department of Fisheries and Game.

(3) Production statistics alone should never be taken as typifying the real conditions of an industry, as such figures are often extremely deceiving. For instance: —

(4) The increased prices, stimulated by an increasing demand, have caused a greater number of men, equipped with the best modern implements, to swell the production by overworking shellfish areas which in reality are not one-fourth so productive as they were ten years ago.

While the general decline of the shellfisheries is a matter of public knowledge, specific illustrations of this decline have been lacking. The present report calls attention to actual facts as proofs of the decline of each shellfishery, by a comparison of the present conditions in various localities with the conditions of 1879. The only past record of Massachusetts shellfisheries of any importance is found in the report of the United States Fish Commission for 1883, and, although this is very limited, it is sufficient to furnish many examples of the extinction or decline of the shellfisheries in certain localities.

In a general consideration of the shellfisheries, it is noticeable that in certain localities the extinction of the industry has been total, in others only partial, while others have remained unchanged or have even improved. This last class is found either where the natural advantages are so great that the resources have not been exploited, or where men have, through wise laws and cultural methods (as in the oyster industry), preserved and built up the shellfisheries.

1879 v. *1907.* — In comparing the present condition of the shellfisheries with that of 1879, it will be seen that many changes have taken place. Even twenty-five years ago inroads were being made upon the natural supply; from that time to the present can be traced a steady decline. During the past five years the production has been augmented by additional men, who have entered into the business under the attraction of higher prices, and the extension of the quahaug and oyster fisheries. Though the annual catch is greater, a disproportionately greater amount of time, labor and capital is required to secure an equal quantity of shellfish.

	1907.	1879.	Gain.
Production (bushels),	562,091	264,818	297,273
Men,	2,912	910	2,002
Capital,	$502,857	$165,000	$337,857
Area (acres),	66,501	66,501	-

The following instances illustrate specific decline in the various natural shellfisheries: —

(1) Oyster industry, natural beds: Wareham, Marion, Bourne, Wellfleet, Charles River.

(2) Sea clam industry: Dennis, Chatham, Nantucket.

(3) Scallop industry: Buzzards Bay and north side of Cape Cod (Barnstable).

(4) Clam industry: Essex, Plymouth, Duxbury, Buzzards Bay, Annisquam, Wellfleet, Nantucket.

(5) Quahaug industry: Chatham, Buzzards Bay, Fall River district.

These are only a few of the more prominent cases. Similar cases will be found all along the coast of Massachusetts, and no one can deny that the natural supply is rapidly becoming exhausted, and that methods are needed to increase the production, or at least to save the little that remains.

B. Causes of the Decline.

I. *An Increasing Demand.* — The indirect cause of the decline of the shellfisheries is the increased demand. To-day more shellfish are consumed than ever before, and the demand is much greater each succeeding year. It is an economic principle that there must be an equilibrium between supply and demand. If the demand is increasing, either the supply has to increase to meet the demand, or the price of the commodity goes up and a new equilibrium is established. The supply must equal the demand of the market. This increasing demand has worked havoc with the shellfisheries. There was a time when the natural supply was of such abundance that the moderate demand of those early days could be met without injury to the fishery. Soon this limit was passed, and with a steadily increasing demand came a corresponding drain on the natural resources, which little by little started a decline, the result of which is to-day apparent.

The ill-advised policy of the past has been to check the demand by various devices, such as closed seasons, limited daily production, etc. These not only have proved without benefit to the fisherman, but also have hurt the consumer by the increased price. The demand can be checked by raising the price, but this tends towards a class distinction between the rich and the poor. The poor man should be able to enjoy "the bounties of the sea" as well as the rich. The policy of the future should be not to check the demand, but rather to increase the supply.

Several causes contribute to this demand, which has unlimited possibilities of expansion: —

(1) The popularity of shellfish as an article of diet is steadily increasing, not merely for its nutritive value, but for variety and change in diet. Fashionable fads, *i.e.*, the "little neck" of the restaurants and hotels, contribute to the popularity of these shellfish.

(2) In the present age, transportation facilities and cold storage make possible shipments to all parts of the United States, and continually widen the market for sea foods.

(3) The influx of summer people to the seashore not only causes an additional summer demand, but also widens the popular knowledge of these edible mollusks.

(4) Advertising and more attractive methods of preserving and selling sea food by the dealers still further increase the demand.

II. *Overfishing.* — The immediate and direct cause of the decline is *overfishing.* Increased demand causes a severe drain upon the shellfish beds, which soon leads to *over*fishing. It is not merely the hard working of the beds, but the continuous unmethodical and indiscriminate fishing which has caused the total extermination of once flourishing beds in certain localities. Under present methods a bed is worked until all its natural recuperatory power is exhausted, and then it is thrust aside as worthless, a barren area. Prof. Jacob Reighard, in "Methods of Plankton Investigation in their Relation to Practical Problems,"[1] aptly sums up the situation in his opening paragraph: —

> In this country the fisherman as a rule continues to fish in any locality until fishing in that locality has become unprofitable. He then moves his operations to new waters until these in turn are exhausted. He is apt to look upon each new body of water as inexhaustible, and rarely has occasion to ask himself whether it is possible to determine in advance the amount of fish that he may annually take from the water without soon depleting it.

In this way the shellfish beds have become exhausted through the indifference and lack of knowledge on the part of the fishing public. In colonial days the resources of the shellfisheries were apparently inexhaustible. The conviction that man could ever exhaust the resources of nature took firm hold of the Puritan mind, and even in the present generation many still cling to this illogical doctrine, although proof to the contrary can be seen on all sides. This idea has caused great harm to the shellfisheries, stimulating men to wreck certain localities by overfishing.

III. *Pollution of Harbors and Estuaries and the Ill Effects upon Public Health through the Shellfisheries.* — The unscientific disposal of sewage, sludge, garbage and factory waste may tend to rapidly fill up the harbor channels, as well as the areas where the currents are not so rapid.

Competent authorities scout the idea that Boston harbor is at present filling up to any considerable degree with sewage sludge, but the problem must be met in the not distant future. This sewage sludge upon entering salt or brackish water precipitates much more rapidly than in fresh water or upon land, and becomes relatively insoluble, hence the accumulation in harbors, *e.g.,* Boston and New Bedford harbors and the estuaries of the Merrimac, Taunton and other rivers. This sludge, instead of undergoing the normal rapid oxidation and nitrification, as it does when exposed to the air on land, undergoes in the sea water a series of changes, mainly putrefactive, which results in the production of chemical substances which in solution may (1) drive away the fish

[1] United States Fish Commission Pamphlet, 1898.

which in incredible quantities formerly resorted to that place; (2) impair the vitality and even kill whatever fish spawn or fry may be present; (3) check the growth of or completely destroy the microscopic plants and animals which serve as food for the young fish and shellfish; (4) by developing areas of oily film floating upon the surface of the water, enormous numbers of the surface-swimming larvæ of clams, quahaugs, scallops, oysters, mussels and other marine animals may be destroyed annually. But most serious of all is the fact that all the edible mollusks, notably the clam, quahaug, oyster and mussel, act as living filters, whose function is to remove from the water the bacteria and other microscopic plants and animals. Most of these microscopic organisms serve as food for the mollusk; and in instances where the mollusk is eaten raw or imperfectly cooked, man is liable to infection, if the bacillus of typhoid fever or other disease chances to be present in the mollusk. Though the chance of such infection is remote, it is nevertheless actually operative. Many typhoid epidemics in this country and abroad have been found to be directly referable to shellfish from sewage-polluted waters. For these reasons approximately 1,500 acres in Boston harbor and 700 acres in New Bedford harbor have become unsuitable for the growth of shellfish; and the State Board of Health, after investigation, decided that clams, oysters and quahaugs found within these areas are likely to be the direct cause of a dangerous epidemic of typhoid. For this reason the taking of these shellfish for any purpose was very properly prohibited; but at the last session of the Legislature a bill was passed which permitted the taking of such shellfish for bait, upon securing permits from the Board of Health, and providing heavy penalties for both buying and selling. As a matter of fact, however, it is well-nigh impracticable to properly enforce this law, for the reason that it is possible only in very rare instances to keep any one lot of clams known to have been dug under these conditions under surveillance from the time of digging until they are placed upon the hook as bait. Complete prevention of the *taking* of such shellfish is the only method by which the public health can be properly safeguarded. Even though in our opinion the annual financial loss to the public from the destruction of this public fishery by the dumping of city sewage into the water is not less than $400,000, the public health is of greater consequence, and should not be jeopardized, as is the fact under present conditions. Until such a time as the public realize that economic disposal of sewage must take place on land rather than in water, laws absolutely preventing any contact with the infected shellfish should be enforced without exception. In instances like these it is greatly to be deplored that but rarely under our system of government can legislation, which the best knowledge and common-sense demand for the public weal, be passed in its adequate and beneficial entirety, but is so frequently emasculated in the selfish interests of a few persons.

IV. *Natural Agencies.* — The above causes are given as they are obviously important, but by no means are they to be considered the only reasons. Geographic and climatic changes often explain the extinction of shellfish in certain localities.

The Present Abuses of the Shellfisheries.

Not only has this survey shown by specific examples the alarming but actual decline of the natural shellfish supply (in spite of deceptive production statistics), but it has brought to light numerous evils of various kinds. These abuses have developed gradually with the rise of the shellfisheries, until at the present day they cannot be overlooked or considered unimportant. So closely are these connected with the present status of our shellfishery that upon their abolition depends its future success or failure. Some need immediate attention; others will require attention later. After a thorough and competent investigation, remedies for the correction of each evil should be applied.

In the future Massachusetts will have to utilize all her wealth of natural resources, to keep her leading position among the other States of the Union. To do this she should turn to her sea fisheries, which have in the past made her rich, and hold forth prospects of greater wealth in the future. Untold possibilities of wealth rest with her shellfisheries, if obsolete methods and traditions can be cast aside. In any age of progress the ancient and worthless must be buried beneath the ruins of the past, while the newer and better take their place. There is no more flagrant example of obsolete methods and traditions holding in check the development of an industry than with the shellfisheries, and it is time that Massachusetts realized these limitations.

The shellfisheries of Massachusetts are in a chaotic state, both legally and economically. The finest natural facilities are wasted, and thousands of acres of profitable flats are allowed to lie barren merely for a lack of initiative on the part of the general public. This chaotic and unproductive state will exist until both the consumer and the fishermen alike understand the true condition of affairs, and realize that in the bays, estuaries and flats of Massachusetts lies as much or more wealth, acre for acre, as in the most productive market gardens.

In Rhode Island the clam and scallop fisheries have almost disappeared. Five or ten years from now the shellfisheries of Massachusetts will be in a similar condition, and beyond remedy. Now is the time for reform. The solution of the problem is simple. Shellfish farming is the only possible way in which Massachusetts can restore her natural supply to its former abundance.

I. *The Shellfish Laws.* — The first evils which demand attention are the existing shellfish laws. While these are supposed to wisely regulate the shellfisheries, in reality they do more harm than good, and are direct obstacles to any movement toward improving the natural resources. Before Massachusetts can take any steps toward cultivating her unproductive shellfish areas, it will be necessary to modify the worst of these laws.

A. Fishery Rights of the Public. — The fundamental principle upon which the shellfish laws of the State are founded is the so-called beach or free fishing rights of the public. While in other States property extends only to mean high water, in Massachusetts the property holders own to extreme low-water mark. Nevertheless, according to further provisions of this ancient law, the right of fishing (which includes the shellfisheries) below high-water mark is free to any inhabitant of the Commonwealth.

(1) *Origin.* — The first authentic record of this law is found under an act of Massachusetts, in 1641–47, by which every householder was allowed "free fishing and fowling" in any of the great ponds, bays, coves and rivers, as far "as the sea ebbs and flows," in their respective towns, unless "the freemen" or the General Court "had otherwise appropriated them." From this date the shellfisheries were declared to be forever the property of the whole people, *i.e.*, the State, and have been for a long period open to any inhabitant of the State who wished to dig the shellfish for food or for bait.

(2) *Early Benefits.* — In the early days, when the natural supply was apparently inexhaustible and practically the entire population resided on or near the seacoast, it was just that all people should have common rights to the shore fisheries. As long as the natural supply was more than sufficient for the demand, no law could have been better adapted for the public good.

(3) *Present Inadequacy.* — Two hundred and fifty years have passed since this law was first made. The condition of the shellfisheries has changed. No longer do the flats of Massachusetts yield the enormous harvest of former years, but lie barren and unproductive. The law which once was a benefit to all has now become antiquated, and incapable of meeting the new conditions.

(4) *Evil Effects.* — If this law were merely antiquated, it could be laid aside unnoticed. On the contrary, as applied to the present conditions of the shellfisheries it not only checks any advancement, but works positive harm. From the mistaken comprehension of the so-called beach rights of the people, the general public throughout the State is forced to pay an exorbitant price for sea food, and the enterprising fishermen are deprived of a more profitable livelihood. The present law discriminates against the progressive majority of fishermen in order to benefit a small unprogressive element.

(5) *Protection.* — If shellfish farming is ever to be put on a paying basis, it is essential that the planter have absolute *protection.* No man is willing to invest capital and labor when protection cannot be guaranteed. What good does it do a man to plant a hundred bushels of clams, if the next person has a legal right to dig them? Since the

law absolutely refuses any protection to the shellfish culturist, Massachusetts can never restock her barren flats and re-establish her shellfisheries until this law is modified to meet the changed conditions.

(6) *Who are the Objectors?* Objectors to any new system are always found, and are not lacking in the case of shellfish culture. These would immediately raise the cry that the public is being deprived of its rights. To-day the public has fewer rights than ever. The present law causes class distinctions, and a few are benefited at the expense of the public. The industrious fisherman suffers because a few of the worthless, unenterprising class, who have no energy, do not wish others to succeed where they cannot. In every seacoast town in Massachusetts the more enlightened fishermen see clearly that the only way to preserve the shellfisheries is to *cultivate* the *barren areas*.

Hon. B. F. Wood, in his report of the shellfisheries of New York, in 1906, clearly states the case.[1]

There is, unfortunately, in some of the towns and villages upon our coast an unprogressive element, composed of those who prefer to reap where they have not sown; who rely upon what they term their "natural right" to rake where they may choose in the public waters. They deplete, but do not build up. They think because it may be possible to go out upon the waters for a few hours in the twenty-four (when the tide serves) and dig a half peck of shellfish, that it is sufficient reason why such lands should not be leased by the State to private planters. It might as well be said that it is wrong for the government to grant homestead farms to settlers, because a few blackberries might be plucked upon the lands by any who cared to look for them.

The following is taken from the report of the Massachusetts Commissioners on Fisheries and Game for 1906:[2] —

There are at least four distinct classes within our Commonwealth, each of which either derive direct benefits from the mollusk fisheries of our coast, or are indirectly benefited by the products of the flats: —

(1) The general public, — the consumers, who ultimately pay the cost, who may either buy the joint product of the labor and capital invested in taking and distributing the shellfish from either natural or artificial beds, or who may dig shellfish for food or bait purposes for their own or family use.

(2) The capitalist, who seeks a productive investment for money or brains, or both. Under present laws, such are practically restricted to *distribution* of shellfish, except in the case of the oyster, where capital may be employed for *production* as well, — an obvious advantage both to capital and to the public.

(3) The fishermen, who, either as a permanent or temporary vocation, market the natural yield of the waters; or, as in the case of the shellfisheries, may with a little capital increase the natural yield and availability by cultivating an area of the tidal flats after the manner of a garden.

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[1] New York Shellfish Report, p. 7.

[2] Report on the Shellfisheries, pp. 33–35.

(4) The owners of the land adjacent to the flats, who are under the present laws often subjected to loss or annoyance, or even positive discomfort, by inability to safeguard their proper rights to a certain degree of freedom from intruders and from damage to bathing or boating facilities, which constitute a definite portion of the value of shore property.

All of these classes would be directly benefited by just laws, which would encourage and safeguard all well-advised projects for artificial cultivation of the tidal flats, and would deal justly and intelligently with the various coincident and conflicting rights of the fishermen, owners of shore property, bathers and other seekers of pleasure, recreation or profit, boatmen, and all others who hold public and private rights and concessions.

That any one class should claim exclusive "natural valid rights," over any other class, to the shellfish products of the shores, which the law states expressly are the property of "the people," is as absurd as to claim that any class had exclusive natural rights to wild strawberries, raspberries, cranberries or other wild fruits, and that therefore the land upon which these grew could not be used for the purpose of increasing the yield of these fruits. This becomes the more absurd from the fact that the wild fruits pass to the owner of the title of the land, while the shellfish are specifically exempted, and remain the property of the public.

The class most benefited by improved laws would be the fishermen, who would profit by better wages through the increased quantity of shellfish they could dig per hour, by a better market and by better prices, for the reason that the control of the output would secure regularity of supply. Moreover, when the market was unfavorable the shellfish could be kept in the beds with a reasonable certainty of finding them there when wanted, and with the added advantage of an increased volume by growth during the interval, together with the avoidance of cold-storage charges. Thus the diggers could be certain of securing a supply at almost any stage of the tide and in all but the most inclement weather, through a knowledge of "where to dig;" moreover, there would be a complete elimination of the reasoning which is now so prolific of ill feelings and so wasteful of the shellfish, viz., the incentive of "getting there ahead of the other fellow."

B. All the shellfish laws should be revised, to secure a unity and clearness which should render graft, unfairness and avoidable economic loss impossible, and be replaced with a code of fair, intelligent and forceful laws, which would not only permit the advancement of the shellfish industry through the individual efforts of the progressive shellfishermen, but also protect the rights of the general public.

C. The majority of the shellfish laws of the State are enacted by the individual towns. In 1880 the State first officially granted to each town the exclusive right to control and regulate its own shellfisheries, as provided under section 68 of chapter 91 of the Public Statutes. This was slightly modified by the Acts of 1889 and 1892 to read as follows (now section 85 of chapter 91 of the Revised Laws): —

SECTION 85. The mayor and aldermen of cities and the selectmen of towns, if so instructed by their cities and towns, may, except as provided in the two preceding sections, control, regulate or prohibit the taking of eels, clams, quahaugs and scallops within the same; and may grant permits prescribing the times and methods of taking eels and such shellfish within such cities and towns and make such other regulations in regard to said fisheries as they may deem expedient. But an inhabitant of the commonwealth, without such permit, may take eels and the shellfish above-named for his own family use from the waters of his own or any other city or town, and may take from the waters of his own city or town any of such shellfish for bait, not exceeding three bushels, including shells, in any one day, subject to the general rules of the mayor and aldermen and selectmen, respectively, as to the times and methods of taking such fish. The provisions of this section shall not authorize the taking of fish in violation of the provisions of sections forty-four and forty-five. Whoever takes any eels or any of said shellfish without such permit, and in violation of the provisions of this section, shall forfeit not less than three nor more than fifty dollars.

Responsibility has thus been transferred from the State to the towns, and they alone, through their incompetence and neglect, are to blame for the decline of the shellfisheries. The town laws are miniature copies of the worst features of the State laws. While a few towns have succeeded in enacting fairly good laws, the majority have either passed no shellfish regulations at all, or made matters worse by unintelligent and harmful laws. It is time that a unified system of competent by-laws were enacted and enforced in every town.

The ill-advised features which characterize the present town laws are numerous, and are best considered under the following headings: —

(1) *Unintelligent Laws.* — One of the worst features of our town shellfish laws is their extreme unfitness. Numerous laws which are absolutely useless for the regulation and improvement of these industries have been made by towns, through men who knew nothing about the shellfisheries. These laws were made without any regard for the practical or biological conditions underlying the shellfish industry. It is to be expected that laws from such a source would often be ill-advised and unintelligent, but under the present system it cannot be avoided. Until sufficient knowledge of the habits and growth of shellfish is acquired by the authorities of State and town, Massachusetts can never expect to have intelligent and profitable shellfish laws. While the majority of these unintelligent laws do no harm, there are some that work hardship to the fishermen and are an injury to the shellfisheries.

(2) *Unfairness; Town Politics.* — Town politics offers many chances for unscrupulous discrimination in the shellfish laws. Here we find one class of fishermen benefiting by legislation at the expense of the other, as in the case of the quahaugers *v.* oystermen. In one town the oystermen will have the upper hand; in another, the quahaugers. In every case there is unfair discrimination, and a resultant financial loss to both parties. The waters of Massachusetts are large enough for both

industries, and every man should have a "square deal," which is frequently lacking under the present régime.

Besides party discrimination, there is discrimination against certain individuals, as illustrated in giving oyster grants. Town politics plays a distressing part here. Favoritism is repeatedly shown, and unfairness results. All this shows the unpopularity and impracticability of such regulations and the method of making them.

(3) *Present Chaotic State.* — The present town laws are in a chaotic condition, which it is almost impossible to simplify. No one knows the laws, there is merely a vague impression that such have existed. Even the selectmen themselves, often new to the office and unacquainted with the shellfisheries, know little about the accumulated shellfish laws of the past years, and find it impossible to comprehend them. The only remedy is to wipe out all the old and replace them with unified new laws.

(4) *Unsystematic Laws.* — The present laws are unsystematized. Each town has its own methods, good and bad, and the result is a heterogeneous mixture. Often there are two or three laws where one would definitely serve. To do absolute justice there should be a definite system, with laws elastic enough to satisfy the needs of all.

(5) *Nonenforcement.* — The worst feature of allowing town control of the shellfisheries is the nonenforcement of the laws already passed. We find in many towns that good by-laws have been made, but from inattention and lack of money these have never been enforced and have become practically nonexistent. The 1½-inch quahaug law of several towns is an instance of this. In but one town in the State, Edgartown, is any effort made to enforce this excellent town by-law, although several of the other towns have passed the same. The proper enforcement of laws is as important as the making, as a law might as well not be made if not properly enforced. The only way that this can be remedied is either to take the control completely out of the hands of the town, or else have a supervisory body which would force the town to look after violators.

Besides the town by-laws there are other evils which result from the present system of town control.

II. *Lack of Protection in Oyster Industry.* — In no case is the management by towns more inefficient and confusing than in the case of the oyster industry. As this subject will be taken up in the oyster report which follows, it is only necessary here to state that there is great need of a proper survey of grants, fair laws, systematic methods, etc. Protection is necessary for the success of any industry, and is especially needed for the oyster industry. The oyster industry of Massachusetts will never become important until adequate protection is guaranteed to the planters. Under the present system, uncertainty rather than protection is the result.

III. *Town Jealousy.* — The evil of town jealousy, whereby one town forbids its shellfisheries to the inhabitant of neighboring towns, is to-day an important factor. It is fair that a town which improves its own shellfisheries should not be interfered with by a town which has allowed its shellfisheries to decline. While this is true perhaps of the clam, quahaug and oyster, it does not hold true of the scallop. The result of this close-fisted policy has resulted in the past in a great loss in the scallop industry. The town law in regard to scallops is all wrong. The scallop fisheries should be open to all the State, and no one town should "hog the fishing," and leave thousands of bushels to die from their dog-in-the-manger attitude.

IV. *Sectional Jealousy.* — Another evil, which in the past has been prominent, but is becoming less and less as the years go by, is the jealousy of the north shore *v.* the south shore, Cape Cod *v.* Cape Ann. In the past this has been a stumbling block against any advance, as any plan initiated on the south shore would be opposed from sheer prejudice by the north shore representatives, and *vice versa.* The cry of "entering wedge" has been raised again and again whenever any bill was introduced for the good of the shellfisheries by either party. Merely for political reasons good legislation has been defeated. However, the last few years have shown a decided change. The jealous feeling has in a large measure subsided; the shellfisheries need intelligent consideration, and all parties realize that united effort is necessary to insure the future of these industries.

V. *Quahaugers* v. *Oystermen.* — On the south shore the worst evil which at present exists is the interclass rivalry between the quahaugers and oystermen. This has caused much harm to both parties, through expensive lawsuits, economic loss, uncertainty of a livelihood, as well as retarding the proper development of both industries.

VI. *Waste of Competition.* — At the present day the utilization of waste products in all industries is becoming more and more important. In this age material which was considered useless by our forefathers is made to play its part in the economic world. Through science industrial waste of competition is being gradually reduced to a minimum, although in any business which deals with perishable commodities, such as fish, fruit, etc., there is bound to be a certain amount of loss.

Under the present system the shellfisheries suffer from the effects of waste resulting from competition. Both the fisherman and the consumer feel the effects of this, in different ways, — the fisherman through poor market returns, the consumer through poor service. As long as the shellfisheries are free to all, there is bound to be that scramble to get ahead of "the other fellow," which not only results in the destructive waste of the actual catch, but also causes a "glutted" market, which gives a low return to the fisherman. Thousands of dollars are thus lost each year by the fishermen, who are forced to keep shipping their shellfish, often to perish in the market, merely because the present system invites ruthless competition. The fishermen in this respect alone should be the first to desire a new system, which would give to each a shellfish farm and the privilege of selecting his market.

VII. At the present moment there are two evils which demand attention, and which can be lessened by the passage of two simple laws: —

(1) During the past three years many thousands of bushels of quahaugs under 1½ inches have been shipped out of the State, merely passing into the hands of New York oystermen, who replanted, reaping in one year a harvest of at least five bushels to every one "bedded." Through the inactivity of town control, the incentive to get ahead of the other fellow and the ignorance that they are wasting their own substance have caused many quahaugers in the past to do this at many places.

The 1½-inch quahaug law has been for years a law for many towns in the State. It has been practically a dead letter in all but Edgartown, where it is enforced thoroughly. There should be a State law restricting the size of the quahaugs taken.

(2) The enforcement of a 1½-inch clam law, especially in the towns of Fall River and Swansea, where the digging has reduced the clams to a small size, likewise deserves immediate attention.

All the present evils have each contributed their share toward the ruin of the shellfisheries, and can be best summed up under one head, *i.e.*, the abuse of nature. All the above evils have either directly or indirectly worked towards this end. This "abuse of nature" has resulted in several ways: (1) indiscriminate fishing, restricted by no laws, augmented by unwise laws; (2) overfishing in certain localities until the supply is exhausted, as, among other instances, with the Essex clam flats and the natural oyster beds of the Weweantit River; (3) exploiting and wasting the natural resources, so that nature cannot repair the inroads. Nature cannot cope with despoiling man, — man must assist nature.

In the past there has been much feeling, especially among the clammers of the north shore, against the Fish and Game Commission. It therefore is necessary to correct a mistaken impression, which has arisen among the clammers, that "the State is going to take the clam flats away from us." This idea is on the face of it absurd. The Massachusetts Fish and Game Commission is seeking only to have this question solved in such a manner as to yield the most satisfactory results for the public good. At the present time it would be highly undesirable to take the complete control of the shellfisheries from any town, as long as that town shows itself capable of regulating them wisely. At the present day but few towns show any signs of this. What is necessary and desirable is to have an intelligent supervisory body, with power to compel each town to take proper care of its shellfisheries. It is advisable that there be a central power, co-operating with the town control in all matters pertaining to the shellfisheries, whether it be regulations or the restocking of barren areas. A board of arbitration, a committee of appeal for any grievance under the town control, and a commission that would act for the interests of the whole State, are what is most desirable at the present time. Such an arrangement would not be changing radically the present system of town control, but it would free it from its existing evils, place it on a firm and just basis, and give the shellfisheries a chance for improvement.

The Fisherman and Laws.

The fisherman of to-day, though nominally his own master, is in reality subject to the demands of the market. To gain a living he is forced to work in all kinds of weather, at cold, disagreeable work. Under the present system he is oppressed by useless special town laws, which merely increase his daily labors without benefiting the fishery in the least. A few good laws only are necessary for the shellfisheries. It is time that the fisherman, one of the great factors in the commercial supremacy of Massachusetts, should be freed from all unnecessary burdens through a new system of satisfactory laws.

The Remedy.

In spite of all the existing evils of the town shellfisheries, the outlook is far from hopeless. To-day the shellfisheries of Massachusetts, owing to great natural resources, are as good or better than those of any other coast States, and only await development under proper methods to ensure a bright future. The Commissioners on Fisheries and Game can only point the way of reform; the result lies in the hands of the intelligent voters of this Commonwealth, whose action decides the future success or failure of the shellfisheries. It should be the object of every thinking voter, whether he be fisherman or consumer, to see that the right action be taken in regard to the shellfisheries.

As shown in the preceding pages of this report, the attempted remedy has been based upon the false economic basis of attempting to check the demand by prohibiting digging for certain periods (closed seasons), limiting the amount to be legally dug by any one person, etc. It would be quite as logical for a town or city to prohibit by by-laws the use or digging of potatoes or any other food crop, when the supply was short, rather than to attempt to *increase* the supply. An increasing demand cannot be checked by any such ill-advised measures, but can be met only by a corresponding increase in the natural production. The only remedy that can be applied successfully is shellfish culture, which means the utilizing of thousands of acres of barren shore area for the planting of farms which will furnish harvests of shellfish. In this way the latent potentialities of nature, which it is criminal to neglect, will be utilized for the good of the entire population of the State.

We learn from the dictionaries that a farm is defined to be a tract of land under one control, devoted to agriculture, etc.; and that agriculture is the cultivation of the soil for food products or other useful or valuable growths. All this is very familiar knowledge, as applied to the dry land; but that there may fairly be brought within these definitions the operations of an industry in which lands covered by the salt waters of our bays and harbors are tilled, cultivated, raked, harrowed and planted with seedling bivalves, and harvests of a valuable product garnered, constituting a superb food for the masses, is less familiar, and to many may seem quite astonishing. It is within a comparatively few years that this unique style of farming has had its growth and development, until now mány thousands of acres of land under water have been carefully surveyed, and the boundaries marked by buoys and stakes.[1]

To bring the shellfisheries of Massachusetts to their maximum production will take years, but within five years the production can be nearly doubled, if work in the right direction is begun at once. Patience will be required to overcome the obstacles which must be met, and the change must necessarily be gradual.

Every year the difficulties of reform increase. Owing to a steadily increasing demand, the natural supply is becoming smaller, and consequently the difficulty of increasing it becomes so much the harder. Soon the line of possibility will be crossed, and the shellfisheries will become an industry of the past. A few shellfish will always remain, but as an important industry, the shellfisheries, if no remedy is applied, in twenty-five years will be commercially extinct. While there is still time, let action be taken.

The utilization of the barren shellfish areas, wise laws, good regulations and systematic methods of culture are necessary, in order to obtain the maximum production from these sea farms. The sea farm possesses one advantage over the ordinary farm, — the soil never becomes exhausted, as the shellfish derive their sustenance from the water, utilizing indirectly the waste nitrates of the land. To do this it is necessary that shellfish culture be at once begun, either by individuals or by towns.

Three methods of shellfish culture offer ways of approach towards the utilization of the waste areas: —

(1) To leave the matter wholly in the hands of the town. This is the poorest way, as has been shown in the past. Unless the town officials were well informed about the shellfisheries, it would be an absurd farce to entrust the future of this important industry wholly in their hands.

(2) Place all power with the State, instead of with the town. Have a unified and simplified system, whereby shellfish farms and grants can be leased by the individuals. This plan, much better than

[1] Forest, Fish and Game Commission Bulletin, Shellfish Culture in New York, 1905. By B. Frank Wood.

the first, and possibly the final solution, is, however, not practical of application to the existing conditions. Later, when these conditions are removed, it may prove the best solution of the problem.

(3) The present system of town control to remain. The appointment of the Fish and Game Commission, or a similar commission, to have complete advisory power over the towns, and power to force each town to properly protect its shellfish. A State law would be passed, legalizing grants to individuals and dividing the flats into two equal parts, — public and private. The leasing of grants would be in the hands of the town authorities, but subject to appeal for any grievance to the Fish and Game Commission.

In the chapter relating to each shellfish will be given the practical methods of cultivation for reclaiming the waste areas. These methods have been proved by the experimental work of this commission, the results of which may be published in a subsequent scientific report upon the shellfish. The commission has definitely shown that shellfish culture in Massachusetts is a possibility, and, moreover, a remunerative possibility.

Who would benefit?

(1) Under the proposed system of practical shellfish culture, many classes of people would be benefited. The person who would be primarily benefited is the fisherman. In the following ways the condition of the industrious fisherman would be bettered: (*a*) his work would be steady, not uncertain; (*b*) he would know his exact annual income, and could govern his living expenses accordingly; (*c*) he would receive more money, with less hardship; (*d*) he would ensure steady market returns, which under the present system are very uncertain; (*e*) he would be his own master, and not forced to work for poor pay, under the stress of wasteful competition.

(2) The shellfisheries are not for any particular class, but should benefit all, and any improvement in the industry affects all people. A second class would also be benefited by an increase in the shellfish industries. This class can be divided into two groups: (*a*) those directly influenced; (*b*) those indirectly. In the first group are the middlemen, — dealers. By an increased trade, more firms enter the business, more men are hired, etc. Comprising the second group are teamsters, coopers, shop owners, sailors, transportation lines, — an indefinite list, which would be indirectly benefited by an increase in the shellfish industry.

(3) Thirdly, the consumer would receive the benefit of improved quality of goods, reasonable prices, etc. Through increased transportation facilities the inland consumer would have the pleasure of partaking of sea food, and what were once the luxuries of the rich could be had by all.

Capital.

Capital is needed for the best success of any business. In a broad sense, the tools, implements, etc., of the shellfisherman are capital. In the future, if the shellfisheries are to become a great industry, money as working capital is indispensable. Blind objection to the employment of capital on the part of the fishermen works against the best interests of the shellfisheries.

Shellfish Monopoly.

For years the fishermen have feared that the shellfisheries would fall into the hands of a few companies or trusts, and the individual fisherman thereby lose his independence. As the present age tends toward the formation of monopolies in all business, the fears of the fishermen are not altogether groundless in this respect; nevertheless, while there are certain chances of monopoly in the shellfisheries, these chances are very small. In the first place, a monopoly of a raw edible product, such as shellfish, is hardly possible. Never can it be possible for any one company to control all or the majority of a shellfish supply, which possesses unlimited possibilities of expansion.

Secondly, there are but two ways in which a monopoly of the shellfisheries can be obtained: one is the control of the market by buying up all the shellfish, — a thing far easier under the present conditions; the other, by buying through contract the rights of the individual planters. The success of such an enterprise would depend wholly upon the personnel of the shellfishermen, and such a result could never become possible if each shellfisherman would refuse to sell his rights.

Summary.

This survey has shown (1) that the shellfisheries have declined (an established fact); (2) that the causes of the decline are overfishing and unwise laws; (3) that the remedy is, not to check the demand, as has been previously attempted, but to increase the production by the utilization of vast areas of barren flats, which have been experimentally proved capable of yielding a great harvest; (4) that the present chaotic laws render this impossible; (5) that there is a need of reform, or else the shellfisheries will soon disappear; (6) that the first step is the removal of these laws to permit the application of proper cultural methods.

Quahaug (*Venus mercenaria*).

Inhabiting common waters with the scallop, the northern range of the quahaug (the hard-shell clam or "little neck") in Massachusetts is Plymouth. Commercially it is found both on the north and south side of Cape Cod and in Buzzards Bay, the principal fisheries being at Wellfleet, Orleans, Edgartown, Nantucket and in Buzzards Bay.

The quahaug, while essentially a southern and warm-water form, being found in the United States along the Atlantic seacoast as far south as the Gulf of Mexico, practically reaches its northern range in Massachusetts. In a few sheltered bays on the Maine coast quahaugs are sometimes found, but in small quantities. However, at Prince Edward Island there is said to be an abundance.

Along the coast of Massachusetts north of Boston very few quahaugs are found, although they were formerly taken near Salem. The black quahaug (*Cyprina islandica*), so called from its dark epidermis, is often caught in the trawls, but this is a deep-sea form, and by no means a true quahaug. In Essex and Ipswich rivers and on Plum Island experimental beds have shown that quahaugs grow in these waters, but no spawn has yet been noticed, though ripe eggs were developed in the planted quahaugs. Owing to the swift currents, which carry the spawn perhaps for miles, it is impossible to determine accurately whether any set has taken place.

During the past three years, as outlined by chapter 78, Resolves of 1905, the Fish and Game Commission has conducted a series of experiments upon the quahaug, designated to furnish sufficient data concerning the growth of this mollusk under a variety of conditions, to demonstrate the possibilities and value of practical quahaug farming. The results of these investigations upon the life, habits and culture of the quahaug are to be published in a later scientific report. It is necessary here to say that all statements in this report concerning the growth and culture of quahaugs have been proved by experiments, the results of which are on file at the office of the department of fisheries and game.

It is the object of this report to present both to the fishermen and consumers (1) actual statistical figures of the industry of the State for 1907; (2) a biological survey of the quahauging areas, outlined by maps and descriptions; (3) a description of the industry. This survey should furnish a basis for determining any decline or advance in the quahaug industry of the future, as well as affording comparison with the United States Fish Commission survey of 1879, made by Ernest Ingersoll.

Massachusetts, situated at the northern limit of the quahaug industry of the United States, is handicapped in comparison with other States, as only the southern waters of the State are given to this industry. Nevertheless, though possessing only a partial industry, Massachusetts ranks the fourth State in quahaug production, according to the 1906 report of the United States Fish Commission.

The same natural conditions which suit so well the shallow-water scallop are also adapted to the growth of the quahaug. In nearly all the sheltered bays, inlets and rivers of the southern coast of Massachusetts the quahaug can be found in varying abundance. Technically, there is more territory which admits the possibility of quahaug growth than of any other shellfish. The bathymetric range of the quahaug is extensive, as the quahaug is raked in all depths of water up to 50 feet. In spite of the vast territory nature has provided for the quahaug in the waters of Massachusetts, the commercial fishery is found only in small parts of this large area. Scattered quahaugs are found over the rest of the area, but in paying quantities only in limited places.

The possibilities of developing this great natural tract of quahaug ground are especially alluring, — far more so than any of the other shellfisheries. The quahaug has a greater area, greater possible expansion and a more profitable market. Nature has equipped southern Massachusetts with numerous bays with remarkable facilities for the production of quahaugs; it only remains for man to make the most of these.

Method of Work. — The method of work used in preparing this portion of the report varied but little from that relating to the other shellfish, though several features made it harder to obtain accurate information. There is a more general obscurity about the history of the quahaug than about any of the other shellfish, even though the quahaug industry is commercially the youngest of all. This is due, perhaps, to the gradual rise of the industry through the discovery of new territory. The only historical record obtainable is E. Ingersoll's report on the quahaug, in 1879, in which he deals briefly with the industry in Massachusetts. Town records help but little in determining the history of the industry, as only of late years have the towns required the taking of permits.

In making the biological survey, the difficulty arises of defining what constitutes quahaug ground, since scattering quahaugs are found over vast territories, but only limited areas are commercially productive. The estimates of the quahaugers, both historically and in regard to production and areas, are often erroneous and vary greatly. By the use of market reports, express shipments, estimates of dealers, estimates of several reliable quahaugers, and all methods at our command, the facts of the industry were compiled and errors eliminated as far as possible. The home consumption is hard to determine, and is merely an estimate. The area of the quahaug territory was plotted on the map, and calculations made from the plots. Whenever personal inspection was not possible, as in Falmouth, the estimates of several quahaugers were taken.

Results.

1. *Is the Quahaug Fishery declining?* — The decline of the quahaug fishery is well recognized. Even the production figures, which, when stimulated by high prices, usually give a deceptive appearance of prosperity to a declining industry, since more men enter the fishery, show a decline in the last few years. When such a point is reached, — when, in spite of higher prices and more men, the annual production becomes less and less, — not many years will pass before the industry will collapse completely.

Increased prices show either an increase in demand or a falling off of the supply. Both are perhaps true of the quahaug industry. The demand, especially for "little necks," has been steadily on the increase, and a broad inland market is gradually opening, since the quahaug is capable of long transportation without perishing. So the increased prices are a sign of the diminution of the supply, as well as of an increased demand, the undeterminal factor being what ratio the one bears to the other.

The only way to determine accurately the decline in the natural supply is to compare the amount the average quahauger could dig ten or twenty years ago with the amount dug to-day. Even this comparison is unfair, as the better rakes, improved methods, etc., of the present time tend to increase the daily yield of the quahauger.

This decline can best be shown by taking special localities: —

(1) *Buzzards Bay.* — The quahaug industry in Buzzards Bay has shown a great decline in the past ten to twenty years, and the industry is now at a low ebb, especially in the towns of Marion and Mattapoisett. Wareham, Bourne and Fairhaven still manage to ship about 27,000 bushels annually, employing over 200 men; but this is hardly up to their former standard. To-day at Wareham the daily catch per man is one-fifth of what it was twenty years ago; in 1887 a man could dig 5 bushels to a catch of 1 bushel now. Buzzards Bay perhaps has shown the greatest quahaug decline.

(2) *South Side of Cape Cod.* — While not so marked a decline has taken place as in Buzzards Bay, every quahauger agrees that the industry is gradually failing. In Bass River, at Hyannis, and in Chatham, there is a marked decrease, while at Cotuit and Osterville the industry has remained stationary.

(3) *North Side of Cape Cod.* — The best quahaug fishery of Massachusetts, except at Edgartown, is found on the north side of Cape Cod, in the towns of Wellfleet, Eastham and Orleans. These three towns give an annual yield of 75,000 bushels. Only about fifteen years old commercially, the industry has passed its prime and is on the decline. This decline is shown both by production figures and by the gradual moving to deeper water. As the quahaugs were thinned out in shallow water, the fishermen moved farther and farther out, using long rakes, until 60-foot rakes are now used at a depth of 50 feet. Probably the 60-foot limit will never be exceeded, unless a method of dredging is devised; and it will be only a question of years when the industry will become extinct.

(4) *Nantucket.* — The industry here has generally declined, though in the last few years there has been a slight increase in production.

(5) *Edgartown.* — The quahaug industry at Edgartown has declined little, if any, while the fishery has been carried on for many years. The natural resources have not been seriously impaired, owing to the efficient town management; and Edgartown can be congratulated on being the only town in the State that can boast of a protected industry.

Although the quahaug industry has not openly shown the tendency to decline that the soft clam has manifested in southern Massachusetts, the danger is nevertheless very great, and the disaster would be far worse. The fishermen of Cape Cod realize that the clam industry has practically gone; but they are blind to the fact that a far more important one — the quahaug industry — is in as grave danger, and only when it is too late will they wake to a realization of the situation.

The clam industry on Cape Cod and Buzzards Bay will never assume the importance it possesses on the north shore, owing to lack of extensive flats. Rather the quahaug industry is the main shellfish industry of the south shore, as it is more valuable, more important, and capable of vast expansion. The development of the quahaug industry should bring many hundred thousand dollars to Cape Cod.

II. *Causes of the Decline.* — The direct cause is overfishing. The quahaug is hardy, little harmed by climatic changes, and has but few natural enemies. Man alone has caused the decline of the natural supply. Not satisfied with taking the mediums and large quahaugs, but spurred on by the high prices offered for the "little neck," the quahaug fisherman has cleaned up everything he can get, and the natural supply has suffered greatly. If the market demands the capture of the "little neck," it is necessary to leave the large quahaugs as "spawners." At the present time, by the capture of both the industry is being ruined.

The Remedy. — Quahaug Farming.

There is only *one way* in which the present decline can be checked, and that is, to increase the natural supply by cultural methods to meet the demands of the market. The only way to accomplish this increase is to plant and raise quahaugs, — in fact, have a system of *quahaug farming* for the whole south shore of Massachusetts. In considering quahaug farming, many questions naturally arise: (1) Is quahaug farming an established fact, or a mere theory? (2) Possibilities of quahaug farming. (3) What is the growth of the quahaug, and how long does it take to raise a crop? (4) What is the value of a quahaug farm? (5) What benefits would the quahaug industry receive from such a system?

(1) *Quahaug Farming an Established Fact, — not a Theory.* — It is not the object of this report to go into a scientific treatise upon experiments in quahaug culture. For the past three years the Commission on Fisheries and Game has been conducting experiments upon the growth and culture of quahaugs, the results of which will be published in a subsequent report. These experiments have shown that quahaug farming is no theory, but an established fact, and that, if taken up, it will make the quahaug fishery the most important shellfish industry of the State. These experiments, consisting of small beds one one-thousandth of an acre in area, were located at different places along the coast. Various conditions in regard to food, current, tide, soil, etc.,

were tested. The results from nearly every bed were excellent, and showed the ease of culture and the great profit which would result if larger areas were thus worked.

The results obtained from the experiments of the commission alone are sufficient to prove the practicability of quahaug farming, even if there were no other proofs. As it is, there have been many tests made by the oystermen, both outside and inside the State. Some years ago the oystermen near New York realized the possibilities of raising quahaugs on their oyster grants, and to-day Massachusetts ships many barrels of "seed" quahaugs out of the State to these far-sighted business men, who reap large returns by replanting these small "little necks." The Massachusetts oystermen have not been slow to realize the large returns afforded by quahaug culture, and some have planted many bushels of the "seed," thus turning their grants into partial quahaug farms. These men have proved that this style of farming is practical, and that as a money-making proposition the quahaug is far ahead of the oyster.

As affairs exist to-day in Massachusetts, a few men alone have the privilege of raising quahaugs, while the rest stand idle. Theoretically and legally, no one has the right to plant and raise quahaugs in the State; but practically and secretly it is done with great success. Who can blame the oysterman for raising quahaugs with his oysters, in view of the fast-declining quahaug industry? Rather by so doing he is helping perpetuate the natural supply. The objection to this present system of secret quahaug farming is its unfairness. A few men are enjoying the privileges that many others should likewise enjoy. There is plenty of room, and quahaug farming might as well be carried on openly, to the benefit of all.

While the oystermen have made a move toward general quahaug farming, and have shown the great possibilities that this system possesses, the quahaugers have also exhibited a tendency in a similar direction. The originators of the town law in Eastham, Orleans and Wellfleet, which provides for the leasing of 5,625 square feet of flat for bedding the catch, and thus makes possible the advantage of a favorable market, probably did not imagine that this was the first great step on the part of the quahaugers towards shellfish farming. The success of this scheme has here opened the eyes of the intelligent quahaugers to the even better possibilities of quahaug culture, and any well-devised scheme of shellfish farming will be favorably received.

The main impulse that makes people turn to quahaug culture is the steady decline of the industry, especially during the last few years. In the previous pages of this report there have been shown: (1) the actuality of the decline; (2) the causes of this decline. The proof of the decline is so generally apparent that it has created a popular demand for a fair system of quahaug farming, to check the diminution of the present supply.

(2) *Possibilities of Quahaug Farming.* — The quahaug has a wide range; it is found in all depths of water, from high tide line to sixty feet, and in various kinds of mud and sand bottom. This natural adaptability gives the quahaug a wider area than any other shellfish, as it will live in nearly any bottom, although the rate of growth depends essentially upon its location in respect to current. This permits the utilization of vast areas which to-day are unproductive, and which can all be made into profitable quahaug farms. Quahaugs will grow on thousands of acres of flats, such as the Common Flats of Chatham, if they are planted. There are indefinite possibilities of expansion in quahaug farming through the reclamation of this unproductive sea bottom.

(3) *Rate of Growth of Quahaug.* — The rate of growth of the quahaug varies greatly in regard to its location in respect to the current. The quahaugs which have the better current or circulation of water show the faster growth. The fastest growth recorded by the experiments of the Department on Fisheries and Game was a gain of 1 inch a year; *i.e.,* 1½-inch quahaugs attained in one year a length of 2½ inches. The average growth is between ½ and ¾ inch a year, or a yield of 3 to 5 bushels for every bushel planted, or the return in one year of $4 for every $1 invested. In the more favorable localities there would be the enormous gain of $8 for every dollar invested. All this can be done in six months, as the quahaug grows only during the six summer months. The above figures are taken from experiments which have been conducted on Cape Cod, in Buzzards Bay and at Nantucket.

(4) *Value of a Quahaug Farm.* — An acre of "little-neck" quahaugs has a high market value. A conservative estimate of 10 per square foot gives the yield in one year of 2½-inch quahaugs as 600 bushels per acre. This means that 120 bushels of 1¾-inch quahaugs were planted to the acre. The price paid for the same would be $600, at the high price of $5 per bushel. The price received for the same, at $3 per bushel, would bring $1,800, or a gain of $3 for every $1 invested. This is a conservative estimate on all sides. Quahaugs could be planted two or three times as thick, seed might be purchased for less money, more money might be received for private shipments, and faster growth can be obtained. The only labor necessary is gathering the quahaugs for market. The quahaug farm requires no such care as the agricultural farm, and offers far more profit.

(5) *Advantage of Quahaug Culture.* — The quahaug is the most remunerative of any of our shellfish. It possesses several advantages over the oyster: (1) it is hardier, — less influenced by climatic conditions; (2) it has fewer enemies, as it lies protected under the sand; (3) it possesses a market the whole year; (4) there is more money for the planter in raising "little necks" than in raising oysters. If oyster culture has succeeded in Massachusetts, there is no question that, given a proper chance, quahaug culture can be put on a firm basis, and

made the leading shellfish industry of Massachusetts. The value of the present quahaug industry lies chiefly in the production of "little necks." Under a cultural system of quahaug farms, this could be made a specialty. Old quahaugs would be kept as "seeders," and "little necks" alone raised for the market. The advantage of furnishing "little necks" of uniform size would lead to increased prices; steady customers would be obtained and certainty of production guaranteed. All the advantages lie with quahaug farming, as opposed to the present method of "free-for-all" digging.

The quahaug industry of the future, if put on a cultural basis, will not only check the decline of a valuable industry, but will increase the present production many fold. A far larger supply, work for more men and better prices for the consumer will result.

(6) *Spat Collecting.* — The main obstacle that stands in the way of permanent quahaug culture is a lack of sufficient young "seed" quahaugs. While several heavy sets have been recorded, the "seed" quahaugs are never found in vast quantities, as are the young of the soft clam (*Mya arenaria*). The set of quahaugs is usually scattering and slight. A method of spat collecting, *i.e.,* catching the spawn and raising the small quahaugs, is alone necessary for the complete success of quahaug culture. While nothing of practical importance has yet been found, indications are favorable that some means will be devised in the next few years, and that quantities of young quahaugs can be raised. Experiments have already shown that as many as 75 can be caught per square foot in box spat collectors; but a more practical method than this must be found to make the business profitable.

The Quahaug Industry.

Methods of Capture. — Several methods of taking quahaugs are in vogue in Massachusetts, some simple and primitive, others more advanced and complex, but all modifications of simple raking or digging. These methods have arisen with the development of the industry, and record the historical changes in the quahaug fishery, as each new fishery or separate locality demands some modification of the usual methods.

(1) *"Treading."* — The early settlers in Massachusetts quickly learned from the Indians the primitive method of "treading" quahaugs, which required no implements except the hands and feet. The "treader" catches the quahaug by wading about in the water, feeling for them with his toes in the soft mud, and then picking them up by hand. Nowhere in Massachusetts is it used as a method of commercial fishery.

(2) *Tidal Flat Fishery.* — Often quahaugs are found on the exposed tidal flats, where they can sometimes be taken by hand, but more often with ordinary clam hoes or short rakes. Owing to the scarcity of quahaugs between the tide lines, this method does not pay for market fishing, and is only resorted to by people who dig for home consumption.

(3) *Tonging.* — In most parts of Buzzards Bay and in a few places on Cape Cod quahaugs are taken with *oyster tongs.* This method is applicable only in water less than 12 feet deep, as the longest tongs measure but 16 feet. Four sizes of tongs are used, 8, 10, 12 and 16 feet in length. Tonging is carried on in the small coves and inlets, where there is little if any rough water. A muddy bottom is usually preferable, as a firm, hard soil increases the labor of manipulating the tongs, which are used in the same manner as in tonging oysters.

(4) *Raking.* — The most universal method of taking quahaugs is with rakes. This method is used in every quahaug locality in Massachusetts, each town having its special kind of rake. Four main types of rakes can be recognized: —

(*a*) *The Digger.* — In some localities, chiefly in Buzzards Bay, the ordinary potato digger or rake, having four or five long, thin prongs, is used. Usually it has a back of wire netting, which holds the quahaugs when caught by the prongs. As the digger has a short handle of 5 feet, it can be used only in shallow water, where the quahauger, wading in the water, turns out the quahaugs with this narrow rake. This method yields but a scanty return, and is more often used for home consumption than for market.

(*b*) *The Garden Rake.* — The ordinary garden rake, equipped with a basket back of wire netting, is in more general use in shallow water, either by wading or from a boat, as it has the advantage of being wider than the potato digger.

(*c*) *The Claw Rake.* — This type of rake varies in size, width and length of handle. It is used chiefly at Nantucket. The usual style has a handle 6 feet long, while the iron part in the form of a claw or talon is 10 inches wide, with prongs 1 inch apart. Heavier rakes with longer handles are sometimes used for deep water, but for shallow water the usual form is the short-claw rake.

(*d*) *The Basket Rake.* — The greater part of the quahaug production is taken from deep water, with the basket rake. These rakes have handles running from 23 to 65 feet in length, according to the depth of water over the beds. Where the water is of various depths, several detachable handles of various lengths are used. At the end of these long handles is a small cross-piece, similar to the cross-piece of a lawn mower; this enables the quahauger to obtain a strong pull when raking. The handles are made of strong wood, and are very thin and flexible, not exceeding 1½ inches in diameter. The price of these handles varies according to the length, but the average price is about $2. As the long handles break very easily, great care must be taken in raking.

Three forms of the basket rake are used in Massachusetts. These rakes vary greatly in form and size, and it is merely a question of opinion which variety is the best, as all are made on the same general principle, — a curved, basket-shaped body, the bottom edge of which is set with thin steel teeth.

The Wellfleet and Chatham Rake. — This rake is perhaps the most generally used for all deep-water quahauging on Cape Cod, and finds favor with all. It consists of an iron framework, forming a curved bowl, the under edge of which is set with thin steel teeth varying in length from 2 to 4 inches, though usually 2½-inch teeth are the favorite. Formerly these teeth were made of iron, but owing to the rapid wear it was found necessary to make them of steel. Over the bowl of this rake, which is strengthened by side and cross pieces of iron, is fitted a twine net, which, like the net of a scallop dredge, drags behind the framework. An average rake has from 19 to 21 teeth, and weighs from 15 to 20 pounds.

Edgartown Basket Rake. — The basket rake used at Edgartown and Nantucket is lighter and somewhat smaller than the Wellfleet rake. The whole rake, except the teeth, is made of iron. No netting is required, as thin iron wires ⅓ inch apart encircle lengthwise the whole basket, preventing the escape of any marketable quahaug, and at the same time allowing the mud to wash out. This rake has 16 steel teeth, 1½ inches long, fitted at intervals of 1 inch in the bottom scraping bar, which is 16 inches long; the depth of the basket is about 8 inches. Much shorter poles, not exceeding 30 feet in length, are used with this rake, and the whole rake is much lighter. The price of this rake is $7.50, while the poles cost $1.50.

The third form of basket rake is a cross between the basket and claw rakes. This rake is used both at Nantucket and on Cape Cod, but is not so popular as the other types. The basket is formed by the curve of the prongs, which are held together by two long cross-bars at the top and bottom of the basket, while the ends are enclosed by short strips of iron. This rake exemplifies the transition stage between the claw and basket types, indicating that the basket form was derived from the former. Handles 20 to 30 feet long are generally used with these rakes.

Shallow v. *Deep Water Quahauging.* — Two kinds of quahauging are found in Massachusetts, — the deep and the shallow water fisheries. This arbitrary distinction also permits a division of localities in regard to the principal methods of fishing. Although in all localities there exists more or less shallow-water fishing, the main quahaug industry of several towns is the deep-water fishery. In all the Buzzards Bay towns except Fairhaven and New Bedford the shallow-water fishery prevails; this is also true of the south side of Cape Cod. On the north side of Cape Cod the opposite is true, as the quahauging at Wellfleet, Eastham, Orleans and Brewster is practically all deep-water fishing. At Edgartown and Nantucket, although there is considerable shallow-water digging, the deep-water fishery is the more important.

The deep-water fishery is vastly more productive than the shallow-water industry, furnishing annually 118,500 bushels, compared to 23,227 bushels, or more than 5 times as much. The deep-water fishery, *i.e.*, the basket-rake fishery, is the main quahaug fishery of the State, and each year it is increasing, because of the opening of new beds. On the other hand, the shallow-water grounds are rapidly becoming barren from overfishing.

The deep-water quahauging is harder work, requires considerable capital but has fewer working days. Naturally the earnings from this fishery should surpass those of the shallow-water industry. The deep-water quahauger averages from $5 to $8 for a working day, while the shallow-water fisherman earns only from $2 to $3 per day.

Deep-water Quahauging. — Both power and sail boats are used in deep-water quahauging, though power is gradually replacing the old method of sailing, because of its increased efficiency and saving of time. When the quahaug grounds are reached, the boat is anchored at both bow and stern, one continuous rope connecting both anchors, which are from 500 to 600 feet apart, in such a way that the bow of the boat is always headed against the tide. A sufficient amount of slack is required for the proper handling of the boat, which can be moved along this anchor "road" as on a cable, and a large territory raked. The rake is lowered from the bow of the boat, the length of the handle being regulated by the depth of the water, and the teeth worked into the sandy or muddy bottom. The quahauger then takes firm hold of the cross-piece at the end of the handle, and works the rake back to the stern of the boat, where it is hauled in and the contents dumped on the culling board or picked out of the net. In hauling in the net the rake is turned so that the opening is on top, and the mud and sand is washed out before it is taken on board. The long pole passes across the boat and extends into the water on the opposite side when the rake is hauled in. This process is repeated until the immediate locality becomes unprofitable, when the boat is shifted along the cable.

The usual time for quahauging is from half ebb to half flood tide, thus avoiding the extra labor of high-water raking. Deep-water raking is especially hard labor, and six hours constitute a good day's work.

Boats. — Nearly all kinds of boats are utilized in the quahaug fishery, and are of all values, from the $10 second-hand skiff to the 38-foot power seine boat, which costs $1,500. The shallow-water industry requires but little invested capital. Dories and skiffs are the principal boats, costing from $10 to $25. Occasionally a sail or power boat may be used in this fishery. The deep-water industry requires larger and stronger boats. These are either power or sail boats, often auxiliary "cats," and their value runs anywhere from $150 to $1,500. The average price for the sail boats is $250, while the power boats are assessed at $350. At Orleans several large power seine boats, valued at about $1,500, are used in the quahaug fishery. These seine boats are 30 to 38 feet over all, have low double cabins, and are run by 8 to 12 horse-power gasolene engines. The ordinary power boats have gasolene engines from 2 to 6 horse-power. In this way each method of quahauging has its own boats, which are adapted for its needs.

Dredging. — So far as known, dredging is never used in quahauging in Massachusetts, although it is sometimes used on sea-clam beds. It has been tried, but without success, chiefly because of the uneven nature of the bottom. The invention of a suitable dredge is necessary, and there can be little doubt that in the future, if this difficulty is overcome, dredging will be used in the quahaug fishery. In 1879 Mr. Ernest Ingersoll reports in Rhode Island the use of a quahaug dredge similar in structure to our rake. Evidently this form was never especially successful, possibly because these dredges could not be dragged by sail boats.

Outfit of a Quahauger. — The implements and boats used in quahauging have already been mentioned. The outfit of the average quahauger in each fishery is here summarized: —

Deep-water Quahauging.		*Shallow-water Quahauging.*	
Boat,	$300	Boat,	$20
2 rakes,	20	Tongs or rakes,	3
3 poles,	6	Baskets,	2
	$326		$25

Season. — The quahaug fishery is essentially a summer fishery, and little if any is done during the winter. The season in Massachusetts lasts for seven months, usually starting the last of March or the first of April, and ending about the first of November. The opening of the spring season varies several weeks, owing to the severity of the weather; and the same is true of the closing of the season.

As a rule, the Buzzards Bay industry, where digging is done in the shallow waters of protected bays and coves, using short rakes and tongs, has a longer season than the quahaug industry of Cape Cod, where the fishery is carried on in deep and open waters. With the former, the cold work and hardship alone force the quahaugers to stop fishing, a long time after storms and rough weather have brought the latter industry to an end.

The actual working days of the deep-water quahauger number hardly over 100 per season, while those of the shallow-water fishermen easily outnumber 150. The deep-water quahauger's daily earnings are two or three times the daily wages of the shallow-water quahauger, but the additional number of working days in part make up this difference.

The quahaug season can be divided arbitrarily into three parts: (1) spring; (2) summer; (3) fall. The spring season lasts from April 1 to June 15, the summer season from June 15 to September 15, and the fall season from September 15 to November 1. These seasons are marked by an increase in the number of quahaugers in the spring and fall. The men who do summer boating quahaug in the spring before the summer people arrive, and in the fall after the summer season is over. The opening of the scallop season, in towns that are fortunate enough to possess both industries, marks the closing of the quahaug season.

These two industries join so well, scalloping in the winter and quahauging in the summer, that a shellfisherman has work practically all the year.

The Principal Markets. — The principal markets for the sale of Massachusetts quahaugs are Boston and New York. In 1879 the Boston market, according to Mr. Ernest Ingersoll, sold comparatively few. At the present time the Boston market disposes of many thousand bushels annually, but nevertheless the greater part of the Massachusetts quahaugs are shipped to New York. This, again, is due to the better market prices offered by that city. Besides passing through these two main channels, quahaugs are shipped direct from the coast dealers to various parts of the country, especially the middle west. This last method seems to be on the increase, and the future may see a large portion of the quahaug trade carried on by direct inland shipments.

Shipment. — Quahaugs are shipped either in second-hand sugar or flour barrels or in bushel bags. The latter method is fast gaining popularity with the quahaugers and dealers, owing to its cheapness, and is now steadily used in some localities. When quahaugs are shipped in barrels, holes are made in the bottom and sides of the barrel, to allow free circulation of air and to let the water out, while burlap is used instead of wooden heads.

"Culls." — Several culls are made for the market. These vary in number in different localities and with different firms, but essentially are modifications of the three "culls" made by the quahaugers: (1) "little necks;" (2) "sharps;" (3) "blunts." The divisions made by the firm of A. D. Davis & Co. of Wellfleet are as follows: (1) "little necks," small, 1½–2¼ inches; large, 2¼–3 inches; (2) medium "sharps," 3–3¾ inches; (3) large "sharps," 3¾ inches up; (4) small "blunts;" (5) large "blunts."

Price. — The prices received by the quahaugers are small, compared with the retail prices. "Little necks" fetch from $2.50 to $4 per bushel, sharps and small blunts from $1.10 to $2, and large blunts from 80 cents to $1.50, according to the season, fall and spring prices necessarily being higher than in summer. The price depends wholly upon the supply in the market, and varies greatly, although the "little necks" are fairly constant, as the demand for these small quahaugs is very great. To what excess the demand for "little necks" has reached can best be illustrated by a comparison between the price of $3 paid to the quahauger per bushel, and the actual price, $50, paid for the same by the consumer in the hotel restaurants.

Bedding Quahaugs for Market. — By town laws in Orleans, Eastham and Wellfleet, each quahauger may, upon application, secure from the selectmen a license, giving him not more than 75 feet square of tidal flat upon which to bed his catch of quahaugs. While no positive protection is guaranteed, public opinion recognizes the right of each man to his leased area, and this alone affords sufficient protection for the success of this communal effort, which is the first step by the people toward quahaug farming.

The quahauger needs only to spread his catch on the surface, and within two tides the quahaugs will have buried themselves in the sand. Here they will remain, with no danger of moving away, as the quahaug moves but little. The quahauger loses nothing by this replanting, as not only do the quahaugs remain in a healthy condition, but even grow in their new environment.

The result of this communal attempt at quahaug culture is beneficial. While the market price for "little necks" is almost always steady, the price of the larger quahaugs fluctuates considerably, and the market often becomes "glutted." This would naturally result in a severe loss to the quahauger if he were forced to keep shipping at a low price. As it is, the fortunate quahauger who possesses such a grant merely replants his daily catch until the market prices rise to their proper level. An additional advantage is gained by the quahauger, who at the end of the season has his grant well stocked, as higher prices are then offered. As many as 1,000 barrels are often held this way at the end of the season.

Food Value. — See food value table in scallop report.

Uses. — Besides its many uses as a food, raw, cooked and canned, the quahaug is of little importance in Massachusetts.

(1) For bait the soft clam (*Mya arenaria*) is generally preferred, and but few quahaugs are used for this purpose.

(2) The shell was once prized by the Indians for their wampum; now it is occasionally used for ornamental purposes.

(3) Oystermen use it for cultch when they can get nothing better; though more fragile shells are usually preferred, so that the masses of oyster "set" can be easily broken apart.

(4) Shell roads are occasionally made from quahaug shells. Possibly lime could be profitably obtained.

History of Quahaug Industry in Massachusetts.

South of Plymouth harbor quahaugs have always been plentiful along the shores of Cape Cod, Buzzards Bay and the islands of Nantucket and Martha's Vineyard. Frequent shell heaps show that the Indians were accustomed to use this mollusk as a food, and even indulged in an occasional clam bake. Colonial records show us that the early colonists were not slow in learning to "tread out" this mollusk from the mud flats. The shells of the quahaug were much prized by the Indians for wampum beads, because of their purplish color.

Although reckoned inferior by many to the soft clam (*Mya arenaria*), the quahaug was dug for home consumption for years in Massachusetts, and but little attempt was made to put it on the market. The commercial quahaug fishery started on Cape Cod, about the first of the nineteenth century, growing in extent until about 1860. From 1860 to 1890 the production remained about constant. The production in 1879 for Massachusetts, as given by A. Howard Clark, totaled 11,050 bushels, valued at $5,525. It is only in the last fifteen to twenty years that the actual development of the quahaug fishery has taken place. The present production of Massachusetts is 144,044 bushels, valued at $194,687. To the popular demand for the "little neck" can be attributed the rapid development of the quahaug industry during the last ten years. This development has furnished employment for hundreds of men, and has given the quahaug an important value as a sea food. What it will lead to is easily seen. The maximum production was passed a few years ago, constant overfishing caused by an excessive demand is destroying the natural supply, and there will in a few years be practically no commercial fishery, unless measures are taken to increase the natural supply. Quahaug farming offers the best solution at the present time, and gives promise of permanent success.

The following statistics, taken from the United States Fish Commission reports, show the rapidity of the development of the quahaug fishery: —

Date.	Bushels.	Value.	Price (Cents).
1879, ...	11,050	$5,525	50.0
1887, ...	35,540	21,363	60.0
1888, ...	26,165	14,822	56.5
1898, ...	63,817	50,724	79.5
1902, ...	106,818	131,139	124.0
1905, ...	166,526	288,987	155.0

Not only has there been an increase in production, but also an increase in price, as can be seen from the above table, which shows that the price has more than doubled between 1888 and 1902. This increase in price has alone supported a declining fishery in many towns, making it still profitable for quahaugers to keep in the business, in spite of a much smaller catch. The advance in price is due both to the natural rise in the value of food products during the past twenty-five years and also to the popular demand for the "little neck," or small quahaug.

State Laws. — There are no State laws governing the quahaug fishery, except the regulations of the State Board of Health in regard to sewage pollution in Acushnet River and Boston Harbor.

Town Laws. — Regulation of the quahaug fishery was given to each town by the State under the general shellfish act of 1880; the industry is therefore entirely governed under the by-laws of the town.

An interesting comparison can be made between the quahaug regulations of the different towns. Good, useless and harmful laws exist side by side. One town will pass excellent regulations, and enforce them; another town will make the same, but never trouble to see that they are observed. Edgartown enforces the 1½-inch quahaug law; Orleans, Eastham and Wellfleet have the same law, but fail to enforce it. Many towns allow the small seed quahaugs to be caught and shipped out of the State, thus losing $4 to every $1 gained. These towns refuse to make any regulation, such as a simple size limit, which would remedy this matter, and have no thought for the future of their quahaug industry. All that can be said is that the quahaug laws are the best of the town shellfish regulations, and that is but faint praise.

Statistics of the Quahaug Fishery.

In the following table the towns are arranged in alphabetical order, and the list includes only those towns which now possess a commercial quahaug fishery. In giving the number of men, both transient and regular quahaugers are included. In estimating the capital invested, the boats, implements, shanties and gear of the quahauger are alone considered, and personal apparel, such as oil-skins, boots, etc., are not taken into account. The value of the production for each town is based upon what the quahaugers receive for their quahaugs, and not the price they bring in the market. The area of quahaug territory given for each town includes all ground where quahaugs are found, both thick beds and scattering quahaugs.

Town.	Number of Men.	Capital invested.	Number of Boats.	Number of Dories and Skiffs.	1907 Production.		Area in Acres.	Value of Yield per Acre.
					Bushels.	Value.		
Barnstable,	25	$850	-	25	2,500	$3,700	950	$3 95
Bourne,	46	1,000	-	46	5,400	8,400	2,500	3 36
Chatham,	50	5,750	25	25	6,700	10,000	2,000	5 00
Dennis,	15	150	-	10	500	950	200	4 75
Eastham,	25	8,000	12	-	10,000	11,500	4,000	2 87
Edgartown,	70	12,000	42	18	20,000	32,000	1,800	17 77
Fairhaven,	115	5,000	11	100	15,000	16,500	3,000	5 50
Falmouth,	-	-	-	-	100	115	400	29
Harwich,	7	200	-	7	1,500	2,550	100	25 50
Marion,	19	250	-	19	800	1,500	400	3 75
Mashpee,	7	70	-	5	250	285	400	71
Mattapoisett,	28	500	-	28	800	1,500	750	2 00
Nantucket,	48	6,750	30	10	6,294	8,487	5,290	1 60
Orleans,	75	25,000	30	25	33,000	41,350	1,500	27 56
Wareham,	50	1,000	-	50	6,000	10,500	1,300	8 08
Wellfleet,	145	27,500	100	-	33,000	41,350	2,500	16 54
Yarmouth,	20	240	-	10	2,200	4,000	1,000	4 00
Totals,	745	94,260	250	378	144,044	194,687	28,090	Average $6 93

Barnstable.

Barnstable, with its extensive bays both on the north or bay side and on the south or Vineyard Sound side, offers great possibilities for quahaug production. Although the quahaug ranks, in productive value, the third shellfish industry of Barnstable, the natural resources permit an expansion under cultural methods which would place the quahaug ahead of the oyster, which at the present time is the leading shellfish industry of the town.

In Barnstable harbor, on the north coast of the town, a few quahaugs are found scattered in isolated patches. (See Map No. 9.) These are relatively of small importance commercially, and no regular fishery is carried on. In the future the vast barren flats of this harbor may be made productive of quahaugs as well as clams, although at present the total area of quahaug grounds is hardly 5 acres.

The greater part of the quahaug industry of Barnstable is conducted on the south shore of the township, which is especially adapted, with its coves and inlets, for the successful growth of this shellfish. The principal fishery is in Cotuit harbor and West Bay, and is chiefly shared by the villages of Osterville, Marston's Mills and Cotuit, which lie on the east, north and west sides, respectively, of the bay.

While the greater part of Cotuit harbor is taken up by oyster grants, there are certain parts, though limited in area, which are set aside for quahauging. The principal area for quahauging is the flat which runs along Oyster Island. This was originally an oyster grant taken out by Wendell Nickerson, and thrown open to quahaugers to protect the quahaug interests from the oyster planters. This territory, which comprises 70 acres, is mostly hard sand. Directly west in the center of the harbor lies a strip of 80 acres of mud and eel grass, where both quahaugs and scallops abound. The depth of water on quahauging grounds varies from 1 to 14 feet.

Scattering quahaugs are found also in Osterville harbor, West Bay, Popponesset River and East Bay. This bottom is practically all sand, and comprises a total of 1,650 acres. This cannot all be considered good quahaug ground, although quahaugs can occasionally be found.

At Hyannis the quahaug grounds are confined to Lewis Bay, where they cover an area of 800 acres. The quahaugs lie in scattered patches over this area, but in no place is there especially good quahauging. The bottom is hard, usually sandy, with patches of eel grass, while the average depth of water is hardly more than 6 feet.

In Osterville Bay about 20 men, in Lewis Bay about 5, using the same number of dories, make a business of quahauging in the summer months. Three styles of implements are used: (1) oyster tongs, varying from 8 to 16 feet, according to the depth of water; (2) large basket rakes, with 30-foot handles; (3) ordinary garden rakes, with wire basket, for shallow-water digging.

At Cotuit the quahaugs run one-third "little necks," one-third mediums and one-third large. Here several men, using long-handled rakes, make from $3 to $5 per day in favorable weather. The markets are principally New York and Boston, where the quahaugs are shipped, mostly in sacks, which is a cheaper and better way than shipment in barrels. Here the quahaug season lasts from April 1 to November 1, most of the work being done in the summer, when the oyster business is at a standstill.

There are no town laws governing the quahaug fishery, other than forbidding a non-resident of the town the right of quahauging; and no licenses are required.

No records of the history of the quahaug industry at Barnstable can be found. A. Howard Clark in 1879 makes the following brief statement, which is the only record obtainable: —

> Both soft clams and quahaugs are found in the harbor [Osterville harbor], but no considerable fishing for them is carried on.

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	950
Number of men,	25
Number of boats,	–
Value of boats,	–
Number of dories,	25
Value of dories,	$500
Value of implements,	$350

Production.

"Little necks": —	
Bushels,	800
Value,	$2,000
Quahaugs: —	
Bushels,	1,700
Value,	$1,700
Total: —	
Bushels,	2,500
Value,	$3,700

Bourne.

The town of Bourne was formerly included in the town of Sandwich, and many old laws relating to shellfish, such as oyster regulation in Barlow River, were enacted by the town of Sandwich. Situated at the head of Buzzards Bay, and separated from the adjacent town of Wareham by Cohasset Narrows, Bourne has many advantages for a profitable quahaug industry. It possesses nearly twice as much quahaug territory as Wareham, but, as most of this lies unproductive, has a smaller annual output. The territory includes over 2,500 acres of ground, most of which consists of flats of mud, sand and eel grass, covered with shallow water. It is very sparsely set with quahaugs. Outside the oyster grants practically the entire stretch of coast from

Buttermilk Bay to Wings Neck is quahauging ground, as can be seen on Map No. 17. Other quahaug grounds lie between Basset's Island, Scraggy Neck and Handy's Point. It is our opinion that this large territory, which to-day yields on the average less than $3.50 per acre, in the future, under cultivation, can be made to yield an average of $100 per acre, thereby bringing into the town of Bourne a yearly income of at least $250,000, and furnishing labor for hundreds of men.

About 46 men are engaged in the quahaug fishery of Bourne, using the same number of skiffs and dories, which represent approximately an investment of $875. The fishery lasts usually seven months during the summer, April 1 to November 1, while the winter digging is of small account. Practically all the digging is done in comparatively shallow water, with short-handled rakes or tongs. Rather more than a third of the quahaugs appear to be "little necks," while the mediums constitute one-tenth of the total catch. "Blunts" are of little consequence.

The selectmen issue permits for the taking of quahaugs and clams. In 1906, 46 permits were issued, entitling the holder to 10 bushels of clams and 10 bushels of quahaugs per week.

There is little to be said concerning the history of the Bourne quahaug industry, as no early records exist. Its development has been similar to that of the industries of the other Buzzards Bay towns. During the last few years the Bourne fishery, unlike most of the towns on Buzzards Bay, has shown signs of increasing. This is not due, however, to any increase in the natural supply, but to the decline of the oyster industry, which gives more opportunity to the quahaugers. The same antagonistic feeling that is prevalent in Wareham exists here between the oystermen and quahaugers.

Summary of Industry.

Area of quahaug territory (acres),	2,500
Number of men,	46
Number of boats,	–
Value of boats,	–
Number of skiffs,	46
Value of skiffs,	$875
Value of implements,	$125

Production.

"Little necks": —	
Bushels,	2,000
Value,	$5,000
Quahaugs: —	
Bushels,	3,400
Value,	$3,400
Total: —	
Bushels,	5,400
Value,	$8,400

Chatham.

Chatham is favorably situated in regard to the quahaug fishery, as this shellfish is found in the waters on the north and south sides of the town. The grounds are extensive, covering about 2,000 acres, the greater part of which consists of the vast area south of the town known as the "Common Flats."

The quahauging grounds are in four localities: (1) Pleasant Bay; (2) Mill Pond; (3) Stage Harbor; (4) Common Flats.

(1) Part of the waters of Pleasant Bay belong to the town of Chatham. In an arm of this bay, known as Crows Pond, the best Pleasant Bay fishery is carried on in water varying from 6 to 16 feet in depth.

(2) An excellent "little neck" fishery is carried on in the upper part of the Mill Pond, in comparatively shallow water, comprising an area of 3 acres. On these bars in 1905 there was a very heavy set of small quahaugs, which were rapidly taken up before they had a chance to attain to a fair size.

(3) Quahaugs are raked on the west side of Stage Harbor in 5 to 15 feet of water, in an area of 4 acres of muddy bottom.

(4) The Common Flats comprise 1,700 acres, and are covered at low tide by a depth of only 1 to 2 feet of water. Quahaugs are found throughout this territory in scattering quantities, but practically all is good quahaug ground except the shifting outer part of the flat. The soil varies from a pure sand to a sandy mud, and in parts is thickly covered with eel grass, which makes raking hard. This area offers one of the best opportunities for successful quahaug planting in the State. The area is large, seed can be obtained easily and quahaugs grow well in this locality. If it were not for the lack of protection, Chatham could establish one of the best quahaug industries in the State by leasing out the Common Flats for planting purposes.

Quahaugs are taken at Chatham only with rakes. In the deep water in Crows Pond and in Stage Harbor basket rakes are used; but in the shallow water on the Common Flats and in the Mill Pond the usual implement is an ordinary garden rake, with wire netting basket. Handles from 20 to 25 feet in length are used with the basket rakes.

The quahaug industry has existed in Chatham for the past twelve years.

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	2,000
Number of men,	50
Number of boats,	25
Value of boats,	$5,000
Number of dories,	25
Value of dories,	$350
Value of implements,	$400

Production.

"Little necks": —	
Bushels,	2,200
Value,	$5,500
Quahaugs: —	
Bushels,	4,500
Value,	$4,500
Total: —	
Bushels,	6,700
Value,	$10,000

Dartmouth.

The quahaug industry of Dartmouth is of little consequence. In 1907, 320 permits were granted, mostly to New Bedford fishermen for "bait."

Dennis.

The quahauging grounds of Dennis are practically all in Bass River, where Dennis has equal fishery rights with Yarmouth. The area of these grounds is 200 acres, with a maximum depth of 6 feet of water over the beds. The history of the industry is the same as that of Yarmouth, as the two industries are closely associated, and a similar decline has resulted. The laws for both towns are the same.

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	200
Number of men (transient),	15
Number of boats,	–
Value of boats,	–
Number of skiffs,	10
Value of skiffs,	$100
Value of implements,	$50

Production.

"Little necks": —	
Bushels,	300
Value,	$750
Quahaugs: —	
Bushels,	200
Value,	$200
Total: —	
Bushels,	500
Value,	$950

Eastham.

Eastham is similar to Orleans in situation, possessing a good coast line on both the east and west, which affords excellent opportunities for the quahaug fishery.

On the west or bay side are extensive beds of quahaugs, for the most part blunts, extending into deep water for nearly 3 miles. This quahauging territory comprises about 4,000 acres, which is open to the quahaugers of both Wellfleet and Orleans. While scattering quahaugs are found over approximately all this territory, the fishery is conducted in only certain definite places.

In Nauset harbor on the east side during the season of 1906 numerous beds of "little necks," about the 1½-inch size, were discovered. It is thought that these came from the spawn of certain quahaugs which the life savers were accustomed to bed in the harbor for their own use. These quahaugs were torn up and scattered by the ice during a severe winter, and in this way the nucleus of a new fishery was formed. Two men who discovered the best of these beds cleared $60 in one week.

On the west coast of the town 25 men commonly dig with long-handled rakes. These fishermen work at quahauging about 100 days in the year, and average from 5 to 6 bushels per day. Power boats are used for the most part, although the boats are not so large or expensive as those of the Orleans fishermen, for the Eastham quahauger digs in the more sheltered waters of Wellfleet Bay.

The production for 1906 was 10,000 bushels, but this does not give the true yield of the Eastham flats, as the Wellfleet and Orleans fishermen rake to a great extent in Eastham waters, and so many more bushels are actually taken within the town limits.

The town laws of Eastham are the same as those of Wellfleet. (See Wellfleet.) The history of the Eastham quahaug industry is so closely connected with that of Orleans and Wellfleet that no additional features require mention.

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	4,000
Number of men,	25
Number of boats,	12
Value of boats,	$7,375
Number of dories,	–
Value of dories,	–
Value of implements,	$625

Production.

"Little necks": —	
Bushels,	1,000
Value,	$2,500
Quahaugs: —	
Bushels,	9,000
Value,	$9,000
Total: —	
Bushels,	10,000
Value,	$11,500

Edgartown.

The finest "little neck" fishery in Massachusetts is found in Katama Bay, in the town of Edgartown. Two-fifths of the entire catch are "little necks." The most productive grounds are situated in the lower part of Katama Bay, while quahaugs are also found in Edgartown harbor and in Cape Poge Pond, the total area of these localities comprising 1,800 acres.

The fishing is mostly done from power dories or sail boats with basket rakes. Poles from 20 to 25 feet long are used, as the water over the beds is less than 20 feet deep. Some quahaugs are taken in the shallow water with small claw rakes. The catch is shipped to the New York and Boston markets.

The quahaug industry of Edgartown is the best-regulated shellfish industry in Massachusetts. If excellent care had not been taken of the "little neck" fishery of Katama Bay by enforcing a size limit of 1½ inches, through the employment of a special shellfish warden, the quahaug fishery of Edgartown would have been ruined long ago by the exportation of small "seed" quahaugs. To-day the number of small quahaugs which are returned to the water greatly exceeds the amount of marketable quahaugs taken. This is the only case in Massachusetts where the quahaug fishery, by careful regulations of the town, has maintained an undiminished supply. If other towns had taken similar care of their quahaug fisheries in the past, the general decline of the industry in this State would never have become so serious.

The following is a copy of the shellfish permit, which every Edgartown quahauger is required to take out, at the cost of $2, before he can rake quahaugs for market. Any man over sixty years old obtains his permit free. This permit should serve as a model for other towns.

SHELLFISH PERMIT.

TOWN OF EDGARTOWN, SELECTMEN'S OFFICE, 190 .

In consideration of having received from of Edgartown the sum of $2, permission is hereby granted to him to take from any of the waters of this town daily, between sunrise and sunset, twenty-five bushels of scallops or clams, including shells, and four bushels, including shells, of quahaugs; of these four bushels, not more than two bushels are to be of the size known as "little necks."

The acceptance of this permit constitutes an agreement by the holder thereof that he will, and that any other person who for the time being has or shall have in his custody or possession any building, boat, barrel, box, tub, crate or other vessel or receptacle containing or suitable for or capable of containing shellfish, and belonging to or under the control of the holder of this permit, shall, at any time or place when requested so to do by either of said selectmen or by their authorized agent, or by any constable or fish warden of said town, or by any other officer authorized to enforce the laws relating to shellfish or shellfisheries in said town, open any such building, boat, barrel, box, tub, crate or other vessel or receptacle, and fully expose to them or either of them the contents thereof for inspection; and if the holder of this permit or such other person as aforesaid, when so requested, refuses or neglects so to do, said selectmen may revoke this permit or suspend the same for any stated time, at their discretion.

The holder of this permit is subject to the regulations for the taking of eels and shellfish as made and posted by the selectmen, and also to any additional regulations which said board may hereafter make and publish.

If the person having this permit for the taking of shellfish violates any law of the Commonwealth or any regulation now or hereafter made by said selectmen, relating to shellfish or shellfisheries in said town, said selectmen may revoke said permit, or suspend the same for any stated time at their discretion.

No person is allowed by law to take from the waters of said town, or to sell or offer for sale, or to have in his possession, any "little neck" clams or quahaugs measuring less than one and one-half inches across the widest part. Any person violating this provision of law is liable to a fine of not less than ten nor more than one hundred dollars.

This permit will expire April 1, 190 , unless sooner revoked.

Selectmen of Edgartown.

Ernest Ingersoll in 1879 makes the following statement concerning the quahaug fishery of Martha's Vineyard: —

Martha's Vineyard used to be bordered by good quahaug ground, but I am not aware that many are caught there now. In an old book I find the following allusion to it: "The poquau (*Venus mercenaria*) is found in Old Town Harbor, at Cape Poge, and in Menemsha Pond: great quantities are exported."

A. Howard Clark in 1879 says: —

Soft clams and quahaugs are abundant in the harbor, and are used by the fishermen for bait. . . . Three hundred bushels of quahaugs and sea clams, valued at $150, were taken during the year 1879.

If such were the conditions in 1879, the industry has had a great development. To-day Edgartown is one of the best quahaug towns of the State, and produces the finest "little necks." Comparing the production figures of 1879 and 1907, a great increase is noted: —

Production, 1879.

Bushels,	300
Value,	$150

Production, 1907.

Bushels,	20,000
Value,	$32,000

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	1,800
Number of men,	70
Number of boats,	42
Value of boats,	$10,500
Number of dories,	18
Value of dories,	$450
Value of implements,	$1,050

Production.

"Little necks": —	
Bushels,	8,000
Value,	$20,000
Quahaugs: —	
Bushels,	12,000
Value,	$12,000
Total: —	
Bushels,	20,000
Value,	$32,000

Fairhaven.

At Fairhaven the quahaug industry is of considerable importance, and the output from this town alone is nearly half the entire production of Buzzards Bay.

Some 3,000 acres are more or less bedded with quahaugs. Of this, probably not more than one-tenth is very productive. The best quahauging is in Acushnet River, where digging for market has been forbidden because of sewage pollution (see New Bedford), and in Priests Cove as far as Sconticut Neck. In these grounds "little necks" are numerous. The grounds around West Island and Long Island, once very productive, are now largely dug out. Little Bay and the east coast of Sconticut Neck are fairly productive, while the west coast yields only a small amount. Most of the quahaugs now dug come from the deep water west-southwest of Sconticut Neck. Here, with rakes having handles from 40 to 60 feet long, the quahaugers dig in water 7 fathoms or more in depth. The quahaugs, mostly large sharps, are in bluish mud or sticky bottom, and are all large. A number of blunts are found with these large sharps. In the Acushnet River, owing to the enforced closed season, there are a large number of "little necks."

About 115 men are employed now in quahauging. Before the Acushnet River was closed by law, over twice that number are reported to have been engaged in the business. Six power boats and five cat boats, besides a considerable number of skiffs and dories, are used in the fishery.

No permits are required for ordinary quahauging except in the prescribed territory of Acushnet River, where permits to catch a certain amount for bait are given as in New Bedford.

The production for 1879, as given by A. Howard Clark in "The Fisheries of Massachusetts," was 3,000 bushels, which is just one-fifth of the present production. The supply of quahaugs has decreased the last few years, though new territory is constantly being opened up, as the quahaugers go out further into the deeper water. The increased price, however, probably more than counterbalances the decline in production.

Summary of Industry.

Area of quahaug grounds (acres),	3,000
Number of men,	115
Number of boats,	11
Value of boats,	$2,600
Number of skiffs,	100
Value of skiffs,	$1,500
Value of implements,	$900

Production.

"Little necks": —	
Bushels,	1,000
Value,	$2,500
Quahaugs: —	
Bushels,	14,000
Value,	$14,000
Total: —	
Bushels,	15,000
Value,	$16,500

Falmouth.

There is practically no quahaug industry in Falmouth. Hardly 100 bushels are dug annually, and those only for home consumption. A few quahaugs are perhaps shipped by the oystermen.

This town, with its numerous inlets, bays and brackish water ponds, offers perhaps as fine an opportunity for shellfish culture, especially for quahaugs, as exists in Massachusetts. There is no reason why the water of Waquoit Bay and the other brackish ponds should not produce a great supply of quahaugs, if properly worked.

Quahaugs are found mostly in scattering quantities over a large area in Waquoit Bay and in small quantities on the north and west side of Great Pond, comprising a total of nearly 400 acres. Not all this ground, which is the greater part mud, is capable of producing quahaugs, but many parts could produce good harvests. On the bay side of the town small patches of good quahaugs are found at North Falmouth, Squeteague Pond, West Falmouth harbor on the southeast side, and a few are found in Hadley harbor, Naushon. These, together with the small patches in Great Pond, comprise about 1 acre of good quahaug ground, and are mostly dug by summer people.

In the past twenty-five years there has been a great decline in the quahaug industry, especially in Waquoit Bay, which to-day barely produces 50 bushels. A. Howard Clark states, in 1879:[1] —

Quahaugs are plenty in Waquoit Bay, and are gathered and eaten by the villagers, but none are shipped. It is estimated that about 500 bushels of quahaugs are annually consumed by the people of Falmouth town.

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	400
Number of men,	–
Number of boats,	–
Value of boats,	–
Number of dories,	–
Value of dories,	–
Value of implements,	–

Production.

"Little necks": —	
Bushels,	10
Value,	$25
Quahaugs: —	
Bushels,	90
Value,	$90
Total: —	
Bushels,	100
Value,	$115

Harwich.

The quahaug fishery of the town of Harwich is carried on in that part of Pleasant Bay which lies within the town limits. In the southern waters of the town, on the Sound side, scattering quahaugs are found in certain localities, but are not of any commercial importance. The most important of those localities are off Dean's Creek and in Herring River, where quahaugs are dug for home consumption.

Harwich shares with Chatham and Orleans the quahaug fishery of Pleasant Bay, but has a more limited territory, as only a small portion of Pleasant Bay lies within the town limits. Practically all this territory, comprising 100 acres, is quahauging ground, though the commercial quahauging is prosecuted over an area of 10 acres only. Scattering quahaugs are found over an area of 100 acres.

As the waters of Pleasant Bay are sheltered, the fishing is all done from dories, with basket rakes having 20 to 25 foot poles. The depth of water over the quahaug beds is from 6 to 16 feet.

[1] "The Fisheries of Massachusetts," United States Fish Commission Report, Section II., p. 253.

In regard to the quahaug fishery in Pleasant Bay, Mr. Warren J. Nickerson of East Harwich, who has been acquainted with the industry for many years, says: —

Pleasant Bay is and has been a very valuable quahaug ground. Some fifty years ago there were shipped in vessels to New Haven and other places 13,000 bushels in one year from its waters. Since then there has been more or less taken from these waters by fishermen from the towns of Orleans, Chatham and Harwich. During the last few years there have been 25 regular fishermen and perhaps 12 transient. Probably 8,000 bushels a year for the last five years would be a fair estimate of the catch. Thirty per cent. of these were "little necks."

Summary of Industry.

Area of quahaug territory (acres),	100
Number of men,	7
Number of boats,	–
Value of boats,	–
Number of dories,	7
Value of dories,	$100
Value of implements,	$100

Production.

"Little necks": —	
Bushels,	700
Value,	$1,750
Quahaugs: —	
Bushels,	800
Value,	$800
Total: —	
Bushels,	1,500
Value,	$2,550

Marion.

The town of Marion, situated on the western side of Buzzards Bay, possesses a spacious harbor, the waters of which furnish excellent quahaug grounds.

This territory, comprising a total of 400 acres, is chiefly confined to Marion harbor, running in a narrow strip parallel to the shore from Aucoot Cove all along the coast to Planting Island. Almost all the head of the harbor and all of Blankinship's and Planting Island Cove is quahaug area. Small grounds are also found at Wing's Cove and in the Weweantit River.

The town law requires each year the possession of a permit costing $1 before a person is entitled to dig quahaugs for sale. Nineteen of these licenses were issued in 1906, but not more than 2 or 3 of these went to men who depend upon quahauging for a living. The remaining 16 engage in the fishery to a greater or lesser extent in the summer season.

The annual production for 1906 was 800 bushels, valued at $1,500, as about half were "little necks." Mediums are not numerous, and are bought by the quahaug dealers at $1.25 per bushel and sold by them at so much per hundred.

In Marion the quahaug industry once flourished to a marked degree, but at present is very much on the decline. The coves, which once were bedded with "little necks" and quahaugs, are now nearly exhausted. No reasons exist for this condition of affairs, so far as known, except overdigging. Gradually for many years the supply has perceptibly declined, until now it is at a very low ebb. Where a thousand barrels were formerly produced, it is doubtful if a thousand bushels are now dug during the entire season, and the overworked beds are becoming each year more depleted. A. Howard Clark, in his report on the fisheries of Marion, estimates the quahaug production in 1880 as 2,000 bushels. The yield for 1906 is only 800 bushels, which shows an alarming decline in production. If once the waters of Marion could produce a large amount of quahaugs, there is no reason why they cannot again be made to produce the same, or more.

Summary of Industry.

Area of quahaug territory (acres),	400
Number of men,	19
Number of boats,	–
Value of boats,	–
Number of skiffs,	19
Value of skiffs,	$200
Value of implements,	$50

Production.

"Little necks": —	
Bushels,	400
Value,	$1,100
Quahaugs: —	
Bushels,	400
Value,	$400
Total: —	
Bushels,	800
Value,	$1,500

Mashpee.

The quahaug industry at Mashpee is at a low ebb. Natural facilities are favorable, but a lack of initiative on the part of the inhabitants causes a small production. The best grounds are found in Popponessett Bay and River, where a territory of 200 acres includes several oyster grants which are worked but little. On the east side of Waquoit Bay scattering quahaugs are found in Mashpee waters.

There are 3 regular and 4 intermittent quahaugers, with an invested capital of $70, who are obliged by the town laws to have a permit costing $1. The quahaug industry of the town has remained about the same for the last twenty-five years, and now a good quahauger can scarcely average 1½ to 2 bushels per day.

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	400
Number of men,	7
Number of boats,	–
Value of boats,	–
Number of skiffs,	5
Value of skiffs,	$50
Value of implements,	$20

Production.

"Little necks": —	
Bushels,	25
Value,	$60
Quahaugs: —	
Bushels,	225
Value,	$225
Total: —	
Bushels,	250
Value,	$285

Mattapoisett.

The town of Mattapoisett, situated to the west of Marion, receives but little income from her shellfisheries, as the waters are for the most part too open and exposed for shellfish culture. The quahaug fishery is the most important shellfish industry of the town, but even this, when compared with the quahaug fishery of other towns, is rather unimportant, as most of the suitable territory is nonproductive.

Quahaugs are very unevenly distributed over 800 acres. The best quahaugs are found in Aucoot Cove and at Brants. In the main harbor quahaugs are found, though scattering, as indicated on the map.

No licenses or permits are required of the 28 men and boys who add to their income from time to time by quahauging. Most of these depend on other sources of employment for their main support. The industry as a whole is gradually declining, as overfishing has made it impossible for the natural supply to perpetuate itself.

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	750
Number of men,	28
Number of boats,	–
Value of boats,	–

Number of skiffs,	28
Value of skiffs,	$425
Value of implements,	$75

Production.

"Little necks": —	
Bushels,	400
Value,	$1,100
Quahaugs: —	
Bushels,	400
Value,	$400
Total: —	
Bushels,	800
Value,	$1,500

Nantucket.

The quahaug industry of Nantucket ranks second to the main shellfish industry, the scallop fishery, and brings annually about $8,000 to the island. Nantucket is especially adapted for quahaugs, as Nantucket harbor, Maddequet harbor and the Island of Tuckernuck possess extensive territory. In spite of these natural advantages, which are as fine as any in the State, Nantucket produces only 6,000 bushels annually, whereas her resources, under proper cultural methods, warrant an annual production exceeding even that of Wellfleet, which is at present shipping 33,000 bushels.

The quahauging territory of Nantucket is divided into three sections: (1) Nantucket harbor; (2) Maddequet harbor; and (3) Tuckernuck.

In Nantucket harbor quahaugs are found over an area of 2,290 acres, both scattering and in thick patches. The principal areas are situated as follows: —

(1) Near the town between Monomoy Heights and the wharves is a territory of 240 acres. In the deep water directly out from the wharves there has been good quahauging although the bed was discovered only a few years ago.

(2) On the east side of the harbor, between Abram's Point and Pocomo Head, including Polpis harbor, are extensive grounds, comprising about 900 acres, of scattering quahaugs.

(3) On the opposite side of the harbor lies a strip of quahaug territory of 250 acres, which extends between Third Point and Bass Point.

(4) At the head of the harbor on both sides quahaugs are found over an area of 900 acres.

Maddequet harbor on the western end of the island has approximately 300 acres suitable for quahaugs, running from Broad Creek to Eel Point.

On the eastern end of Tuckernuck Island is a bed of quahaugs covering about 200 acres; while on the west side, between Muskeget and

Tuckernuck, is a large area of 2,500 acres, which is more or less productive. The Tuckernuck fishery is largely "little necks," and it is from here that the shipment of small "seed" quahaugs has been made.

In the spring and fall men who have been boatmen during the summer work at quahauging. While 48 men work irregularly, about 18 men are engaged in the fishery during the entire summer, though probably never more than 30 are raking at any one time.

The production in 1906, from April 1 to November 1, was 2,159 barrels, or 6,477 bushels; value, $7,557.

PRODUCTION, 1907.[1]

MONTHS.	Quahaugs.				"Little Necks."			
	Barrels.	Average Price per Barrel.	Bushels.	Value.	Barrels.	Average Price per Barrel.	Bushels.	Value.
April,	138	$3 50	414	$483	-	-	-	-
May,	257	4 00	771	1,028	4	$14 00	12	$56
June,	460	4 00	1,380	1,840	13	14 00	39	182
July,	355	3 00	1,065	1,060	33	14 00	99	462
August,	312	3 50	936	1,092	20	15 00	60	300
September,	302	3 42	906	1,032	22	10 00	66	220
October,	123	4 00	369	492	9	10 00	27	90
November,	50	3 00	150	150	-	-	-	-
Total,	1,997	$3 60	5,991	$7,177	101	$12 97	303	$1,310
"Little necks,"	101		303	1,310				
Grand total,	2,098		6,294	$8,487				

[1] Returns of Special Agent Wm. C. Dunham.

The month of June shows the largest production, as the summer people do not arrive in any numbers until July. The men who do the summer boating are engaged in the quahaug fishery during this month, naturally increasing the production.

The principal method is raking from a boat or dory with a long-handled basket rake, very similar in form to the rake used on Cape Cod. The second method, applicable only in shallow water, employs the use of a claw rake with a much shorter handle. The quahauger uses this rake in the shallow water, where he can wade at low tide. The largest claw rakes are often wider than the basket rakes, and are much cheaper.

At Nantucket about 5 per cent. of the entire catch is "little necks," which are found mostly at Tuckernuck. The quahauger usually makes three culls of his catch: (1) "little necks"; (2) medium; (3) large. A few blunts are obtained. The quahaugs are shipped chiefly to New

York and Boston markets, either directly by the quahaugers or through Nantucket firms.

The boats used in the industry, numbering 24 sail, 6 power and 10 single dories, and approximating $6,150 in value, are in a way transitory capital, and are used in the winter for scalloping and other fishing. Nevertheless, it is necessary to class them as capital used in the quahaug fishery.

No special town laws are made for the regulation of the Nantucket quahaug fishery, although at any time by vote of the town suitable regulations and by-laws can be made.

Quahaugs have probably always been abundant at Nantucket, as over fifty years ago they were reported as plentiful. It is only of late years that the fishery has assumed any great importance, when the increasing prices, especially for the "little necks," made it profitable for men to enter the business. As it is, many men now quahaug only when they have nothing else to do.

From the statistics of the United States Fish Commission for 1879 we find that the annual catch for that year amounted to 150 bushels, valued at $75. As a striking contrast to this, the present production of 6,294 bushels, valued at $8,487, shows the great development of the fishery, which has been caused by more men entering the business, the opening up of new beds, such as the "little neck" beds of Tuckernuck, and the improved methods of raking in the deep water.

It is rather difficult to state definitely, from lack of past statistical figures, whether Nantucket industry is declining or improving. Between 1879 and 1906 no records are obtainable. The production figures for 1906 show 6,477 bushels, as compared with 6,144 bushels in 1907. Whether there was merely a sudden temporary increase in the supply by the opening up of new beds in 1906, or whether there is a steady decline, can only be determined by the production of future years. Many indications point to the latter, in spite of the assurance of the quahaugers that 1907 was a good season, because of high market prices.

The last few years have witnessed a change in the quahaug fishery, — a realization that there is more money in planting and raising quahaugs than in oyster culture. The out-of-State oystermen, especially in New York, have been the first to realize this, and have been buying, at the rate of $4 to $5 per bushel, all the small quahaugs they can procure, merely replanting, to reap the following year a yield of 3 to 6 bushels for every bushel planted.

Under the stimulus of the high prices offered, many bushels of small quahaugs have been shipped from the town, which thus lost what the planters gained. There is much feeling against such a practice, but so far nothing has been done by the town to stop this shipping of "seed" quahaugs. As the town has full control of its shellfisheries, it has only to pass a simple law allowing no quahaugs under 2 inches to be taken, and see that it is properly enforced. Such a matter should be attended to at once, as not only is the actual value of the catch diminished, but the industry is seriously impaired by the capture of these small quahaugs before they can spawn.

The only other way to remedy this difficulty is to grant licenses allowing the replanting of these small quahaugs on the barren parts of the harbor until they have obtained a proper size. The results obtained from the experiments of the commission in Polpis harbor show that quahaugs will grow rapidly when thus replanted in suitable places, and that a gain of ½ to ¾ of an inch, or 3 to 6 bushels for every bushel bedded, can be obtained during the six summer months (May to November).

Summary of Industry.

Area of quahaug territory (acres),	5,290
Number of men,	48
Number of boats,	30
Value of boats,	$5,800
Number of dories,	10
Value of dories,	$350
Value of gear,	$600

Production.

"Little necks": —	
Bushels,	303
Value,	$1,310
Quahaugs: —	
Bushels,	5,991
Value,	$7,177
Total: —	
Bushels,	6,294
Value,	$8,487

New Bedford.

The quahaug industry of New Bedford was practically annihilated by the law of 1905, which closed the Acushnet River and Clark's Cove to both clammer and quahauger. Good beds of quahaugs, particularly "little necks," exist in both these waters, but can be taken only for bait. As several sewers run into the Acushnet River, and the public health was endangered by the consumption as food of the quahaugs taken from the river and the waters near its mouth, nearly 400 acres of quahaug territory were closed by the State Board of Health. What little available territory there is outside the prescribed area, off Clark's Point, is free to all.

A license is required to dig quahaugs for bait in this territory, and such is issued free of charge. The maximum amount permitted to be dug is 2 bushels per week of clams or quahaugs, or of both. Some

320 permits have been issued since the law was passed, in 1905. Eleven of these have been since revoked for unlawful conduct on the part of the possessors. For the first offence the license is merely revoked, for the second a fine of $10, and for the third $100 is imposed.

Orleans.

Although Orleans is well represented by all four main types of shellfish, the quahaug fishery is the leading industry of the town. A favorable coast line, fronting on the west the waters of Cape Cod Bay and bounded on the east by Pleasant Bay, provides excellent facilities for the quahaug fishery.

The main quahauging territory is in Cape Cod Bay. While the west coast of Orleans is only about a mile long, the privileges which allow the citizens of Orleans free fishing in Eastham waters, according to the act of incorporation in 1792, "whereby the benefits of the shellfishery were to be mutually shared," opens up an extensive tract of quahaug territory, from 2 to 3 miles in width, extending north as far as Billingsgate Island and the Wellfleet line. The actual Orleans quahaug territory consists only of 1,000 acres, which furnish but poor quahauging, while the water is several fathoms deep.

On the east side an entirely different condition prevails. Here in the waters of Pleasant Bay is a bed of quahaugs which, though worked for a long time, is still in excellent condition. The proportion of "little necks" is larger than on the west side, running about one-half the entire catch; neither is the water as deep here, rarely having a greater depth than 12 feet, and by no means as rough as the more exposed waters of Cape Cod Bay. The quahauging grounds here comprise 500 acres.

Although there are 1,500 acres of quahaug territory in the town of Orleans, only a small part of this is commercially productive, and the larger part of the fishery is carried on in Eastham waters.

The possession of two entirely different quahaug grounds, one on the east, the other on the west coast, makes practically two different industries, each of which will have to be considered separately.

(1) *Cape Cod Bay Industry.* — In Cape Cod Bay 50 men rake quahaugs whenever the weather will permit. Owing to the great depth of water, the work is difficult, requiring rakes with handles often 60 feet long. Two men generally go in one boat, the usual type being an elongated dory, some 30 to 32 feet over all, carrying from 4 to 12 horsepower gasolene engines. These boats are built to stand rough weather, and cost from $700 to $1,000 apiece. Thirty boats are employed in this business in the bay.

The quahauger averages perhaps 100 working days in a year, as in a strong wind and choppy sea it is impossible to rake in the deep water. A good fisherman expects to rake from 2 to 3 barrels of quahaugs a day. Five to ten years ago as many as 15 barrels were dug in a day by one man, but this is impossible now. Even as it is, the profits are large. The best quahauger in Orleans cleared in 1906 over $1,600, while several others made nearly $1,400. As at Wellfleet, the Orleans quahaugers receive licenses to replant their quahaugs along the shore, and it is customary to thus keep them until the New York or Boston markets offer suitable prices. Nearly two-thirds of these deep-water quahaugs are blunts, and perhaps one-tenth of the catch is "little necks."

(2) *Pleasant Bay Industry.* — About 25 men dig here from ordinary dories, using short rakes and tongs. The average wages are $2 to $3 per day, which is considerably less than the high wages of the Cape Cod Bay fishery; but many more days can be utilized during the year, while the work is much easier and the necessary outlay of capital is slight. Here the quahaugs run about one-half "little necks," and the proportion of blunts is small.

Little evidence of decline can be seen in Pleasant Bay, where the bed of quahaugs, although raked for a long time, still shows few signs of decrease. On the Cape Cod Bay side the reverse is true, and the supply is gradually diminishing.

The same town laws for regulation of the quahaug fishery apply for Wellfleet, Eastham and Orleans. (See Wellfleet.)

The main historical features of the quahaug industry at Orleans have been similar to Wellfleet, the industry lying practically dormant until 1894, when it rapidly reached its present production. Unfortunately, but little data can be obtained for comparison of the industry of 1879 with 1907. Ernest Ingersoll reports, in 1879: —

At Orleans, some few men who go mackereling in summer stay at home and dig clams in winter, getting perhaps 50 barrels of quahaugs among others, which are peddled in the town.

Comparing the two years by table, we find: —

	1879.	1907.
Annual production, . . .	150 bushels, . . .	33,000 bushels.
Value of production, . .	$82.50, ...	$41,350.
Number of men, . . .	A few, ...	75.
Location, quahaug beds, . .	Pleasant Bay, . .	Cape Cod Bay and Pleasant Bay.
Market, ...	Home consumption, .	New York and Boston.

SUMMARY OF INDUSTRY.

	Cape Cod Bay.	Pleasant Bay.	Total.
Area (acres),	1,000	500	1,500
Number of men,	50	25	75
Number of boats,	30	-	30
Value of boats,	$23,000	-	$23,000
Number of dories,	-	25	25
Value of dories,	-	$500	$500
Value of implements,	$1,250	$250	$1,500
Production.			
"Little necks": —			
Bushels,	2,700	3,000	5,700
Value,	$6,750	$7,000	$13,750
Quahaugs: —			
Bushels,	24,300	3,000	27,300
Value,	$24,300	$3,300	$27,600
Total: —			
Bushels,	27,000	6,000	33,000
Value,	$31,050	$10,300	$41,350

Provincetown.

No commercial quahaug fishery is carried on at Provincetown. A few quahaugs, chiefly "little necks," are found in the tide pools among the thatch on the northwestern side of the harbor.

Swansea.

A quahaug fishery existed in Swansea until three years ago. Since that time there has been no commercial fishery, though a few quahaugs are still dug for home consumption.

Truro.

Occasionally a few scattering quahaugs are found on the bars, which extend out one-quarter of a mile from shore on the bay side. No quahaug fishery is carried on.

Wareham.

The town of Wareham, situated on the northeast side of Buzzards Bay and separated from the adjoining town of Bourne by Cohasset Narrows, has a coast line indented with numerous small inlets, bays and rivers, which afford excellent opportunities for the growth of the quahaug. The villages of Onset, Wareham and part of Buzzards Bay enjoy the privileges of this fishery.

Quahaugs are found over practically the entire territory, and comprise a total area of about 1,300 acres. Although much of this area is barren, the commercial fishery is maintained by small isolated beds which occur here and there.

The two principal centers of the industry are in the Wareham River and in Onset Bay. At Onset the whole bay, except the oyster grants, as included between the southeast end of Mashnee Island and Peters Neck, is used for quahauging. A few quahaugs are found in Broad Cove, and fair digging is obtained in Buttermilk Bay and Cohasset Narrows. The Wareham River, outside the oyster grants, and a narrow shore strip from Weweantit River to Tempe's Knob, comprise the rest of the territory. In Onset Channel a fine bed exists in deep water, 2 to 4 fathoms, but the ground is so hard that not much digging is done.

It will be seen from the map that practically 75 per cent. of the quahaug territory is taken up by oyster grants, especially in the Wareham River and Onset Bay. Town sentiment is in a chaotic state over the oyster and quahaug deadlock, and much friction naturally exists between the opposing factions, the quahaugers and oystermen. The struggle between these two parties was at its height several years ago, and the enmity still continues, though not so openly, owing to the decline of the quahaug industry. Rightly managed, affairs ought to be so arranged that prosperity might be brought to both factions; but town customs and town laws, poorly enforced at the best, are hardly able to cope with this evil, which has resulted in much expense legally and financially to both parties, and both industries are badly crippled in consequence, — the oyster industry by lack of protection and the quahaug industry by loss of grounds. It is hoped that in the future suitable arrangements can be made for both industries, and that the quahaug industry, which is at present declining, can be put on an equal footing with the oyster industry, by granting licenses to plant and grow quahaugs.

Most of the digging is done with garden rakes, potato diggers or by hand. Some tongs are used, but few if any long-handled basket rakes, since the digging is chiefly confined to the shallow water, not more than 10 feet deep, except in Onset Channel, where it ranges from 12 to 24 feet.

No information or statistical records of the quahaug fishery of Wareham can be obtained, and it is therefore impossible to draw any comparison between the present industry and the industry of twenty-five years ago.

The decline of the quahaug fishery in Wareham is an established fact. The production of 6,000 bushels for 1906 is far less than the production of five years ago. Since 1901 the output has steadily declined, and where the quahauger once was able to rake 5 bushels at a tide, to-day he can rake scarcely 1 bushel in the same time. It is only a question of a few years when the natural supply will be completely exterminated. The only salvation of the industry in Wareham is to increase the natural supply by quahaug farming.

Summary of Industry.

Area of quahaug territory (acres),	1,300
Number of men,	50
Number of boats,	–
Value of boats,	–
Number of dories,	50
Value of dories,	$750
Value of implements,	$250

Production.

"Little necks": —	
Bushels,	3,000
Value,	$7,500
Quahaugs: —	
Bushels,	3,000
Value,	$3,000
Total: —	
Bushels,	6,000
Value,	$10,500

Wellfleet.

The town of Wellfleet possesses the finest quahaug industry in Massachusetts. More men are engaged in the business and the annual production is larger than that of any other town of the State.

In colonial days the towns of Orleans, Eastham and Wellfleet were incorporated as one town, — the town of Eastham. In 1763 an act was passed incorporating the North Precinct of Eastham into a district by the name of Wellfleet, "Reserving to the inhabitants of said town the privileges by them heretofore enjoyed of all ways to and of erecting houses on the beaches and islands for the convenience of the fishery of all kinds, and of anchorage and of landing all goods or wares at any of their common landing places in any of the harbors of said Eastham in like manner as they might have done if this act had never been made and passed." By this act were created the two independent towns of Eastham and Wellfleet, which held in common all fisheries, thus giving the mutual right of the shellfisheries to both towns.

In 1797 another act of incorporation, separating Orleans from Eastham, was enacted, which provided that the benefits of the shellfisheries of these two towns were to be mutually enjoyed.

The result of these two acts was to give Eastham and Wellfleet and at the same time Eastham and Orleans mutual rights of the shellfishery, but forbidding mutual shellfisheries between Wellfleet and Orleans. While this may seem to give theoretically the advantage to Eastham, actually the town gains nothing in the quahaug fishery, as Orleans has practically no productive grounds on the bay side, and the Orleans quahaugers fish in the Eastham waters.

The quahaug territory of Wellfleet comprises about 2,500 acres, and approximately takes up all the harbor, wherever there are no oyster grants, running from the "Deep Hole" between Great Island and Indian Neck southward to the Eastham line. Outside of these limits a few quahaugs are found on the flats of Duck Creek and along the shore flats of the town. They are more abundant on the north side of Egg Island, where they are taken in shallow water with ordinary hand rakes. The best quahauging is found in the channel extending from an imaginary line between Lieutenant's Island and Great Beach Hill south to Billingsgate. The greatest depth at low tide is 4½ fathoms and the general average is about 3 fathoms. In this channel are found most of the "little necks," small blunts and small sharps.

Outside of the oyster grants, quahaugs are found south of Great Island, north of Billingsgate Island on the west side of the harbor, on Lieutenant's Island bar and at the mouth of Blackfish Creek. A few quahaugs, both sharps and blunts, are raked with 25-foot rakes in the shallow water 6 to 8 feet near the beach, usually on a sandy bottom.

The principal market for Wellfleet quahaugs is New York, though many are sent to Boston and other parts of the country, even to the middle west. Quahaugs have been shipped from Wellfleet to Milwaukee and arrived in good condition after ten days.

The annual production is 33,000 bushels, one-sixth of these, 5,500 bushels, being "little necks." There were 140 men engaged in the fishery in 1906, and 145 permits were granted in 1907. The average yield for a day's raking is 4 bushels, although an exceptional quahauger can sometimes rake 7 bushels.

Practically all the raking is done in deep water, with rakes the handles of which are often 47 feet long. Each quahauger has a set of handles of various lengths for different depths of water. Both power boats and "cats" are used here in quahauging, the power boats possessing considerable advantage over the sail boat. Thirty-eight power boats and 62 sail boats, both single and double manned, are used at Wellfleet.

At present there is every indication of a declining fishery. Until the last three years the industry has been steadily on the increase since 1894. The maximum production was reached a few years ago, and the industry is slowly on the decline, unless the opening up of new beds gives it a fresh start. Unfortunately, all the quahaugers do not realize the possibility of this seemingly inexhaustible supply giving out, and believe it will continue forever; but any one can see that it is impossible for the natural supply to continue when such inroads are yearly made, and that it is only a question of time when the best business asset of the town will become extinct.

For years there has been an antagonistic feeling between the quahaugers and the oystermen, due to the conflicting interests of these industries. Although the quahaug territory has been narrowed down by the giving of oyster grants in the harbor, the quahaug fishery has not suffered severely, as the poorer quahaug grounds were alone granted, with the idea that more money could be made by using these for oyster culture. Although these grants were laid out in good faith, injustice in many instances has been done the quahaug industry; but on the whole the change has been for the benefit of the town. In the broad waters of Wellfleet harbor there is room for both industries, and there is no reason why both should not prosper if wisely regulated, without the intervention of town politics. At present this antagonism has hurt the interests of both, and it is manifestly unfair that either should drive the other out while there is room for both to prosper.

Wellfleet is the only town that can boast of a quahaug club. This club was formed in 1904, and had an enrollment of practically all the quahaugers.

Permits are required of every man engaged in the quahaug fishery. These cost $1 apiece, and are granted on application to any one who has been a resident of the town for six months. These permits are to be obtained each year, on or before May 1, after which date an additional charge of 50 cents is made for collecting. No person without a regular permit is allowed to catch quahaugs for market. Permits were first issued in 1904.

Section 2 of chapter 269 of the Acts of 1904 is as follows: —

Section 2. No inhabitant of said towns shall sell or offer for sale little neck clams or quahaugs which measure less than one and one-half inches across the widest part, and no person shall in any of said towns sell or offer for sale little neck clams or quahaugs which measure less than one and one-half inches across the widest part.

This excellent law was passed for the towns of Eastham, Orleans and Wellfleet, but has never been enforced. Although enacted and technically lived up to, no measures are made for its enforcement, which would necessitate a shellfish inspector. This furnishes an example of the non-enforcement of one of the few good town laws.

Section 4 of chapter 269 of the Acts of 1904 is as follows: —

Section 4. The selectmen of the said towns may, in their respective towns, grant licenses or permits for such periods, not exceeding two years, and under such conditions as they may deem proper, not however covering more than seventy-five feet square in area, to any inhabitants of the town to bed quahaugs in any waters, flats and creeks within the town at any place where there is no natural quahaug bed, not impairing the private rights of any person or materially obstructing any navigable waters. It shall be unlawful for any person, except the licensee and his agents, to take any quahaugs in or remove them from the territory covered by any such license.

The above should receive well-deserved praise, as it is one of the most useful town laws ever enacted in Massachusetts. Each quahauger is thus enabled to stake off a little plot 75 feet square on the flats, whereon he can bed his catch whenever the market price is too low for shipment. This not only makes steadier work for the quahaugers, since a dull market does not stop digging, as before, but also enables him to obtain a better price for his quahaugs, and he is not forced to lose through the wastes of competition.

Quahaugs have always been abundant at Wellfleet. Forty years ago about 15 men were engaged in the business, and shipped their catch to Boston by packet boats, quahaugs then wholesaling at 50 cents per bushel.

In 1879 (report of the United States Fish Commission) Ernest Ingersoll gives the following account of the quahaug industry at Wellfleet, which furnishes such an excellent comparison with the present industry that it is given here: —

The early productiveness of Cape Cod is shown by the presence of numerous shellfish heaps, particularly in Wellfleet and Barnstable harbors, filled up by the Indians, and consisting almost wholly of the shells of this mollusk. Though in greatly depleted numbers, the quahaug still survives along the inside of the Cape, and at Wellfleet has been raked from early times by the settlers. Mr. F. W. True contributes some notes on this place, from which I learn that the quahaug fishery as a business there dates from the beginning of the nineteenth century. It grew in extent until 1863, and from that time until 1868 the trade was at its height, since when it has diminished year by year, owing to lack of good market rather than failure of the supply. Between 1863 and 1869 the average catch each year was not less than 2,500 bushels. Of this amount a comparatively small part was consumed at Wellfleet, and the rest were shipped to Boston, Provincetown, Salem, Newport, Manchester and a few other New England ports. From 1870 to 1876 the quantity of quahaugs taken per year decreased from 2,500 bushels to 1,800 bushels, and this latter amount has remained constant to the present year. Of the total catch in 1878, fully one-half, or 900 bushels, was consumed in Wellfleet, and the remaining 900 bushels were shipped to Boston and other neighboring towns. For three years, beginning with 1876, 75 bushels of quahaugs have been annually shipped to New York City.

Quahaugs are found in all parts of Wellfleet Bay except in a small spot near the wharves, called the "Deep Hole," and a similar one on the west side of the bay. Both of these places are covered with a thick, soft mud. It is not usual, however, to fish in parts of the bay where the average depth at low water exceeds 8 feet. Most of the raking is done on the western side. In ordinary years, quahaug raking is begun the last of March and continues until the first of October. As a general thing, no raking is done through the winter months, although in some years a small amount has been done through holes cut in the ice. The fishermen rake about four tides per week, beginning at half-ebb and raking to half-flood. The boats used are either cat boats or yawls rigged with two sails. Each boat carries 1 man.

The rake employed at Wellfleet is described by Mr. True as similar in form to an oyster rake, but made of steel instead of iron. In former days this instrument was of iron, the tips of the teeth only being of steel. An average rake has seventeen teeth, and weighs about 12 pounds. The handle or tail is of wood, and is about 23 feet long. The baskets in which the quahaugs are collected and measured are of ordinary manufacture, and hold about a bushel each ; and the whole outfit of a quahaug fisherman does not cost over $150, and the total amount of capital invested in apparatus at the present time in Wellfleet does not exceed $800. This amount is about evenly divided between 5 men, none of whom are engaged in this fishery more than a part of their time.

Quahaugs are sent to market always in the shell, and packed in second-hand flour or sugar barrels. The wholesale price of quahaugs for many years averaged 60 cents per bushel, but in 1879 it fell to 55 cents. One dollar and seventy-five cents is the average wholesale price per barrel. Quahaugs retail in Wellfleet at 80 cents per bushel. The usual method of transportation is by packet, at a cost of 25 cents per barrel.[1]

COMPARISON OF 1879 WITH 1907.

	1879.	1907.
Annual production,	1,800,	33,000.
Annual value,	$990,	$41,250.
Average price per bushel,	55 cents,	$1.25.
Number of men,	5,	145.
Capital,	$800,	$25,950.
Market,	Boston and New York,	New York, Boston, and other cities.
Season,	April 1 to October 1,	April 1 to October 1.
Boats,	5 sail boats,	100 boats, one-third power, two-thirds sail.
Deepest water,	8 feet,	40 feet.
Longest rake,	23 feet,	47 feet.
Best quahaug beds,	West side of harbor,	Channel.

From the account of Mr. Ingersoll the above table has been formulated, showing the vast increase in the quahaug business of Wellfleet since 1879, as well as certain changes in the industry. This by no means proves that the quahaug industry is on the increase; it merely shows that it has taken a tremendous development since 1879, and the fact that the quahaug industry of Wellfleet has passed its maximum production a few years ago and is now on the decline should not be overlooked in consulting this table, which otherwise would give an erroneous impression. The changing of the quahaug grounds from shallow to deeper water alone is a sign of the decline of the industry. The quahaug industry has developed to its present extent only since 1894, and is

[1] "The Oyster, Scallop, Clam, Mussel and Abalone Industries," by Ernest Ingersoll. United States Fish Commission Report, Section V., Vol. 2, p. 603.

comparatively recent. By the opening of the great beds of "little necks" and quahaugs in the channel and deep water the industry suddenly became important.

SUMMARY OF INDUSTRY.

Area of quahaug territory (acres),	2,500
Number of men,	145
Number of power boats,	38
Value of power boats,	$14,000
Number of sail boats,	62
Value of sail boats,	$10,300
Value of implements,	$3,200

Production.

"Little necks": —	
Bushels,	5,500
Value,	$13,850
Quahaugs: —	
Bushels,	27,500
Value,	$27,500
Total: —	
Bushels,	33,000
Value,	$41,350

Yarmouth.

The quahaug grounds, which lie mostly in Bass River, are free to the inhabitants of Dennis and Yarmouth, as these two towns have common fishery rights. Quahaugs are found in four localities: (1) Bass River; (2) Mill Creek; (3) Barnstable Bar on the north shore; and (4) Lewis Bay. The total area is 1,000 acres, which includes all grounds where there are any quahaugs, as there are now no thick beds. The average depth of water over the quahaug grounds is 4 feet.

The town law governing the quahaug fishery reads thus: —

All persons other than the inhabitants of the towns of Dennis and Yarmouth are prohibited from taking clams and quahaugs from the shores and waters of the town of Yarmouth. Inhabitants of the Commonwealth not residents of Dennis and Yarmouth may obtain permits of the selectmen to take sufficient quantity of said shellfish for their family use.

The history of the quahaug industry of Yarmouth is one of decline. The industry has existed for fifteen years, starting in 1892. Mr. Edgar N. Baker, who has been interested in the business ever since it started, says: —

In the last ten years it is safe to say that the catch has fallen off fully 75 per cent., and nothing but the constant advance in prices and lack of profitable employment has prompted men to give their attention to this method of obtaining their "bread and butter." The most conservative estimate would not put it below 50 per cent.

Summary of Industry.

Area of quahaug territory (acres),	1,000
Number of men (transient),	20
Number of boats,	–
Value of boats,	–
Number of skiffs,	10
Value of skiffs,	$100
Value of implements,	$140

Production.

"Little necks": —	
Bushels,	1,200
Value,	$3,000
Quahaugs: —	
Bushels,	1,000
Value,	$1,000
Total: —	
Bushels,	2,200
Value,	$4,000

Scallop (*Pecten irradians*).

The common shallow-water scallop is unknown commercially on the north shore, occurring only south of Boston. It is usually found in abundance along the southern shore of Cape Cod, in Buzzards Bay, and about the islands of Nantucket and Martha's Vineyard.

For the past three years investigations in regard to its growth, habits and culture have been carried on by the Commissioners on Fisheries and Game. These investigations are now practically completed. In another report the whole life history of this bivalve will be given, showing the application of this scientific study to the existing conditions of the industry.

The scallop fishery in Massachusetts is only a partial industry, as it does not concern the whole coast line, but merely the Vineyard Sound and Buzzards Bay shore. Compared with other States, the production of Massachusetts is favorable, New York alone exceeding it in output. The southern coast of Massachusetts is especially adapted for this shellfish. Its bays, sheltered harbors and inlets afford excellent ground for the scallop, which requires protection against the heavy seas. Thousands of acres of eel-grass flats from 1 to 60 feet under water were formerly covered by beds of scallops, and in parts are still thickly set. While the extent of the scalloping area is large, only portions are ever productive at any one time. A set may be in one part this year, and the next year's spawn may catch in a different place. Thus, while all the ground is suitable for scallops, only a small part is in productive operation each year.

While the possibilities of future development are not as alluring as in the other shellfisheries, yet much can be done to assist nature and help preserve the supply. Wise laws and well-directed efforts can save many bushels of the young scallops which yearly die on the exposed flats where they have set in unfavorable places.

Scope of the Report. — The object of this report is to present certain information concerning the scallop industry which will be of use to the scallop fishermen, and of interest to the general public and the consumers. While the scallop is well known as an article of food, the majority of people know little about the animal. It will therefore be necessary in the following report to give brief descriptions of the various methods used in the capture of this bivalve, in order to make clear the more technical portions.

The first part of the report considers the general results of the survey, the history of the industry, the scallop laws, the methods of scalloping and the statistics of the industry. The second part gives a more detailed description, the following points being considered under each town: (1) survey; (2) statistics of industry; (3) town laws; (4) history.

Methods of Work. — Several difficulties stand in the way of procuring exact information concerning the scallop industry, especially in regard to historical data which should show the improvement or decline of the fishery. The town records are incomplete, lost, or furnish but slight information. Little has been written about this industry, and we were thus forced to rely upon the scallopers for information concerning the history and former production of each town. Fortunately, the scallop industry is of recent origin (thirty years), and the information is very nearly correct. By the use of town records, market reports, records of express shipments, personal surveys and estimates by the various scallopers, and by all other methods at our command, the facts of the last few years have been obtained in an approximately correct form.

The area of the scallop territory was obtained by personal inspection and calculated by plottings on the maps. In designating the area suitable for scallops in any town by a certain number of acres or by plottings on the map, it does not mean that scallops are found each year over all this territory. Allowances must be made for the uncertainty of the scallop supply. Some years there will be no scallops; in other years, plenty. Even when scallops are plentiful, they rarely cover the whole territory, but are found only in certain parts in different years. The designation of an area as scallop territory means that scallops have been found in the past over this territory, and that the natural conditions of the territory appear favorable for scallops.

The Decline.

The most important questions which first come to mind when considering the scallop industry of to-day are these three: (1) Has there been any decline in the industry? If so, how extensive? (2) What are the causes of the decline? (3) How can the fishery be improved?

I. *Extent of the Decline.* — There is no question but that the industry as a whole has declined. This decline has made itself manifest, especially in certain localities, *e.g.,* Buzzards Bay, where until 1907 the entire fishery, except at New Bedford and Fairhaven, had been totally extinct for the past seven years.

Along the south side of Cape Cod, at Edgartown and Nantucket, the supply has on the average remained the same. Of course there is varying abundance each year, but as a whole the industry in these localities can hardly be said to have declined.

On the other hand, on the north side of Cape Cod we find a marked decline. A scallop fishery no longer exists at Plymouth, Barnstable harbor, Wellfleet and Provincetown, though twenty-five years ago these places boasted of a valuable industry.

So we have to-day in Massachusetts three localities, two of which show a marked decline in the scallop fishery, while the other shows some improvement. Of the two depleted areas, the one (north of the Cape) may never revive the industry; the other (Buzzards Bay) gives indications that the industry can once more be put on a very profitable footing. The only thing necessary is perpetual precaution on the part of the fishermen, in order to prevent this decline. Massachusetts must not allow the industry to become extinct, as in Rhode Island.

II. *Causes of the Decline.* — The causes of the decline of this industry can be grouped under three heads: (1) natural enemies; (2) overfishing by man; (3) adverse physical conditions.

The natural enemy of the scallop which works the greatest mischief is the starfish, or "five finger," as it is often called. The starfish destroys the scallop in the same manner as it attacks the oyster. The decline of the scallop fishery in Buzzards Bay is attributed by the fishermen to the inroads of this pest. Undoubtedly the starfish was the chief apparent cause, since, according to report, dredges full of starfish could be hauled up. In other localities in Massachusetts the starfish has not been so plentiful.

While the main cause of the decline of the natural clam, quahaug and oyster beds is overfishing by man, the decline of the scallop fishery cannot be so considered. The scallop has a short life, hardly 25 per cent. passing the two-year limit; so it does no harm to capture the marketable scallops which are over sixteen months old, as the scallop spawns when one year old, and dies a natural death usually before it reaches a second spawning season. When only old scallops are taken, as is generally the case, it is probably *impossible* for man to exterminate the scallops by *overfishing*. Unfortunately, in certain localities in the past there has been a large capture of the "seed" scallop, viz., the scallop less than one year old, which has not spawned. This has worked the ruin of the scalloping in these localities. The capture of the spawners for another year merely makes the next year's set so much smaller, and causes a rapid decline.

As a rule, it is hardly profitable to catch the "seed" scallop, owing to its small size. But a direct relation can be established between a high market price and the capture of seed. When the market price is high and scallops scarce, it becomes profitable to catch the young "seed." The present scallop law now defines a "seed" scallop, and forbids its capture. By protecting the "seed" scallop the State has done all that at present appears expedient to insure the future of the industry; the rest lies in the hands of the towns.

So, while the scallop has declined in certain localities, and the decline has been hastened by unwise capture of the "seed" scallop, the main decline of the fishery cannot be attributed to wholesale overfishing, as it is impossible to overfish if only the old scallops (over one year old) are taken; for, unlike most other animals, the scallop usually breeds but once, and its natural period of life is unusually brief. These scallops, if not taken, will die, and prove a total loss; so every fisherman should bear in mind that, as long as the "seed" scallops are protected, severe fishing of large scallops is not likely to injure the future scallop industry.

The principal causes of the decline of the fishery, besides the inroads of man, are best termed "adverse physical conditions." Severe winters, storms, anchor frost, etc., work destruction upon the hapless scallop. The "infant mortality" is especially great.

As the scallop dies before reaching its second birthday, only one set of scallops spawn in any one season. There are never two generations of scallops spawning at one time. I quote from Ernest Ingersoll in this connection: —

This represents a case where the generations follow one another so rapidly that there are never two ranks, or generations, in condition to reproduce their kind at once, except in rare individual instances, since all, or nearly all, of the old ones die before the young ones have grown old enough to spawn. If such a state of affairs exists, of course any sudden catastrophe, such as a great and cold storm during the winter, or the covering of the water where they lie for a long period with a sheet of ice, happening to kill all the tender young (and old ones, too, often) in a particular district, will exterminate the breed there; since, even if the older and tougher ones survive this shock, they will not live long enough, or at any rate, will be unable to spawn again, and so start a new generation.[1]

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[1] E. Ingersoll, "The Scallop Fishery," United States Fish Commission report, 1881.

The set of young scallops is abundant in shallow water upon the eel-grass flats, which often, as is the case of the Common Flats at Chatham, are exposed at extremely low tides. A severe winter often kills off all the "seed" thus exposed. In this case no spawn is obtained the following summer, causing the suppression of the scallop fishery in that locality for at least a few years, and possibly its permanent extinction.

III. *Improvement; restocking Barren Areas.* — The scallop industry, unlike the clam and quahaug, offers but little inducement to private enterprise. For successful private culture small bays or coves would be needed, and suitable areas are very scarce. The scallop offers better opportunity for communal culture, *i.e.,* by towns.

There is but one way now known of artificial propagation for the scallop industry, and that is by transplanting in the fall the abundant set from the exposed places to the deeper water before the seed is killed by the winter. It is merely assisting nature by preventing a natural loss, and in no sense can properly be termed propagation. It is merely a preventive, and money used in this way to preserve the scallops is well expended. Usually the set is abundant, and can be transferred in large numbers. This is the only practical method now known of increasing our scallop supply, though it is hoped in the future that other methods may be devised.

In connection with the above comes the question, if we can thus preserve scallops doomed to destruction, will it not be profitable to transplant scallops to places where the scalloping has been exterminated by various causes, and by means of these "seeders" furnish succeeding generations which may populate the barren areas? This plan is practical and feasible, and should be given due consideration. Why should not scallops be transplanted to our Buzzards Bay harbors, to again restock these areas? Often the attempt might fail, but there is bound to be success if there is perseverance. The best time to plant these scallops is in the fall, as a double service will be given: (1) preservation from destruction of the seed scallops; (2) furnishing spawn and young in the barren locality. Ingersoll speaks of the restocking of Oyster Bay in 1880: —

> In the spring of 1880 eel grass came into the bay, bringing young scallops [the eel grass carries the scallops attached to it by the thread-like byssus]; thus the abundance of that year was accounted for, though there had not been a crop before in that bay since 1874.

If such a restocking can be accomplished by nature, it can be done with more certain effect with man's assistance.

The Industry.

I. *The Methods.* — The methods of scalloping follow the historical rise of the fishery. As the industry grew more and more important, improvements became necessary in the methods of capture, and thus, parallel with the development of the industry, we can trace a corresponding development in the implements used in the capture of the scallop.

(*a*) *Gathering by Hand.* — When the scallop was first used as an article of food, the primitive method of gathering this bivalve by hand was used. This method still exists on the flats of Brewster, and often in other localities after heavy gales wagons can be driven to the beach and loaded with the scallops which have been blown ashore.

(*b*) *Scoop Nets.* — This hand method was not rapid enough for the enterprising scallopers, and the next step in the industry was the use of scoop nets, about 8 inches in diameter, by which the scallops could be picked up in the water. These nets were attached to poles of various lengths, suitable to the depth of water. "This method," writes Ingersoll, "was speedily condemned, however, because it could be employed only where scallops are a foot thick and inches in length, as one fisherman expressed it."

(*c*) *The Pusher.* — The next invention was the so-called "pusher." The "pusher" consists of a wooden pole from 8 to 9 feet long, attached to a rectangular iron frame 3 by 1½ feet, upon which is fitted a netting bag 3 feet in depth. The scalloper, wading on the flats at low tide, gathers the scallops by shoving the "pusher" among the eel grass. When the bag is full, the contents are emptied into the dory and the process repeated. The scallopers who use the "pusher" go in dories, which are taken to the various parts of the scalloping ground and moved whenever the immediate locality is exhausted. This method is in use to-day, but is applicable only to shallow flats, and can be worked only at low tide, where dredging is impossible. It is hard work, and not as profitable as the better method of dredging. This method of scalloping is used chiefly at Chatham, Dennis and Yarmouth; occasionally it is used at Nantucket and other towns.

(*d*) *Dredging.* — The greater part of the scallop catch is taken by dredging, which is the most universal as well as the most profitable method. The dredge, commonly pronounced "drudge," consists of an iron framework about 3 by 1½ feet, with a netting bag attached, which will hold from one to two bushels of scallops. Cat boats, carrying from 6 to 10 dredges, are used for this method of scalloping. These boats, with several "reefs," cross the scallop grounds pulling the dredges, which hold the boat steady in her course. A single run with all the dredges overboard is called a "drift." The contents of all the dredges is said to be the result or catch of the "drift."

When the dredges are hauled in they are emptied on what is known as a culling board. This board runs the width of the boat, projecting slightly on both sides. It is 3 feet wide, and has a guide 3 inches high along each side, leaving the ends open. The scallops are then separated from the rubbish, such as seaweed, shells, mud, etc., while the refuse and seed scallops are thrown overboard by merely pushing them off the end of the board. Each catch is culled out while the dredges are being pulled along on the back "drift," and the board is again clear for the next catch. The culled scallops are first put in buckets and later transferred either to bushel bags or dumped into the cockpit of the boat.

Two men are usually required to tend from 6 to 8 dredges in a large cat boat, but often one man alone does all the work. This seems to be confined to localities, as at Nantucket nearly all the cat boats have two men. At Edgartown the reverse is true, one man to the boat, though in power dredging two men are always used.

Several styles of dredges are used in scalloping, as each locality has its own special kind, which is best adapted to the scalloping bottom of that region. Four different styles are used in Massachusetts, two of which permit a subdivision, making in all six different forms. Each of these dredges is said by the scallopers using them to be the best; but for all-round work the "scraper" seems the most popular.

(1) *The Chatham or Box Dredge.* — As this dredge was first used in Chatham, the name of the town was given to it, to distinguish it from the other styles. At the present time its use is confined to Chatham and the neighboring towns of the Cape. With the exception of a very few used at Nantucket, it is not found elsewhere in Massachusetts.

The style of the box dredge is peculiar, consisting of a rectangular framework, 27 by 12 inches, of flat iron 1 by 1/4 inches, with an oval-shaped iron bar extending back as a support for the netting bag, which is attached to the rectangular frame. To the side of the rectangular frame is attached a heavy iron chain about 4 feet long, to which is fastened the drag rope.

(2) *The Scraper.* — As can be seen by the illustration, this style of dredge consists of a rigid iron frame of triangular shape, which has a curve of nearly 90° at the base, to form the bowl of the dredge. Above, a raised cross bar connects the two arms, while at the bottom of the dredge a strip of iron 2 inches wide extends from arm to arm. This strip acts as a scraping blade, and is set at an angle so as to dig into the bottom. The top of the net is fastened to the raised cross bar and the lower part to the blade.

The usual dimensions of the dredge are: arms, 2 1/2 feet; upper cross bar, 2 feet; blade, 2 1/2 feet. The net varies in size, usually holding about a bushel of scallops, and running from 2 to 3 feet in length. Additional weights can be put on the cross bar when the scalloper desires the dredge to scrape deeper. A wooden bar, 2 feet long, buoys the net.

Two styles of this dredge are in use. At Nantucket the whole net is made of twine, while at Edgartown and in Buzzards Bay the lower part of the net is formed of a netting of iron rings, the upper half of the net being twine. The iron rings are supposed to stand the wear better than the twine netting. This difference seems to be merely a matter of local choice. The "scraper" is perhaps the dredge most generally used, as, no matter what style is in use, a scalloper generally has a few "scrapers" among his dredges.

(3) *The "Slider."* — The principle of the "slider" is the reverse of the "scraper," as the blade is set either level or with an upward incline, so the dredge can slide over the bottom. This dredge is used on rough bottom and in places where there is little eel-grass. In some dredges the blade is rigid, but in the majority the blade hangs loose.

The "slider" used at Edgartown differs from the "scraper" by having perfectly straight arms and no curved bowl, the blade being fastened to the arms in a hook-and-eye fashion. The dimensions of this dredge are the same as those of the "scraper," although occasionally smaller dredges are found.

(4) *The "Roller" Dredge.* — This style of dredge is used only in the town of Mattapoisett, where the scallopers claim it is the most successful. The dredge is suitable for scalloping over rough ground, as the blade of the dredge is merely a line of leads, which roll over the surface of the ground gathering in the scallops.

The dredge consists of an oval iron frame, 32 by 20 inches, which acts as the arms, and is attached to another iron frame, 32 by 3 inches. The blade of the dredge consists of a thin rope with attached leads. The net is made wholly of twine, and is about 2½ feet long.

Scalloping with Power Boats. — The season of 1907 has witnessed in Massachusetts the first use of auxiliary power in the scallop fishery. At Edgartown the main part of the scalloping is now done by power, which, in spite of the additional expense of 5 gallons of gasolene per day, gives a proportionately larger catch of scallops. The Edgartown scallopers claim that their daily catch, using power, is from one-third to one-half better than under the old method of dredging by sail. Not only can they scallop when the wind is too light or too heavy for successful scalloping by sail, but more "drifts" can be made in the same time. A slight disadvantage of scalloping with power is the necessity of having two men, as the steering of the power boat demands much closer attention than the sail boat, which is practically held to a fixed course by the dredges. A power boat for scalloping possesses only the disadvantage of additional cost; but it is only necessary to look forward a few years, when expedition rather than cheapness will be in demand, to a partial revolution in the present methods of scalloping, whereby the auxiliary cat boat will take the place of the sail boat in the scallop fishery.

II. *Preparing the Scallop for Market.* (1) *The "Eye."* — The edible part of the scallop is the large adductor muscle. The rest of the animal is thrown away, though in certain localities it is used as fish bait and in others for fertilizer. Why the whole of the animal is not eaten is hard to say. Undoubtedly all is good, but popular prejudice, which molds opinion, has decreed that it is bad, so it is not used as food. This is perhaps due to the highly pigmented and colored portions of the animal. Nevertheless, there is a decided possibility that in the future we shall eat the entire scallop, as well as the luscious adductor muscle.

The adductor muscle is called by the dealers and fishermen the "eye," a name given perhaps from its important position in the animal, and its appearance. The color of the "eye," which has a cylindrical form, is a yellowish white.

(2) *The Shanties.* — The catch of scallops is carried to the shanty of the fisherman, and there opened. These shanties are usually grouped on the dock, so the catch can be readily transferred. Inside of these shanties, usually 20 by 10 feet or larger, we find a large bench 3 to 3½ feet wide, running the length of the shanty, and a little more than waist high. On these benches the scallops are dumped from the baskets or bags, and pass through the hands of the openers. Under the bench are barrels for the shells and refuse.

(3) *The Openers.* — The openers are usually men and boys, though occasionally a few women try their hand at the work. Of late years there has been a difficulty in obtaining sufficient openers, and the scallopers often are forced to open their own scallops. The openers are paid from 20 to 30 cents per gallon, according to the size of the scallops. One bushel of average scallops will open 2½ to 3 quarts of "eyes." An opener can often open 8 to 10 gallons in a day, making an excellent day's work. The price now paid is more than double that paid in 1880, which was 12½ cents per gallon. Some openers are especially rapid, and their deft movements cause a continual dropping of shells in the barrel and "eyes" in the gallon measure.

(4) *Method of opening the Scallop.* — The opening of a scallop requires three movements. A flat piece of steel with a sharp but rounded end, inserted in a wooden handle, answers for a knife. The scallop is taken by a right-handed opener in the palm of the left hand, the hinge line farthest away from the body, the scallop in its natural resting position, the right or smooth valve down. The knife is inserted between the valves on the right-hand side. An upward turn with a cutting motion is given, severing the "eye" from the upper valve, while a flirt at the same moment throws back the upper shell. The second motion tears the soft rim and visceral mass of the scallop and casts it into the barrel, leaving the "eye" standing clear. A third move-

ment separates the "eye" from the shell and casts it into a gallon measure. Frequently the last two movements are slightly different. The faster openers at the second motion merely tear off enough of the rim to allow the separation of the "eye" from the shell, and on the third movement cast the "eye" in the measure, while the shell with its adhering soft parts is thrown into the refuse barrel. These last two motions can hardly be separated, so quickly are they accomplished.

(5) *"Soaking."* — The "eye" is then usually put through the following course of treatment before marketing; the treatment is what is familiarly known as "soaking." It has been noticed that whenever salt water products are allowed to soak in fresh water, an increase of bulk is found. This is due to a change, called osmosis, which causes the swelling of the tissues. The "eye" can be increased, by the process of osmosis, to a gain of more than one-third its natural size; that is, 4½ gallons of scallop "eyes" can be increased to 7 gallons by judicious "feeding" with fresh water. Also, a change has taken place in the scallops after a few hours' soaking. No longer do we find the poor yellow-colored small "eye" of the freshly opened scallop, but a beautiful white, plump "eye," which at once tempts the purchaser. While these changes have added to the salable properties of the scallop by beautifying its appearance and increasing its size, the scallop has lost much of its sweet flavor and freshness.

Practically every scallop sold in the markets or shipped from any scalloping center is soaked, as the "soaking," if not already done by the fishermen, is administered by the retail dealers. There are scallopers who are ready to ship the unsoaked scallops at a proportionate price the moment the market demands them; but the consumer, through ignorance, demands the large, nice-appearing "eyes," and thus unwittingly favors the practice. However, as long as pure water is used and other sanitary precautions taken, no actual harm may arise from soaking scallops.

Two methods of swelling scallops are in use. When the scallops are shipped in kegs, which usually contain 7 gallons, the following method is applied: 4½ to 5 gallons of "eyes" are placed in each keg, and are allowed to stand over night in fresh water; in the morning before shipment more water is added and the keg closed, and by the time of arrival to the New York or Boston market the scallops have increased to the full amount of 7 gallons.

The second method of "soaking" is slightly more elaborate. The eyes are spread evenly in shallow wooden sinks 5 by 3 feet, with just enough fresh water to cover them, and left over night. In the morning a milky fluid is drawn off, and the "soaked" scallops are packed for market in kegs or butter tubs.

(6) *Shipment.* — The kegs in which the scallops are shipped cost 30 cents apiece, and contain about 7 gallons. A full keg is known as a "package." The butter tubs are less expensive, but hold only

4 to 5 gallons. Indeed, anything which will hold scallops for shipment is used to send them to market.

When the scallops get to the market they are strained and weighed, 9 pounds being considered the weight of a gallon of meats. In this way about 6 gallons are realized from every 7-gallon keg. With the improved methods of modern times scallops can be shipped far west or be held for months in cold storage, for which purpose unsoaked scallops are required. Certain firms have tried this method of keeping the catch until prices were high, but it has not been especially successful.

(7) *Market.* — One of the greatest trials to the scallop fisherman is the uncertainty of market returns when shipping. He does not know the price he is to receive; and, as the price depends on the supply on the market, he may receive high wages or he may get scarcely anything. The wholesale market alone can regulate the price, and the fisherman is powerless. While this is hard on the scalloper, it does not appear that at the present time anything can be done to remedy the uncertainty of return. The scallop returns from the New York market are usually higher than from the Boston market. The result of this has been to give New York each year the greater part of the scallop trade, and practically all the Nantucket and Edgartown scallops are shipped to New York.

Either from a feeling of loyalty, or because the market returns are sooner forwarded, or because the express charges are less, Cape Cod still ships to the Boston market, in spite of the better prices offered in New York. Why so many Cape scallopers should continue to ship to Boston, and resist the attractions of better prices, is impossible to determine, and appears to be only a question of custom.

(8) *The Price.* — The price of scallops varies with the supply. The demand is fairly constant, showing a slight but decided increase each year. On the other hand, the supply is irregular, some years scallops being plentiful, in other years scarce.

The Maine or Deep-sea Scallop. — In the Boston market the shallow-water scallop has a formidable rival in the giant scallop of the Maine coast, which is nearly twice as large. Nevertheless, the Cape scallop maintains its superiority and still leads its larger brother in popular favor, wholesaling at 50 to 70 cents more a gallon. There is no doubt that this competition has had a tendency to lower the price of the Cape scallop, possibly accounting for the higher market price in New York.

Outfit of a Scalloper. — While we have traced the scallop from its capture among the eel-grass to its final disposition, we have not considered the equipment of the scalloper. The average capital invested in the business can best be summed up under these two heads, — the boat fisherman and the dory fisherman.

Boat Fisherman.

Boat,	$500 00
Dory,	20 00
Six dredges,	25 00
Rope and gear,	25 00
Culling board,	2 00
Incidentals,	3 00
Shanty,	50 00
Total,	$625 00

Dory Fisherman.

Dory,	$20 00
Oars,	1 50
Pusher,	2 50
Shanty,	25 00
Total,	$49 00

III. *The Scallop Season.* — There is considerable diversity of opinion among the scallopers as to when the scallop season should open. Some advocate November 1 as the opening date, instead of October 1, as the present law reads; and many arguments are put forth by both sides.

The class of fishermen who desire November 1 are those who are engaged in other fishing during the month of October, and either have to give it up or lose the first month of scalloping. Naturally, they wish a change, putting forth the additional argument of better prices if the season begins later. The scalloper who is not engaged in other fishing of course desires the law to remain as it is at the present time, claiming that the better weather of October gives easier work, more working days, and allows no chance of loss if the winter is severe.

Under the present law, the town can regulate the opening of its season to suit the demands of the market and the desire of the inhabitants. This does away with the necessity of any State law on this point, which, under the present system of town control, would be inadvisable.

The general opinion of the fishermen is in favor of the present date, October 1. As nearly as could be determined, about 75 per cent. favor October 1 and 25 per cent. November 1. This sentiment is divided by localities, as more men were in favor of November 1 at Nantucket and Edgartown than on Cape Cod and Buzzards Bay, where very few favored a change.

IV. *The Utilization of Waste.* — While it seems an enormous waste that out of a bushel of scallops only 2½ to 3 quarts of edible meats are obtained, it is not all absolute loss. Oyster growers buy the shells for cultch to catch the oyster seed, paying from 3 to 5 cents per bushel. Other uses are found, such as ornaments and in making shell roads. The refuse is used for fish bait, and often barrels of it are salted for this purpose. It is also used in some places for manure for agricultural purposes.

In the last year a new use for scallop shells has developed. Similar to the souvenir postal card, scallop shells bound together with ribbon and containing miniature photographic views have been put on the market. Three firms near Boston make a business of this, and use only the lower or bright valve of the scallop. Certain scallopers furnish these scallop shells, cleaned of meat, at the rate of $6 per barrel; and, though it takes considerable time to separate the shells when opening, the excellent price makes this new industry pay. The question of the future is to find new and more important uses for our waste sea products. Some day what is now waste in the scallop industry may be utilized for the benefit of the public.

V. *Food Value.* — As a food the scallop stands ahead of all the other shellfish, containing much more nourishment than the oyster. The following figures are from the tables of Professor Atwater, rearranged by C. F. Langworthy:[1] —

	Refuse, Bone, Skin, etc. (Per Cent.).	Salt (Per Cent.).	Water (Per Cent.).	Protein (Per Cent.).	Fat (Per Cent.).	Carbohydrates (Per Cent.).	Mineral Matter (Per Cent.).	Total Nutrients (Per Cent.).	Fuel Value per Pound (Per Cent.).
Oysters, solids, . . .	-	-	88.3	6.1	1.4	3.3	.9	11.7	235
Oysters, in shell, . .	82.3	-	15.4	1.1	.2	.6	.4	2.3	40
Oysters, canned, . .	-	-	85.3	7.4	2.1	3.9	1.3	14.7	300
Scallops, ...	-	-	80.3	14.7	.2	3.4	1.4	19.7	345
Soft clams, in shell, . .	43.6	-	48.4	4.8	.6	1.1	1.5	8.0	135
Soft clams, canned, . .	-	-	84.5	9.0	1.3	2.9	2.3	15.5	275
Quahaugs, removed from shell.	-	-	80.8	10.6	1.1	5.2	2.3	19.2	340
Quahaugs, in shell, . .	68.3	-	27.3	2.1	.1	1.3	.9	4.4	65
Quahaugs, canned, . .	-	-	83.0	10.4	.8	3.0	2.8	17.0	285
Mussels, ...	49.3	-	42.7	4.4	.5	2.1	1.0	8.0	140
General average of mollusks (exclusive of canned).	60.2	-	34.0	3.2	.4	1.3	.9	5.8	100

The Laws.

The State laws regulating the fishery were made for the benefit of the industry and for the preservation of the "seed" scallop, which is the only requirement necessary for insuring the future supply.

Each town has charge over its scallop fishery, under the general shellfish act of 1880, which entrusted all regulation of the shellfisheries to the selectmen of the towns. The town laws governing the scallop fishery are by far the most satisfactory of the shellfish laws of the towns. Although in many respects beneficial, they have certain disadvantages.

[1] United States Department of Agriculture, Farmers' Bulletin 85, 1898.

The main disadvantage of the town laws is found in the jealousy of neighboring towns. One town may make a law to oppose another town, and will often injure its own interests thereby. In this connection the condition at Dennis, during the winter of 1904–05, was an instance. As scallops were remarkably abundant, the town made by-laws intended to exclude from its scallop fisheries the residents of other towns. At the close of the scalloping season, when the ice came, the scallops were still abundant. The inhabitants of the town thought they could get the rest next season. They did not know that the scallop does not live two years. The next year not a single scallop of that set was to be found; they had died. If other scallopers had been allowed to go there, thousands of dollars could have been saved, and many scallopers given employment. This one case illustrates the disadvantages of town jealousy; and Dennis is by no means to blame, as it merely protected itself against the similar restrictions of neighboring Cape Cod towns.

The town laws which benefit the scallop industry are made each year according to the condition of the industry. Edgartown and Nantucket have perhaps the best-governed scallop industries. Laws requiring licenses, regulating the opening of the season and restricting at proper times the catch, so as to get the best market prices instead of overstocking the market when the prices are low, are to be recommended on account of their benefit to the scallopers.

History.

In considering the rise of a fishing industry, it is often difficult to state exactly the year when the industry started, as there are differences of opinion as to how large a fishery should be before it could be justly considered an industry. The scallop fishery has existed for years, but did not become an established industry of the State before the year 1872. At that time there was hardly any demand for scallops, and the catch was with difficulty marketed. Since then the market demand for the scallop has steadily increased, until the supply can hardly meet the popular demand. It seems almost incredible that the scallop as an article of food should once have been scorned and practically unknown.

During the years of 1876 and 1877 the industry took a sudden spurt. At this time the introduction of the dredge on Cape Cod revolutionized the industry, and made it possible to open up the deep-water fields. The industry on Cape Cod first started at Hyannis, where a number of men entered the new business; and for several years the production increased rapidly, with the opening of new territories and improved methods of capture. While the natural supply has remained the same or declined in certain localities, as has been shown in a previous part of this report, the value of the industry, in regard to the number of men engaged and capital invested, has steadily increased.

SCALLOP PRODUCTION FOR MASSACHUSETTS.[1]

YEAR.	Bushels.	Value.	Gallons.	Price per Gallon.
1879, ...	10,542	$3,514	7,028	$0 50
1887, ...	41,964	38,933	27,976	1 39
1888, ...	26,168	43,202	17,446	2 48
1898, ...	128,863	85,383	85,908	0 99
1902, ...	66,150	89,982	44,100	2 04
1905, ...	43,872	98,712	29,248	3 37½

[1] Statistics taken from the United States Fish Commission reports.

These figures show that the price of scallops varies greatly, dependent largely upon the amount caught that season; also that there has been, in spite of the irregularity of the catch, a gradual rise in prices since 1879, due to a more extensive market.

In considering the scallop industry the following points should be noted: (1) It has been necessary to record as scallop area any grounds where scallops have ever been found, in spite of the fact that only a portion of this total area is in any one year productive. (2) The boats engaged in the scallop fishery are but transitory capital, which is utilized, outside of the scallop season, in other fisheries. (3) The quahaug and scallop fisheries in many towns supplement each other, as the same men and boats are engaged in both industries. (4) The length of the season varies in the different localities. In New Bedford and Fairhaven the scallops are mostly caught in a few weeks, as many boats enter the business temporarily. This necessarily gives an excess of invested capital and a small production. In these two towns the number of scallop licenses are recorded as showing the number of men engaged in the fishery, while as a fact but a small part of these are steadily engaged in the industry.

TOWN.	Number of Men.	Boats.		Extra Dories.		Value of Gear.	Production, 1907-1908.		Area of Scallop Grounds (Acres).
		Number.	Value.	Number.	Value.		Gallons.	Value.	
Barnstable,	39	23	$8,000	-	-	$575	1,530	$2,004	2,800
Bourne,	38	30	15,000	-	-	1,200	12,000	15,720	3,000
Chatham,	107	35	10,650	61	$1,430	1,185	34,615	45,345	2,000
Dennis,	30	9	4,230	9	180	368	2,950	3,865	2,250
Edgartown,	39	26	8,000	-	-	550	17,000	22,270	2,000
Fairhaven,	73 [1]	50	12,500	-	-	1,500	1,300	1,703	2,500
Harwich,	12	7	2,350	-	-	280	2,170	2,843	3,200
Marion,	44	16	5,300	24	250	580	7,000	9,170	1,500
Mattapoisett,	22	19	6,900	-	-	760	5,000	6,550	1,200
Nantucket,	99	47	13,250	20	500	700	20,245	26,539	4,500
New Bedford,	38 [1]	20	5,000	-	-	600	700	917	400
Tisbury,	20	8	3,000	6	90	300	3,000	3,930	800
Wareham,	45	36	10,800	-	-	1,300	10,000	13,100	2,500
Yarmouth,	41	15	3,750	10	200	475	8,000	10,480	2,250
Total,	647	341	$108,730	130	$2,650	$10,373	125,510	$164,436	30,900

[1] Licenses.

Barnstable.

The principal scalloping grounds of the town of Barnstable are found in Hyannis bay and at Cotuit. Scallops are said to have once been abundant in Barnstable harbor, on the north side of Cape Cod. At the present day the scallop is unknown commercially in this locality, and few are found on the sand flats of the harbor. A. Howard Clark, in his report on the fisheries of Massachusetts, in 1880, makes the following statement concerning this industry in Barnstable harbor: —

> Scallops are abundant along the shores of the harbor, and in 1876 a party of men from Hyannis established themselves here for the purpose of gathering them. In 1877 the price of scallops declined very greatly, forcing these men to abandon their enterprise. The fishery was continued, however, by two men of Barnstable. In the winter of 1877–78 the latter shipped 40 half-barrels of "eyes," and during the winter of 1878–79 only 6 half-barrels. They were sent to Boston and New York.

This furnishes a concrete example of the extinction of the productive scallop beds in certain localities. The chances are that a severe winter or other adverse physical conditions killed all the scallops in the harbor, and rendered impossible any future supply. Although Barnstable harbor, with its swift tides, is not suitable for scallops in all parts, yet there are certain localities where they should thrive. In no way is it visionary or impossible that by the proper transplanting of young scallops from the waters on the south side of the Cape, these "seeders" might furnish other generations of scallops, and revive an extinct industry. At any rate, the chances for success in this line look favorable, and should be carefully considered.

Hyannis. — Although the scallop industry on the north coast of the town is extinct, it still flourishes as of old on the south coast. The bulk of the business is carried on here, and nearly all the shipments are made from this town. The scallop territory comprises 2,700 acres, in the following localities: (1) Lewis Bay; (2) near Squaw's Island; (3) Hyannisport harbor; and (4) the shore waters. At Hyannisport small scallops are taken with "pushers" in the shallow water, while large scallops are taken by dredging in the other three localities. Scallops are found in different parts and in varying abundance each year. Practically all this territory as outlined on the map is suitable for scallops.

Two methods of scalloping are in use at Hyannis: (1) the hand "pusher," used in shallow water, especially in the harbor at Hyannisport; (2) dredging. These two methods cover different territories, and it is possible that one year scallops may be found only on the flats where it was impossible to dredge with a boat, and another year be all in the deep water where the "pusher" cannot be used. However, in most years both methods are in use. The dredge most commonly used is the "scraper," although the Chatham style is found here. Six to nine are carried by each boat.

Hyannis claims the distinction of shipping the first Cape Cod scallops to market. This was in 1874, and was the start of a considerable industry which employed 80 men. There has been more or less scalloping ever since that time. Ernest Ingersoll, in his report on the scallop fishery of the United States, in 1880, says in reference to scallop fishing at Hyannis from 1876 to 1878: —

> The most northerly locality at which such a fishery exists, as far as I am informed, is at Hyannis, Mass., and during the winter of 1877 many persons of all ages and conditions were employed in it there. One firm fitted up a large house expressly for the business, and employed a large number of openers. Skiffs, cat-rigged yawl boats, dories and punts, 200 in number, and of every size, shape, form and color, were used; most of them were flat bottomed, shaped like a flatiron, and therefore very "tender" when afloat. Each boat carried two dredges, locally termed "drags." In that year, according to Mr. F. W. True, each of the 200 boats averaged 120 bushels, or 100 gallons, during the season, which would give a total of 24,000 bushels, or 20,000 gallons for the fleet. The scallops were sent to New York and also to Boston, and an average price of $5 per half-barrel was received. In 1876 the price was $7, and in 1878 only $3.50. Further inquiries show that this spurt at Hyannis had no precedent, and has completely died away, so that at present there is no catch there, or at least no shipments.

The 1904–05 fishery was very successful, while the season of 1905–06 proved the reverse. The production for 1905–06 was 1,350 gallons, valued at $3,200; while the 1906–07 season furnished 1,000 gallons, worth $2,000. The following notes, made in November, 1905, give the situation of the industry for that year: —

The scalloping areas this season have been at Squaw's Island and in Lewis Bay, the first locality furnishing the better fishing. By the middle of November both areas were practically exhausted and the season over. The production to November 12 was 900 gallons. After that time the shipments to the Boston and New York markets were small and irregular, in spite of the high price of $3 to $3.50 per gallon.

Cotuit. — In the report of Mr. Ingersoll we find no mention of scalloping at Cotuit. Either there was none in 1879, or it was too small to be of any importance. To-day the scalloping is of slight importance, and practically all is used for home trade. Undoubtedly there has been but little change in the past twenty-five years. Side by side with the pigmy scallop industry has grown the oyster industry, which has made Cotuit famous. Undoubtedly the latter has sapped the strength of the former by encroaching on its area; but it has always been for the best interests of the people, as the oyster industry here is far more valuable than the scallop fishery.

The grounds of Cotuit are quite small, extending over an irregular strip of 100 acres. The bottom is mostly muddy, and covered with patches of eel grass. All the rest of the bay, where the bottom is more suited for oyster culture, is taken up by grants. This scalloping area, although small, is free to the scallopers of Osterville, Cotuit, Marston's Mills and Hyannis, and even where heavily set it is soon fished out.

In the years previous to 1904–05 exceptionally fine scalloping had been reported by the fishermen. The season of 1904–05 was exceptionally poor, and in 1905–06 hardly any scallops were obtainable. In 1907 scalloping began October 1, and by December 15 all the boats were hauled up, as the scallops became too scarce for profitable fishing. Dredging is the only important method employed in the Cotuit fishery, although a few scallops were picked up on the flats.

A town law forbidding the capture of scallops for market before December 1 was passed in 1899. This, nevertheless, permitted any resident of Barnstable, between October 1 and December 1, to catch scallops for his family use, and for this reason could never be strictly enforced. In 1907 this law was repealed, as many believed that it was detrimental rather than helpful to the Cotuit interests, as it gave the Hyannis scallopers, after they had fished for two months in Hyannis Bay, the cream of the Cotuit fishery.

SUMMARY OF INDUSTRY.

TOWN.	Number of Men.	Boats.		Value of Gear.	Production, 1907-08.	
		Value.	Number.		Gallons.	Value.
Hyannis, ...	16	$3,200	8	$200	1,130	$1,480
Hyannisport, . . .	14	2,800	7	200	100	131
Cotuit, ...	9	2,000	8	175	300	393
Total, ...	39	$8,000	23	$575	1,530	$2,004

Bourne.

The villages of Buzzards Bay, Monument Beach and Cataumet share the scallop fishery of the town of Bourne, and have had during 1907–08 a successful season for the first time in eight years.

The available scallop territory of the town covers approximately 3,000 acres, extending from Buttermilk Bay along the whole coast of the town to Cataumet.

The fishing is mostly done by dredging with cat boats, carrying from six to ten dredges per boat, although a few scallopers dredge with power. The dredges are generally of the "scraper" type, with the chain bottom, similar to the dredges used at Edgartown. The scallopers both open their own catch and hire openers to assist them. Thirty boats, 8 carrying 2 men, and 22 with 1 man, totalling 38 men, are employed in the scallop fishery.

The industry lasted until Jan. 1, 1908, when the boats were hauled up for winter. The total estimate for the season is 20,000 bushels, or 12,000 gallons (unsoaked), valued at $15,720. The largest daily catch recorded for one boat was 72 bushels.

The principal market is New York, though part of the catch is sent to New Bedford. The price varied from $1.15 to $3 per gallon. The scallopers claim that they do not soak the scallops, as the "eye" is large enough to sell well without increasing its size. Undoubtedly soaking is done to some extent. The scallops are large, opening about 3½ quarts per bushel.

Twelve hundred dollars are invested in gear and $15,000 in boats, which vary from $300 to $1,300 in value.

Licenses costing $1 are required by the selectmen of every scalloper.

Here again we find the old tale of the decline of a once prosperous industry, and new enthusiasm in the success of the 1907–08 season. The 1906–07 season was an improvement over the previous one, when eight licenses were issued, allowing a maximum of 1,605 bushels to be taken. In previous years no licenses were given, as there were no scallops.

Brewster.

Scalloping at Brewster can hardly be called an industry. Here the primitive method of picking up the scallops on the exposed flats at low tide is alone used. The scallops are washed by the heavy seas on the flats, and can be gathered by men, women and children when the tide goes down. Somewhere in the deeper water is a bed of scallops, but in 1905 no one had been able to locate it. In 1905 only one man made a business of gathering and shipping these scallops. He averaged 2 bushels per tide, going down with a team and carting them to his house, where he opened them. All shipments were made to Boston, at an average price of $1.75 to $2. The people pick up many for home use.

Chatham.

The town of Chatham, situated at the elbow of Cape Cod, possesses abundant facilities for all the shore fisheries. For the past twenty-five years the scallop fishery has held almost equal rank with the lobster and cod fisheries, for which Chatham is noted, and has in many years furnished employment when other fishing had failed.

Scallops are found only in the southern waters of the town. Between Inward Point and Harding's Beach many acres of eel-grass flats, sheltered from the open ocean by Monomoy Island, furnish excellent grounds for scallops. The entire area of these grounds is approximately 2,000 acres, although this whole territory is never completely stocked in any one year. During the season of 1907–08 the following places constituted the scalloping grounds: —

(1) Island Flats in Stage Harbor, on the east side of the channel, opposite Harding's Beach, furnished a number of scallops, which

were rapidly caught the first of the season, as these flats were near the town. Here the water is not more than 1½ to 2 feet deep at low tide, and thick eel grass covers the greater part except near the channel. The first of the season a man could obtain 8 bushels per day, but later a catch of 2 bushels was considered good.

(2) Directly south of Harding's Beach lies John Perry's flat, commonly known as "Jerry's," where there has been good scalloping for many years.

(3) The western half of the Common Flats furnished the best scalloping in 1907–08, as the scallops, though small (6 pecks to a gallon), were plentiful. These flats run nearly dry on low course tides, and are covered with eel grass. Nearly every year there is a heavy set of scallop seed, which, because of the exposed nature of the flats, is wholly or partially destroyed. The entire set was destroyed in the winter of 1904–05, while 30 per cent. was lost in 1906–07.

(4) On the flats just south of Inward Point was another bed of scallops.

(5) In the bend north of Inward Point scallops were plentiful.

(6) On the northwest edge of the Common Flats scallops can be dredged over an area of 160 acres at a depth of 5 fathoms. These are of good size, opening 3½ quarts to the bushel.

Two methods of obtaining scallops are employed: (1) by the use of the "pusher;" and (2) by dredging. As the "pusher" is used on the flats at low water where the boats cannot sail, the boat man possesses the advantage of "pushing" at low tide and dredging at high water. Sixty per cent. of the scallopers at Chatham go in dories and use "pushers," as the Common Flats afford excellent opportunity for this sort of fishing; the remaining 40 per cent. scallop in boats, using "pushers" to a limited extent. Four to six box dredges are used for each boat, the smaller boats carrying four, the larger six.

Summary of Industry.

Number of men,	107
Dory men ("pushers"),	62
Boat men (dredgers),	45
Number of boats,	35
Single-manned,	26
Double-manned,	9
Value of boats,	$10,650
Number of dories,	61
Value of dories,	$1,430
Value of scallop gear for dories,	135
Value of scallop gear for boats,	1,050
Total value of scallop gear,	1,185

Last season 34,615 gallons, valued at $45,345, were shipped to Boston and New York. Shipments are made in butter tubs, containing 4 to 6 gallons each.

The larger scallops in the deep water are from 2½ to 2¾ inches in length, taking 5 pecks to open a gallon of "eyes." On the flats are smaller scallops, from 2 to 2¼ inches in length, of which 6½ pecks are required to make a gallon. About 4,000 gallons were bought in Chatham by two dealers, paying $1.30 per gallon; the rest were shipped to Boston and New York by the individual scallopers, shipments being made semiweekly to New York. The scallops were shipped in butter tubs containing from 4 to 6 gallons, on which the express charges were: to New York, 65 cents; to Boston, 35 cents. The 1907–08 production was 20,000 gallons, valued at $40,000.

In 1905–06 practically all the catch were "seed" scallops of the set of 1905; only about 5 per cent. of the catch were scallops of the 1904 set. Owing to the exceptional cod fishing, only 15 men made a business of scalloping, going mostly one man to a boat, and averaging 3½ bushels per day after the scalloping "struck in," Dec. 1, 1905. The high prices alone made it profitable to catch these small scallops, which gave only 3 pints of "eyes" to a bushel of shells, — just one-half the amount yielded by a bushel of large scallops. The fishermen were all from South and West Chatham. The entire catch was estimated at 2,800 gallons.

Dennis.

The scallop grounds of Dennis and Yarmouth are common property for the inhabitants of both towns, while other towns are excluded from the fishery. The West Dennis scallopers fish mostly on the Yarmouth flats at the mouth of Parker River, and between Bass and Parker rivers on the shore flats. There is also scalloping along the shore on the Dennis grounds. These grounds are for the "pushers." Dredging is carried on at Dennisport, and the boats cover a wide territory at some distance from the shore. The town possesses a large area, which either has scattering scallops or is well stocked one year and barren the next. Nearly 2,250 acres of available territory is included in the waters of the town. The flats, which are of sand with thick or scattering eel grass, according to the locality, afford a good bottom for scallops. Were it not for the eel grass, the scallops would perish by being washed on the shore by southerly winds.

Thirty men make a business of scalloping in the town of Dennis, 22 from Dennisport and 8 from West Dennis. At Dennisport scalloping is practically all done by dredging, while at West Dennis scallops are all taken by the use of "pushers." At Dennisport 9 boats, 3 sail and 6 cat boats, with power, carrying 18 men, are employed in the business. Here also are 4 dory scallopers. At West Dennis the scallopers go mostly in pairs, using only 5 dories.

The dredges used at Dennisport are similar to the Chatham dredge. At Dennisport the scallopers open the scallops and also employ openers, while at West Dennis the scallopers do the entire work.

In 1907–08 the production was 2,950 gallons, valued at $3,865. Scallops were shipped to the New York and Boston markets, although the greater part of the catch went to New York.

The scallops taken at Dennisport are large, opening 3 quarts to the bushel. At West Dennis, where the fishing is done in the shallow water, the scallops are somewhat smaller, yielding only 2½ quarts to the bushel.

During the month of November large quantities of scallops were blown ashore at Dennisport, and it is said that as many as 72 bushels were gathered by one man in a day.

CAPITAL INVESTED.

Value of boats: —	
Sail,	$1,230
Power,	3,000
Dories,	180
Total,	$4,410
Value of gear: —	
Boat,	350
Dory,	18
Total,	$368

Permits are required for scalloping, but are issued free of charge by the selectmen. Dennis and Yarmouth have common scallop fishery rights, the town scallop regulation reading as follows: —

All persons other than the inhabitants of the towns of Dennis and Yarmouth are prohibited from taking scallops from the shores and waters of the town of Yarmouth excepting for their family use, and in no case without a permit.

During the season of 1904–05 there existed off Dennisport one of the largest beds of scallops ever known in Massachusetts. Not only was it extensive, but the scallops were very numerous. An enormous yield was the result, affording great profit to a large number of scallopers, and bringing into the town thousands of dollars. It was stated by the scallopers that when the scalloping ceased because of the severe winter and ice the number of scallops appeared in no way diminished. During the season the catch averaged over 25 bushels per boat. Prospects looked good for the following season, as the fishermen expected the scallops to live until the next year. Unfortunately, the life of a scallop is less than two years, and before spring practically the whole of this large bed was dead, — a heavy loss to the fishing interests of the town and of the State.

In cases like this the exclusion of scallopers from the neighboring towns, through the present system of town laws, has resulted in severe economic and financial loss to the State, as many more scallops could have been captured without injury to the future supply if more fishermen had been given an opportunity to enjoy this fishery.

The following season, 1905–06, presented a marked contrast to that of 1904–05. Some adverse conditions had injured the set of 1905, and as a result there were scarcely any adult scallops. By January 1 the scallops of the 1906 set had become large enough in certain localities to permit capture. Owing to the high prices, these scallops, less than eight months old ("seed" scallops), were profitable to catch, and the season's catch at Dennisport after January 1 consisted of these young scallops. At that time the present "seed" scallop law was not in force, so the capture of these scallops was entirely legal.

About 6 men were engaged during 1905–06 in scalloping at Dennisport. The scallops were obtained by dredging in the deeper water. The average catch was 3 to 4 bushels per day. The 1906–07 season was hardly above the average. At West Dennis 8 men were engaged in scalloping on the flats with "pushers." The scallops were small, averaging about 2 inches in width. It is only once every three or four years that West Dennis scallops are in the deep water where it is necessary to dredge them; usually the scallops are found on the shallow-water flats. The 1907–08 season is the best season the town has had since 1904–05.

Dartmouth.

A few scallops are occasionally found in Slocum's River and other places, but in no quantity to furnish any commercial fishery.

Eastham.

The scalloping grounds are on the west side of the town, about half a mile out. During the season of 1906–07, 6 men, working at intervals during the winter, managed to take a total of 500 bushels from these flats.

Edgartown.

Edgartown, situated at the eastern end of Martha's Vineyard, possesses extensive scallop grounds, and is one of the leading towns in the production of this shellfish. This fishery, even more important than the quahaug industry, furnishes steady winter employment for a large number of the inhabitants.

The important grounds are in Cape Poge Pond and in Edgartown harbor, while occasionally beds of scallops, especially "seed," are found in Katama Bay. These grounds comprise an area of 2,000 acres, chiefly of grass bottom.

At Edgartown scalloping is done both with sail and with power boats, which are generally auxiliary cat boats, though power dories are used to some extent. All but two of the power boats are doubly manned, while the sail boats carry but one man. Eleven sail and 15 power boats, employing 39 men, are engaged in the fishery.

Two kinds of dredges are used, the "scraper" for scalloping in the eel grass and the "slider" for clean surface. The depth of water over the scallop beds is not more than 18 feet, necessitating 10½ fathoms of rope. The price of a dredge, including rope, is about $3, which is cheaper than in the Buzzards Bay towns. Each power boat uses six to eight, which are held out by "spreaders," poles extending from the sides of the boat, in order that the dredges may cover more ground and not trail behind one another.

The greater part of the scalloping is done by power, and, in spite of the extra cost of nearly 90 cents per day, the proportionate increase makes this method more profitable; it is claimed to increase the catch about one-third. Scalloping with power necessitates the services of two men, as one man has to cull while the other steers. At the end of the "drift" the boat is stopped, and both men cull. With sail, culling can be done when dredges are overboard. When two men scallop, the owner of the boat takes three-fifths while his partner shares two-fifths of the profit.

Twenty-five to 30 openers prepare the scallop for market during the afternoons and evenings. These are paid at the rate of 25 cents per gallon, and average about $1.50 per day, a good opener cutting out a gallon of "eyes" in an hour. Small scallops open 700 "eyes" per gallon; the larger ones, 500.

The 1907–08 season was successful, as the scallops were plentiful, the daily catch per boat running between 5 and 50 bushels. About 17,000 gallons, valued at $22,270, were shipped between Oct. 1, 1907, and April 1, 1908.

Shipments are made mostly to the New York market; a very few to Boston market. The freight charges on a keg, which weighs about 70 pounds, is 55 cents. In warm weather scallops are sent by express, the charges being 80 cents. The scallops are packed in butter tubs of large size, averaging from 6 to 7 gallons, and costing 8 cents apiece. These are obtained second hand from the grocery stores at New Bedford. The tubs are packed full and closed tightly. By the time the scallops arrive at market they are reduced in quantity by the jarring, in warm weather from 7 to 6 gallons, and in cold from 7 to 6½. Returns from the market are made in about a week. Scallops can be held back for better prices three to four days in warm weather, and about seven in cold.

CAPITAL INVESTED.

Value of power boats,	$5,250
Value of sail boats,	2,750
Value of gear,	550
Total,	$8,550

By vote of the town, the season for several years has been open one month later than the State season. Shellfish permits costing $2 are required of every scalloper. The daily catch for one man is restricted to 25 bushels.

Edgartown was one of the pioneer towns in the State in the scallop fishery, and as early as 1875 scallops were shipped to the market. The industry has maintained a steady supply, and has not shown the great variation of the Cape and Buzzards Bay fisheries. This is due perchance to the natural conditions, which render favorable the maintenance of an extensive industry.

The last four seasons have been very successful, as when scallops were scarce the increased price more than made up for the diminished supply. The 1904–05 season was favorable, but, owing to the severe winter, fishing ceased about January 1, although scallops were plentiful both in Cape Poge Pond and Edgartown harbor. In 1905–06 scallops were found only in Cape Poge Pond, as the previous severe winter had killed all the harbor "seed." This season was most successful, as Nantucket and Edgartown, owing to the scarcity of scallops in other localities, received very high market prices. Scallops were more abundant in 1906–07, but the lower prices made the industry less prosperous than in the previous season.

Comparison of 1879 with 1907–08 Production.

	1879.	1907–08.
Gallons,	500	17,000
Value,	$250	$22,270

Fairhaven.

Fairhaven possesses, with New Bedford, the scalloping grounds of the Acushnet River, and in addition a much larger territory around Sconticut Neck and West Island. The scalloping territory comprises about 2,500 acres, most of which is unproductive or productive only at intervals.

The town charges $1 for the license to each scalloper. Seventy-three licenses were issued in 1906–07. This is a larger number than has been issued in recent years. The highest number ever issued was 80.

The capital invested is transitory, for the season, as in New Bedford, usually lasts only three weeks. Possibly $14,000 is invested in this way in boats and gear.

In a good season as high as 2,000 gallons have been shipped in a week. The average season hardly produces this amount in the whole three weeks. In the season of 1907–08, 1,300 gallons were shipped. Some years ago the starfish was a source of damage to the fishery, but of late years it has attracted little notice.

We find the following account of the scallop fishery of Fairhaven written by A. Howard Clark in 1879: —

Ten boats took 2,100 bushels of scallops in 1880. Fourteen men with 10 boats dredge for scallops from the middle of October to the middle of January. Great quantities are found in the Acushnet River, as well as along the western shore of the bay. A small dredge, holding about a bushel, is used. It is made with an oval-shaped iron frame, 3½ feet in length. Wire netting is used in the front part and twine at the back. Small sail boats, each with two men, fish with from one to twelve of these dredges in tow, sailing with just enough sheet to allow a slow headway. As soon as a dredge is filled, the men "luff up," haul in, empty, and go on. These little boats take from 10 to 75 bushels a day. If the breeze be unfavorable, one man takes the oars while the other tends the dredges.

The amount of production at the present time is about the same, or even more, than the figures given for 1879. In all other respects the industry has changed. Five times as many men now work at the business, while more boats and capital are invested. This looks as if the industry had improved. The industry as regards the methods of capture has improved, but the actual production has remained the same. Now the season lasts barely three weeks, whereas twenty-five years ago with few men it lasted four months.

Fall River District.

No scallop fishery exists in these waters at the present time. In 1879, 800 gallons were taken from this region. This furnishes an excellent illustration of the total decline of the scallop fishery in certain localities.

Falmouth.

The town of Falmouth cannot be said to support any scallop industry of importance. Each year in Squeteague Pond, Wild Harbor, North Falmouth and in West Falmouth harbor a few scallops can be found; but these are used only for limited local consumption, and usually are very scarce. Scallops are occasionally present in small quantities in Waquoit Bay.

Harwich.

The scallop territory of Harwich covers an extensive area on the south side of the town, and in some places extends for a distance of from 2 to 3 miles out from shore. Usually the scallops are found, as in the last season (1907–08), outside the bar, at a distance of 3 miles from shore, where they can be taken only by dredging from sail or power boats. The intervening body of water sometimes contains a few scallops in a quantity to make a commercial fishery. The total area of the scallop grounds is about 3,200 acres. The bottom is mostly sandy, with patches of eel grass.

All the scallops are caught by dredging, as the water is too deep for any other method. Twelve men were engaged in the fishery during the 1907–08 season. The boats, 7 in number, consisted of 3 power and 4 sail; 5 were manned by 2 men, 2 were sailed singly. The dredges used here are the same style as the Chatham dredge.

The 1907–08 production was 2,170 gallons, valued at $2,843. The scallops were shipped to the Boston and New York markets, the greater part being shipped to New York, at an average price of $1.30 per gallon. The scallops taken in 1907–08 were large, opening 3½ quarts to the bushel.

CAPITAL INVESTED.

Value of boats,	$2,350
Value of gear,	280
Value of shore property,	400
Total,	$3,030

For the last two years there has been practically no scallop fishery. The 1904–05 season was the last successful season, when the large bed of scallops was found off Dennis. The 1907–08 season, however, has been fairly good, and it is thought that the following year may be as successful.

Marion.

Marion was included in the general revival of the scallop fishery which came to Buzzards Bay during the past season of 1907–08, and for the first time in eight years has had a successful scallop season.

The scallop grounds of the town extend over an area of 1,500 acres, situated on both sides of Great Neck, and extending from the Wareham line to Aucoot Cove.

All scalloping is done by dredging. The fishery can be divided into two classes: (1) the boat fishery; (2) the skiff fishery. Under the first class comes the cat boat and sloop, carrying six dredges; while the second class consists of the small sail skiffs, with one dredge. The skiff scalloper rows or sails, as the wind permits, and with his one dredge makes an average catch of 3 bushels per day. Forty-four men, using 16 sail and power boats and 24 skiffs are engaged in the fishery. The business likewise requires the services of nearly 24 openers.

About two-thirds of the dredges are of the "scraper" type, with chain netting; the rest "sliders," with loose blades. A very few "roller" or "lead" dredges are used.

The production for 1907–08 was 7,000 gallons, valued at $9,170. The scallops were mostly sent to the New Bedford market. The scallops are of two sizes: the smaller, which are taken in the shallow water, open only 2½ quarts per bushel, while in the deeper water the larger scallops yield about 3½ quarts. The rest of the body of the scallop, after the removal of the eye, is saved for bait at Marion, the scalloper receiving 30 cents per bucket.

CAPITAL INVESTED.

Value of boats,	$5,300
Value of skiffs,	250
Value of gear,	580
Total,	$6,130

The three towns of Marion, Mattapoisett and Rochester have common fishery rights, as all three were included in the original town of Rochester. In 1852 Marion became an independent town, and in 1857 Mattapoisett was likewise separated from Rochester. Until 1893 Marion and Mattapoisett had separate fishery rights, Rochester having mutual rights with both. Since then the fishery of these towns has been common to all three. Every scalloper is required to have a permit, the boatmen paying $2, the skiff scallopers $1, respectively.

The scallop industry supplanted the waning oyster industry at Marion some twelve years ago, and for a time it flourished greatly. The abundance of scallops and extent of the grounds furnish excellent scalloping. After a few very successful years the industry suddenly died out and became practically extinct. The direct cause is claimed by the scallopers to have been the starfish, which came in the harbor in great abundance at the time of the decline of the industry. Up to this season but little scalloping had been done for several years, and not a single permit was issued for the season of 1906–07.

Mashpee.

The scallop territory of Mashpee lies in the Popponesset River and Bay, comprising at most 200 acres. For the last six years there has been no scallop industry in the town. A few scallops are occasionally taken for home consumption.

Mattapoisett.

The scallop territory of Mattapoisett, comprising an area of 1,200 acres, much of which is open and exposed, is in general confined to the following localities: Nasketucket Bay, Brant Bay, Brant Island Cove, Mattapoisett harbor, Pine Neck Cove and Aucoot Cove. The location and extent of these grounds are indicated on Map 8.

SUMMARY OF INDUSTRY.

Number of men,	22
Number of boats: —	
Sail,	13
Power,	6
Total,	19
Boats, how manned: —	
Single,	16
Double,	3

Dredging is the only method of scalloping used in Mattapoisett. Small cat boats and a few power boats are employed in the fishery. The "roller" dredge is the most popular style with the Mattapoisett scallopers, who claim that on the uneven bottom this dredge is the most successful. This town is the only locality in the State where this kind of dredge is used. The cost of a dredge completely rigged with rope, which is often 15 fathoms long, is $4.50, and 8 to 10 dredges are used for each boat.

During the 1907–08 season the production was 5,000 gallons, valued at $6,550. These were mostly marketed at New Bedford, where they were purchased unsoaked by the New Bedford Fish Company. At the first part of the season it was not uncommon for a boat to catch 25 bushels per day, but as the season progressed the size of the catch gradually diminished. The scallops were large, opening 3 quarts to the bushel.

CAPITAL INVESTED.

Value of boats,	$6,900
Value of gear,	760
Total,	$7,660

The scallop industry at Mattapoisett, though once important, was extinct for several years. The present season has shown a revival, and the industry has again assumed a commercial value.

Nantucket.

Nantucket is one of the leading towns of the State in the scallop fishery. The grounds lie both in Nantucket harbor and in Maddequet harbor on the west end of the island. The former of these is the larger and more important, as the fishery is near the town. When the scallops become scarce in Nantucket harbor, the scallopers adjourn to the fresher beds of Maddequet. Nantucket harbor contains approximately 3,000 acres of scallop territory; Maddequet and Muskeget, 1,500 acres.

Practically all the scalloping is done by dredging from sail boats, employing about 99 men in the fishery. The dredges are of the "slider" and the "scraper" types, the iron frames of which cost $1.50 and the netting bags 30 cents. From 6 to 10 of these are used per boat, and are dragged by 7 fathoms of 15-thread rope. Five regular openers are hired, who receive from 20 to 25 cents per gallon, according to the size of the scallops. A few scallops are taken in the shallow water by the dory fishermen with "pushers," which are locally known as "scoops." These differ from the Cape Cod "pusher," being more rounded and smaller in size.

Summary of Industry.

Number of boats: —	
Power,	10
Sail,	37
Dories,	20
Boats, how manned: —	
Single,	15
Double,	32
Single dories,	20

In 1906–07 the production was 9,820 gallons, valued at $12,875.

1907-08.[1]	Gallons.	Price per Gallon.	Value.
October,	2,639	$1 25	$3,298 75
November,	4,160	1 00	4,160 00
December,	5,430	1 00	5,430 00
January,	5,910	1 50	8,865 00
February,	960	2 00	1,920 00
March,	1,146	2 50	2,865 00
Total,	20,245	$1 31	$26,538 75

[1] Return of Special Agent William C. Dunham.

Shipments were made by express to New York and Boston, the charges to New York being 95 cents, to Boston 55 cents per keg. The greater part was shipped to New York market. The scallops were shipped mostly in 7-gallon kegs, which cost 33 cents apiece. About 30 New York and 20 Boston firms receive shipments from the Nantucket scallopers.

Two kinds of scallops, the large "channel" and the small or "eel grass," are obtained. The small scallops are more numerous than the large, but are naturally less desirable.

Capital invested.

Value of power boats,	$4,000
Value of sail boats,	9,250
Value of dories,	500
Value of gear,	700
Total,	$14,450

Of late years the scallopers have taken an interest in protecting the scallop. Many scallopers when fishing in shallow water "cull out" the small "seed" scallops, and, instead of returning them to the shallow water, transplant them to the deep water of the channel, where they are not only protected in case of severe winter, but produce a larger scallop the following year. This is the only attempt at protecting the scallop ever made in Massachusetts, and shows how important the industry is to the town.

For the two seasons previous to 1907–08 every scalloper was required to have a license. In 1905–06 the price was 50 cents, while the following year, 1906–07, 190 licenses, costing $1 each, were taken out. No licenses were required in 1907–08. Special by-laws, either limiting the catch or enforcing a close season to meet the demands of the fishery, are made by the town each year.

Scallops have been always plentiful, but fifty-five years ago they were not caught, as they were considered poisonous. The present industry started in 1883, and since that time, in spite of its ups and downs, it has remained a constant source of revenue to the island. Notwithstanding a scarcity of scallops, the high prices of 1905–06 enabled the fishermen to have a fairly successful season. Both the 1906–07 and the 1907–08 seasons have been very prosperous, as scallops have been plentiful.

New Bedford.

The scallop industry at New Bedford has been in existence since about 1870, and has furnished a livelihood for an average of 15 men ever since. Of late years the industry has shown a marked decline.

In 1879 A. Howard Clark says: —

Scallops are plentiful in the Acushnet River, and large quantities are taken with dredges from October through the winter. The business of late years has greatly increased.

About the same time Ernest Ingersoll also writes: —

In the Acushnet River and all along the western shore of Buzzards Bay these little mollusks abound, and their catching has come to be of considerable importance in that locality. Mr. W. A. Wilcox, who sends me notes on the subject, says that it is only eighteen years ago that a fisherman of Fairhaven (opposite New Bedford) was unable to sell 5 gallons that he had caught. But the taste has been acquired, and a local market has grown up to important proportions, so that in 1880 14 men and 10 small boats (dories) were dredging for scallops in Buzzards Bay from the middle of October to the middle of January. Mr. Wilcox says: "These small boats will take from 10 to 75 bushels a day." These men are not willing to work every day, however, since the tautog and other fishing calls their attention, and there is danger of overstocking the market. It therefore happens that the total catch reported for both New Bedford and Fairhaven men will not exceed 6,400 gallons, valued at $3,864, 60 cents being a fair price in this and the Boston market. The value of the investment devoted to this business at Fairhaven is about $120.

The scallop industry of 1907 cannot be compared with that of former years. The amount of scallops taken is not one-third of the former production. More men are engaged in the business than twenty-five years ago, but the beds are raked clean in a shorter time. The annual yield has sadly fallen off, in spite of improved methods of capture and increased number of fishermen. This decline cannot here be attributed to either of the natural enemies of the scallop, as neither the starfish nor oyster drill are abundant. Severe climatic conditions and over-fishing by man are the direct causes of this decline.

The scallop area of New Bedford comprises approximately 400 acres, principally in the Acushnet River and in Clark's Cove.

In 1906–07, 38 licenses were issued by the city for scalloping. This is a marked decrease over former years. Probably not all these men fish regularly. In the last few years the season has been rather short, lasting between three and four weeks, as the scallops were practically all caught in that time.

The capital required for the business, consisting of cat boats, skiffs, dredges, shanties, etc., amounts to about $5,600; but this is merely transient, and is only employed for three or four weeks, and then devoted to other fisheries.

ANNUAL PRODUCTION.

Year.	Bushels.	Gallons.	Value.
1905–06,	1,000	1,000	$3,000
1906–07,	1,200	1,200	3,000
1907–08,	700	700	917

All scalloping is done by dredging from either cat boats or dories. Since 1879 improvements have been made, and cat boats instead of dories, each manned by one man with six dredges, now do the work once wholly performed, as Ingersoll says, by dories. All the scalloping takes place in deep water.

When the law of 1905 made the Acushnet River and Clark's Cove forbidden shellfish territory, because of the sewage pollution of the harbor, the capture of scallops in season was still allowed. This was based on the principle that there is no danger in eating the clean "eye" of the scallop, although as a matter of fact there is actual danger of typhoid infection to those handling anything from sewage-polluted waters.

The following notes were made Nov. 21, 1905, upon the fishery of that year: —

At the opening of the season a bed of scallops was discovered just outside the harbor beyond the light. Twenty-five boats set to work immediately, but there was not a sufficient supply of scallops to keep them long employed, and one by one they dropped out, until by November 21 only two or three boats were still engaged in the fishery.

The scallops of this year were of large size, 2½ to 2¾ inches, and turned out a gallon of "eyes" per bushel, — an excellent yield, as the average scallops only shuck out 2½ to 3 quarts to a bushel of shells. If a man could obtain a gallon per day by November 21 he was lucky, and owing to the high retail price, he made a fair day's wages.

Orleans.

On the flats about ½ to 1 mile from the west shore scallops are occasionally found. Six years ago there was a fairly good season, but since that time there have been very few scallops, and these are taken only for home consumption.

Provincetown.

Scallops are obtained on the flats in the east bend of the harbor toward the Truro shore, where they are blown by a southwest wind. Evidently there must be a bed of scallops in the deep water from which the scallops are washed on the flats. In 1905–06 from 2 to 6 men were engaged in picking up these scallops and retailing them for home trade. About 1894 or 1895 scallops were numerous, and it was not uncommon for a man to pick up 5 bushels on the flats at one tide. Since 1900 but few scallops have been found.

Tisbury.

The scalloping grounds of Tisbury are in the harbor at Vineyard Haven. Only Vineyard Haven fishermen make a business of scalloping here. The scallop grounds comprise an area of 800 acres.

Most of the scallops are obtained by dredging from cat boats, which are nearly all equipped with power. With two exceptions the boats are singly manned. Fourteen men go in 8 boats, using from six to eight dredges per boat. Six men scallop in skiffs, using one dredge. The dredges are similar to those used at Edgartown.

During the season of 1907–08, 3,000 gallons of scallops, valued at $3,930 were captured. The fishermen ship chiefly to the New York market. The scallops are of an exceptionally large size, opening, it is said, 4 quarts to the bushel. The proportionate size of the "eye" to the shell is much greater than with the ordinary scallop.

Capital invested.

Value of boats,	$3,000
Value of skiffs,	90
Value of gear,	300
Total,	$3,390

No licenses or permits are required for scalloping. The last season (1907–08) is the second season that scallops have been abundant in this locality.

Wareham.

Situated at the head of Buzzards Bay, the town of Wareham possesses a considerable water area which is suitable for scallops. The entire territory, embracing approximately 2,500 acres, extends in a southwesterly direction from Peter's Neck, including Onset Bay, to Abiel's Buoy and from there to Weweantit River. Scallops are also found in the Wareham River. Scallops are mostly found in the deeper water, which makes dredging the only profitable method of scalloping in this locality.

Scalloping is practically all done by dredging either from sail or power boats, only 3 power boats being in use during the 1907–08 season. Three men from the village of Wareham use "pushers," but the yield from this style of fishing is very small. The style of dredge in most common use is the "scraper." This year the price paid for the frame of the dredge is $3.50. These dredges have the blade set downward firmly, and have a chain bottom of iron rings. The usual number per boat is eight, but at Onset any number from four to fourteen are used, according to the size of the boat and the individual choice of the scalloper. Nearly all the boats are cat boats, averaging in value about $300.

About 30 regular openers have been engaged off and on by the scallopers. When the catch was large at the first of the season more openers were engaged, — often as many as 3 to a scalloper. One-tenth of the number are women.

SUMMARY OF INDUSTRY.

Number of scallopers,	45
Number of boats: —	
Power,	3
Sail,	33
Total,	36

The quantity of scallops taken during 1907–08 was approximately 10,000 bushels, valued at $13,100. During October the catch was about 15 bushels per day for the average scalloper, but later became considerably less. The greater part of the scallops were sold to the New Bedford Fish Company, the representatives of which bought them unsoaked from the fishermen. Certain of the fishermen, however, preferred to ship their catch to the Boston and New York markets.

CAPITAL INVESTED.

Value of boats,	$10,800
Value of gear,	1,300
Value of shore property,	7,000
Total,	$19,100

No permits were issued in 1907–08. Previous to this year, permits were required from every scalloper. Wareham has a fish committee, the duty of which is to enforce the fish laws.

The first scalloping started in Wareham in 1879, when several boats from New Bedford commenced dredging in Wareham waters. From that time the industry rapidly developed, until it assumed considerable importance as a winter occupation. Since 1899 the industry has been practically dead until the present season of 1907–08. The Wareham scallopers to a man attribute this decline to the inroads of the destructive starfish. While the scallops have been so exterminated that no profitable fishery has been conducted the last seven years, they have not been wholly extinct, as a few could be found each year. Lately the number has been increasing, until in 1907–08 the season was very profitable. In connection with this it is said that the starfish were less numerous than usual. The prospects of another good season in 1908–09 are excellent, as "seed" scallops are said to be plentiful in many places, especially in the deep water, which furnishes protection in case of a severe winter.

Wellfleet.

At the present time in Wellfleet Bay there is no commercial scallop fishery, although scattering scallops are found in various parts of the harbor.

Yarmouth.

The scallop grounds of Yarmouth are on the south side of the town, on the flats which border the shore from Bass River to Lewis Bay. Part of the waters of Lewis Bay belong to the town of Yarmouth, and scallops are found over all this territory. The nature of the bottom is the same as at Dennis and Barnstable. The total area of scallop territory is estimated at 2,250 acres. The scallop grounds of Dennis are open to Yarmouth scallopers.

Both dredges and "pushers" are employed in the scallop fishery of the town. The method depends upon the location of the scallops, whether in shallow or deep water, as well as the means of the individual scallopers. Both the Chatham dredge and the "scraper" are used. Forty-one men were engaged in the 1907–08 fishery, using 15 boats and ten dories.

The production for 1907–08 was 8,000 gallons, valued at $10,480. Scallops were shipped to New York and Boston markets.

CAPITAL INVESTED.

Value of boats,	$3,750
Value of dories,	200
Value of gear,	475
Total,	$4,425

The same laws as were quoted for Dennis, the two towns having common fishery rights.

The 1904–05 season was prosperous, as Yarmouth scallopers had the privilege of scalloping in the large bed off Dennis. The two following years were very poor, and even the last season has not been up to the average.

OYSTER (*Ostrea Virginiana*).

Introduction.

RESOLVES OF 1905, CHAPTER 73.

Resolved, That the commissioners on fisheries and game are hereby authorized and directed to make a biological investigation and report as to the best methods, conditions and localities for the propagation of oysters under the conditions found in Massachusetts waters. The commissioners may expend for the purposes of this resolve a sum not exceeding five hundred dollars a year for a period of three years.

As authorized by the above act, the Commissioners on Fisheries and Game have conducted experiments of a biological nature upon the oyster. At the start of the investigations, for a proper understanding of the various conditions in the different localities, it was necessary to make a survey of the oyster industry of the State. Recently this survey has been supplemented by sending printed questions to the oystermen, and the whole put in the form of a report, which gives an account of the industry. This first report on the oyster is merely a broad survey of the whole industry of the State, and is preliminary to future reports of a more scientific character.

The Need of a Survey. — In 1879 Mr. Ernest Ingersoll, in his "Monograph on the Oyster,"[1] gave an excellent account of the oyster industry of Massachusetts. Since that time no complete account, either statistical or biological, has been written. Meanwhile, the oyster industry of the State, owing to its steady improvement, has changed in the past twenty-eight years, and what was true of 1879 is not true of 1907. Not only have localities changed and new areas been opened up, but also the whole industry has expanded through the enterprise and business ability of the oystermen, and to-day Massachusetts possesses an oyster fishery which more than doubles the production of 1879. Thus a survey of this fishery, by comparison with that of 1879, shows the changes that have taken place, and gives some idea of the growth of the industry.

It is hoped that this report will furnish sufficient data to give actual knowledge of the conditions of oyster culture in the State, show the success of this industry, and indicate what is essential for its future improvement. It is necessary, in view of the conflict between the qua-

[1] The Oyster Industry in the United States. Tenth Census of the United States.

haug and oyster fisheries, that the public understand the exact situation, and this is possible only through a published account of each industry.

Scope of the Report. — The object of the report is to furnish information which will be of value both to the oysterman and to the consumer. Primarily the report is for the oysterman, showing the extent of the industry in his own locality and in other parts of the coast, where perhaps he is unacquainted with the conditions. While exact facts are presented for the benefit of the oysterman, this report at the same time tries to give a general description of the industry for the consumer, who perhaps knows nothing of the oyster except as an article of food.

The first part of the report has been arranged under the following headings: (1) the natural oyster beds; (2) results of the survey; (3) history of the industry; (4) the oyster laws; (5) the oyster industry; (6) general statistics. The second part considers separately the industry of each town or section.

Methods of Work. — The statistical figures for the oyster industry are reasonably complete as the oyster fishery is on a more systematic business basis than any of the other shellfisheries. Nevertheless, on certain points it was impossible to obtain absolutely correct information, as, for instance, the area of grants, since no survey is made of the grants when leased, and the oysterman himself does not know the exact area of his granted territory. Thus an estimate has to be made by each oysterman of his granted area, and, while this is approximately correct, it cannot be considered as absolutely true.

The statistical returns were compiled by sending to each oysterman in the State a blank form, containing a series of questions, with the request that he would co-operate with the commission by answering. Many oystermen responded with complete answers, thus permitting the commission, through their aid, to publish an extended report on the oyster fishery. However, it was found impossible to obtain complete information from several towns, as a number of oystermen neglected to return these blanks. The return of each oysterman is filed at the office of the Commission on Fisheries and Game, and only the total for each town is published, thus treating as confidential the private business of individuals. The commission expresses a most cordial acknowledgment to the oystermen for their co-operation in this matter.

The other parts of the report were obtained by personal inspection of the oyster beds as to their biological conditions, by means of town records, and interviews with the oystermen. Town records, which should have given the location, number and areas of the grants, proved nearly worthless in most cases, owing to incompleteness, loss and confusion. Owing to the frequent change in selectmen, little if any information could be obtained from this source, as the new selectmen were generally unacquainted with the work of their predecessors concerning the leasing of oyster grants. The grants were often incompletely described, bounds uncertain and the acreage unknown.

The interviews with the individual oystermen furnished more and better information both in regard to the present condition of the industry and the general history for each town.

Personal inspection of the oyster grounds was made, the biological conditions noted and the area of the grants plotted on the accompanying maps. Not all these grants are worked, and parts of the cultivated grants are unfit for oyster raising. The charted area includes all grants, cultivated or uncultivated.

In reviewing the history of the industry, information was obtained from town records, oystermen who had been in the business for years, and various newspapers and periodicals. For a comparison of the oyster industry of 1879 and 1907 the excellent report of Mr. Ernest Ingersoll upon the "Oyster Industry," published in the tenth census of the United States, was used for comparison, and in many places directly quoted. Were it not for this work and the report of A. Howard Clark on the "Fisheries of Massachusetts," it would have been impossible to draw any reliable comparison with the oyster industry of twenty-eight years ago.

Massachusetts as an Oyster State. — Massachusetts is perhaps not so well adapted for oyster culture as it is for clam or quahaug farming, and does not equal other seacoast States in the extent of its oyster industry. Nevertheless, the oyster industry is on a much firmer footing than the other shellfisheries, and is an important adjunct to the wealth of the southern Massachusetts towns.

All the oyster grants, except in the towns of Wellfleet, Eastham and Orleans, are found south of Cape Cod, as the southern shore of Massachusetts alone is adapted for the oyster industry. Along the south side of Cape Cod and in Buzzards Bay the numerous inlets and estuaries afford with their brackish water excellent ground for the cultivation of this bivalve, and many acres which otherwise would be barren have been made productive through the grant system; while the shores of Massachusetts which adjoin the waters of Narragansett Bay possess, in the Taunton, Cole and Lee's rivers, excellent waters for the growth of seed oysters. Thus Massachusetts possesses good facilities for oyster culture, which are capable of a far greater expansion than present conditions indicate.

However well developed the oyster industry is at present, there is plenty of room for improvement. It is the consensus of opinion among the oystermen that the business is developing every year, — a fact that speaks well for its future. Improvements in the oyster industry can arise in three ways: (1) investment of more capital in the business, which will allow more extensive operations; (2) more intensive cultivation of the present grounds; (3) the opening of new areas for oyster culture and the utilization of waters at present useless. Everything indicates that the oyster industry will take advantage of opportunities as soon as they are given.

The Oyster Grant System. — Oyster culture in Massachusetts is the logical result of the failure of the natural oyster beds. When these beds became destitute of oysters through overfishing, it was necessary that means should be used to perpetuate the stock. Oyster planting had been successfully carried on in the States south of Massachusetts, and it was merely a question of experiment whether the oyster would respond to the same methods in Massachusetts. Thus oyster culture arose in this State at first as an experiment, later as an established industry. Grants were given, as through this way only could oyster planting become a success, and the "free fishery" people were forced to bow to public opinion, which decreed that grants should be leased. Thus oyster grants arose from necessity, as in no other way could Massachusetts preserve her oyster supply.

The system of oyster grants and oyster culture, in spite of its many failings, has shown what can be done to preserve and increase a natural shellfish industry if the proper methods are used. Planted beds have furnished enough spawn to maintain the natural beds, which would have long ago been depleted through the inroads of overfishing. They have preserved a fishery which would have disappeared almost completely, and established a better and more extensive industry, not only benefiting the oystermen, but also those indirectly associated with the business, such as teamsters, transportation companies, etc.

In the following report various abuses of the present system of oyster culture will be enumerated, and it is only necessary to state that many evils must be eliminated before the oyster industry can obtain its maximum expansion. Such evils as town politics, disputes with quahaugers, etc., will have to be remedied. The greatest obstacle which now checks the oyster industry is the *lack of protection.* Until complete protection is given to the oysterman, the industry will never attain to its full development. The removal of the abuses by the organization of the oyster industry of the State under a unified system is the best way to secure proper regulation and improvement of the oyster industry.

The Natural Oyster Beds.

While there has been much discussion whether oysters were ever native in Massachusetts Bay, or merely the result of southern "plants," the consensus of opinion is that there were natural oyster beds in existence when the first settlers came to this coast. Not only do historical records show this, but the remains of the natural beds at the present time indicate that oysters have existed for centuries. Thus there seems to be no reasonable doubt that the northern coast of Massachusetts, as well as the southern, once possessed extensive natural oyster beds.

I. *Location of the Natural Oyster Beds.* — (1) *Parker River.* — A natural bed of oysters once existed in the Parker River at Newbury, and even fifty years ago it is said that oysters could still be obtained from this natural bed. About 1882 the experiment of fattening oysters for market was made, and many bushels were bedded on the flats during the summer by an oyster firm at Newbury. These oysters not only grew well, but threw considerable spawn, furnishing a good set in the river. Oyster raising was then tried, but the result was a failure, as the oysters which were planted in too shallow water were killed during the winter.

(2) *Mystic and Charles Rivers.* — Mr. Ernest Ingersoll states that: "In 1634 William Wood, in his 'New England's Prospect,' speaks of 'a great oyster bank' in Charles River, and another in the 'Mysticke,' each of which obstructed the navigation of its river." He locates the Charles River beds as either off Cambridgeport or near the site of the Boston Museum of Natural History.

Dr. G. W. Field, chairman of this department, in his report in 1902 as biologist to the Charles River Dam Commission, makes the following statement about the Charles River oyster: —

> The oyster (*Ostrea*), formerly abundant, is no longer living, and, from what indications I have been able to gather, probably became extinct within twenty-five years. Their dead shells are brought up by dredging operations. Their peculiar elongated shape is the result of growth being concentrated at the upper end, as a result of their closely crowded position in the bed, or of an attempt to keep the opening above the accumulating mud, and thus avoid being smothered. The fact that there are few signs of small "seed oysters" tends to prove that the bottom was so muddy that they found few places to "set." From the elongated shape of the shells may be inferred that the amount of sedimentation going on in that particular region was rapid during the life of the group of oysters whose shells are to be found in quantities in the material dredged between Harvard and Brookline bridges. This sediment need not necessarily have been sand or clay, or any material which is persistent, but it might have been flocculent organic débris, which remained but a short time and left little or no evidence, beyond its effect upon the shape of the oyster shells.

In the above account Dr. Field not only locates the original oyster beds of Charles River, but also furnishes evidence which indicates the cause of their extinction, *i.e.*, the débris and sewage, or waste poisonous, polluting materials, of a large city emptying into the river. This is not only true of the Charles, but also of the Mystic and Taunton river beds, which have been destroyed in like manner.

(3) Mr. Ernest Ingersoll, in his report on the "Oyster Industry of the United States," in 1880 mentions that natural oyster beds were once at Weymouth, Ipswich, Barnstable and Rowley. Nothing further can be learned concerning these places.

(4) *Wellfleet.* — An extensive oyster bed was found at Wellfleet Bay, which not only furnished a sufficient supply for the first settlers, but enabled the inhabitants of Wellfleet to carry on a considerable trade by shipping them to Boston and other ports, until it was finally destroyed

in 1775. Its destruction was due to overfishing and the utilization of the shells for lime, which soon destroyed the natural bar.

(5) *Chatham.* — A natural oyster bed once existed in the Oyster Pond, but no trace of it now remains.

(6) *Harwich.* — Herring River in the town of Harwich still possesses the remnants of a natural oyster bed, as occasionally a few oysters can be gathered along its banks. This bed once comprised a stretch of three-quarters of a mile along the river.

(7) *Yarmouth.* — The town of Yarmouth once possessed a natural oyster bed in Mill Creek, but this was fished out by 1895 and then granted for oyster culture.

(8) *Barnstable.* — There is a natural oyster bed at Centreville.

(9) *Martha's Vineyard.* — Native oysters are said to have existed in the brackish ponds on the south side of the island; a few are found there at the present time.

(10) *Falmouth.* — A few native oysters are to be found in the salt ponds on the south coast of the town. In Squeteague Pond and Wild Harbor oysters were once native.

Buzzards Bay comprises the best natural oyster territory in the State. At the present time the natural oyster industry has been supplanted by oyster culture, which gradually took the place of the declining natural oyster fishery. While natural beds still exist to some extent, they are, to all practical purposes, extinct. Where once there were extensive areas, now there are only scattering oysters. In many cases the beds have been so completely destroyed that the ground has been granted for oyster culture. That Buzzards Bay is a "natural set area" can be readily seen by the amount of "seed oysters" that are caught by the oystermen who plant shells for the purpose.

(11) *Bourne.* — (*a*) *Red Brook Harbor.* — In 1879 Ernest Ingersoll says: —

> On the southern shore of this harbor, about a mile from its head, exists a living bed of natural oysters some 7 acres in extent, under the protection of the town for public benefit. The oysters growing on it are reported to be large, but not of extraordinary size, scalloped and roundish, differing in no respect from aged oysters grown after transplanting to another part of the bay.

In 1907 this natural bed had been reduced to 3 acres, and the unproductive part granted.

(*b*) *Barlow River.*— In 1873 an act was passed to protect the oyster fishery in Barlow River, by ordering a closed season of one and one-half years. The passage of this act shows that a natural bed of importance existed in this river, and that even in 1873 the effects of overfishing were apparent. At the present time there are but few native oysters in Barlow River, or, as it is sometimes called, Pocasset River.

(*c*) *Monument River.* — A natural bed also existed in Monument

River, which became so depleted that about 1875 the river was surveyed and divided into small grants.

(12) *Wareham.* — (*a*) *Wareham River.* — Natural oysters are found in the Wareham or Agawam River, which has been one of the most productive natural beds in the State, and still furnishes a scant living for two or three men. In view of the overfishing, it is surprising that any of the natural oysters have survived, except on reserved areas of the town, which are opened every three or seven years for the capture of "seed."

(*b*) *Weweantit River.* — The Weweantit River, which lies between the towns of Wareham and Marion, has a larger and better natural oyster bed than the Wareham River, but this has also been depleted by overfishing, except on the reserved areas of the town of Wareham.

(13) *Dartmouth.* — A few oysters are found in Slocum's River.

(14) *Westport.* — Westport River has also a few oysters.

(15) *Taunton River, Coles River and Lee's River.* — These rivers once had extensive beds of natural oysters, but now are wholly devoted to growing oysters. Old records and laws show how important these natural beds were, and also furnish an excellent illustration of the effects of overfishing combined with water pollution from manufacturing sources.

II. *Decline of the Natural Oyster Beds.* — The above-mentioned examples furnish abundant proof that the natural oyster beds of the State, which once were sufficient to supply the wants of our forefathers, have declined to such an extent that at the present time but few natural oysters are tonged for the market. Where there were formerly many acres of excellent native oysters, to-day there is scarcely an acre that can be called good oyster fishing, except in a few cases where the towns maintain a nearly perpetual closed season. No proof of the decline is necessary; it is an established fact.

There have been two principal causes which have ruined the natural oyster beds; besides these two, — (1) water pollution and (2) overfishing, — certain geographical changes have doubtless occurred, which have accelerated the decline.

(1) *Water Pollution.* — The effect of water pollution through the sediment deposited by sewage and manufacturing waste on the natural oyster beds is well illustrated by the destruction of the Charles River beds. This is also shown in a less degree in the Taunton River.

(2) *Overfishing.* — The primary cause of the decline of the natural oyster beds was overfishing. This is particularly true of the beds south of Cape Cod and in Buzzards Bay, which were of large extent, and unpolluted by manufacturing wastes or sewage. This overfishing has not been the result of the last few years, since records show that as early as 1824 Harwich passed an act to preserve the oyster fishery of the town; and that Sandwich, in the part which is now the town of Bourne, in 1832 passed regulations protecting the natural oyster

fishery in Monument River; while at Wellfleet the natural oyster bed was completely exterminated by the year 1775. Overfishing has affected the natural beds in several ways, all of which have worked toward the general decline of the native oyster.

(*a*) The first settlers took the large oysters from the natural beds, which under normal conditions had all they could do to keep up the supply. In this way the beds were deprived of the spawning oysters, with the result that in spite of the closed seasons, which gave little if any benefit, a gradual decline set in.

(*b*) At the same time that the oysters were being taken from the beds, the early oystermen through ignorance were making an economic blunder by not returning the shells to the waters. The oyster shells furnish naturally the best surfaces for the collection of "seed," as spat will set only on clean surfaces. By taking the large oysters and with them the shells and other débris from the bed, the natural oyster bars were destroyed and less space given for the spat to catch. So both the taking of the large oysters in excessive amounts and the destruction of the natural spat collectors, either for lime, as was done at Wellfleet, or for other purposes, were sufficient in the early days to cause the decline of the natural oyster beds.

(*c*) In more recent times the destruction of the natural beds has been hastened by the taking of the small oysters. This practice was due to two reasons: (1) the supply of large oysters was exhausted; (2) oyster culture became important, and the natural beds were raked clean for "seed" which the oystermen obtained for planting on their grants. Thus the oyster grant system has been the chief cause of the destruction of the natural beds in the last forty years. It was only when the natural beds failed that grants were given, and so oyster culture cannot be considered the primary cause of the destruction of the natural beds, but only a later agency in their total extermination. The natural beds in Buzzards Bay all bear testimony to these three means of overfishing, and in recent years particularly to the last.

It has been a most fortunate thing for Massachusetts that the oyster grant system was inaugurated as soon as the decline of the natural fishery became manifest, else at the present time there would be no oysters in the State, for it is recognized that the present natural beds are perpetuated by the spawn which comes from the various oyster grants. Foresight has indeed provided an excellent oyster industry, which is rapidly improving. It is only necessary to apply similar methods of culture to the other shellfish industries of the State to insure their future also; otherwise the decline, which is following the same steps as the destruction of the natural oyster beds, will lead to the commercial extinction of these valuable fisheries.

Results of the Survey.

The survey of the oyster industry has shown several interesting facts which should be brought to the attention of the fishermen and consumers. In the first place, it has shown that the oyster fishery is a larger and more important industry than it has been commonly considered, and that the welfare of the shore fisheries of southern Massachusetts depends upon its maintenance. Secondly, the oyster industry is to-day in a position where it cannot reach its full development for the reason merely that the present laws do not encourage the expansion of the industry. Thirdly, the oyster industry is trammeled by certain abuses, chiefly of a legal nature, which hinder its development, and upon the abolition of which depends its future success. Fourthly, the oyster industry under present conditions encroaches to some extent upon the other shellfish rights, especially in relation to the quahaug fishery, and has caused much jealous feeling; but if properly regulated there should be room for both industries.

In order to obtain the opinion of the oystermen concerning the present abuses of the oyster industry, and how these could be best remedied, the following question was asked of the individual planters: "What measures or laws would, in your opinion, be best adapted for the improvement of the oyster industry?" Although many neglected to answer this question, forty-three opinions were offered, dealing with the problems which the oystermen consider as needing attention and upon which the welfare of the industry depends. These answers have been arranged in tabular form, showing the number of oystermen who advocate certain measures.

MEASURES SUGGESTED.

Present laws satisfactory,	11
Direct State control of oyster industry,	11
Town control, with right of appeal to the department of fisheries and game,	1
Longer length of lease,	4
More certainty of re-leasing grants if improved,	7
More protection for industry,	4
Right to grow all kinds of shellfish,	1
More ground for cultivation,	1
State to forbid marketing of oysters from contaminated waters,	1
Provision for destruction of starfish,	2
Total,	43

While these answers show a diversity of ideas, about 75 per cent. urge that something be done to improve the present system, and, while many are in favor of placing the industry under State control, the majority is definitely of the opinion that the present system of town control is proving a serious drawback to the oyster industry. The best interests of the oysterman and the consumer demand a better method of regulation of this industry. As long as town politics, partiality and carelessness enter into the leasing of oyster grants, and thus deprive certain people of their rights, it is safe to say that the oyster industry can never get beyond its present state of development. One solution of the difficulty might be full State control of leasing the grounds for the oyster industry. This is possibly too radical a step at present, and the system can perhaps be so adjusted as to remedy its defects without taking the control of the fishery entirely away from the hands of the town. Another solution is to continue the system of town control, but to have a State commission which would act as a board of appeal for all who felt aggrieved at the judgment of the selectmen.

The advisability of ten-year grants has caused much comment among the oystermen. Practically all grants are now given for this period of time. As a system it is deservedly unpopular, since it does not help the quahaug interest, and it checks the development of the oyster industry. The oyster business, unlike the other branches of shellfish culture, requires a considerable capital. This system of ten-year grants operates directly to discourage the outlay of capital. If the oysterman were sure of reaping the benefits of his labor and capital, it would be to his selfish interest to develop his own grant to its maximum capacity. But what far-sighted business man will invest money in a business which stands a good chance of being completely "wiped out" in a few years? Again, this system makes three years out of the ten practically worthless. The oysterman usually "seeds" his grant about three years before he expects to reap his harvest; but when his grant has run for seven years, it is evident that he will plant no more oysters because of the uncertainty of obtaining a second lease, and naturally does not desire to invest his labor and money for the benefit of an unknown successor.

The remedy for this is not difficult. If a grant were rented annually as long as the planter desired to hold it, to be forfeited if not improved to a certain standard (to be decided upon), or for non-payment of rent, the difficulties above enumerated would disappear. Much of the territory now held unimproved would either be brought up to a standard of excellence or given over to the quahaugers, and in either case direct benefits would result. If legislation were so arranged that any man might take, by the payment of a nominal rent, a small piece of ground, which he could hold as long as he improved it, the oyster industry could be put on a firmer footing; a man confident of enjoying the fruits of his labors could thus improve his grant, and, as he acquired skill and knowledge, could add other land and ultimately expect to build up a successful business.

A third important suggestion relates to the marketing of oysters in a sanitary condition. The oyster industry of the State has suffered severely because of the scare resulting from the marketing of oysters from contaminated waters. The Cape and Buzzards Bay oysters are in general free from all sewage contamination, and should not be considered on the same basis as the impure varieties from outside the State. Naturally, the Massachusetts oystermen desire that there be some guarantee for the purity of the oysters marketed, as their interests suffer because this impure stock is often sold under the name of the Cape oyster. If laws were passed requiring the inspection and certification of marketed oysters in regard to healthful conditions under which they have been produced, both the oyster planter and the consumer would be benefited.

There is but little doubt that the oyster industry can be still further developed by opening waste territory which at this time does not appear available, since under existing conditions proper capital cannot be induced to enter the business. The oyster industry demands more attention than it has hitherto received, and must be considered an important asset of the Commonwealth.

History of the Industry.

Although the oyster laws are the mile-stones which mark the progress of the oyster industry, and any consideration of the development of these laws naturally gives many historical features, it is nevertheless necessary, at the risk of repetition, to give a separate account of the history of the oyster fishery. The Massachusetts oyster fishery can be divided historically into three distinct periods: (1) the free fishing period; (2) the period of bedding southern oysters; (3) the period of oyster grants.

(1) *The Free Native Fishery* (*1620–1840*). — In the early colonial days the oyster fishery was considered in the same way as the other shellfisheries are now looked upon, *i.e.*, held to be the common property of the inhabitants of the Commonwealth. The natural supply was abundant enough to meet the needs of all the inhabitants, and for many years no signs of decline were manifest. In 1775 the natural beds of Wellfleet gave out, furnishing the first record of unmistakable decline. From that time there arose an extensive series of protective laws, with the one object of preserving the natural supply by limiting the demand. This policy of protective laws, though perhaps temporarily beneficial, was based on an erroneous principle. It was preventive, but not constructive, and did not build up the demolished fishery.

(2) *Oyster Bedding* (*1840–70*). — With the decline of the natural beds, the practice of bedding southern "plants" became an important part of the oyster trade. The southern oysters were bedded on the flats in the spring and taken up for market in the fall. Salem, Wellfleet and Boston were the leading places in this new phase of the oyster industry, and many thousand bushels were annually planted.

(3) *Oyster Grants* (*1870–1908*). — So successful was this summer

bedding of southern oysters that experiments were soon made in rearing oysters. This proved successful from the start, and within a few years the extensive grant system which is now in vogue was inaugurated on Cape Cod and Buzzards Bay.

These three methods, although separated by definite periods in which each have been the leaders, remain to a greater or less extent at the present day. The natural beds are still in existence, and, as at Wareham, are opened once in three or seven years, according to the discretion of the selectmen, for catching "seed." The summer bedding of oysters still continues, as certain planters find it more profitable to fatten than to grow oysters, and the oyster grant system is now in full operation.

A comparison of the industry of 1907 with that of 1879 shows several changes. These changes are for the most part improvements which have arisen with the development of the industry. In some cases the changes have been detrimental, and a few localities have shown a decline. New fields have opened to the oysterman both in new localities and through the extension of the present beds. On the whole, there has been a great increase in the grant system of oyster culture, while the "bedding" of southern "plants," which in 1879 employed many men, boats and extensive capital, has practically disappeared. The annual production has increased gradually, and for 1906–07 is approximately five times as large as in 1879. The following figures, except for 1907, are taken from the United States Fish Commission's reports, and show the gradual increase in production: —

Year.	Bushels.	Value.	Year.	Bushels.	Value.
1879, ...	36,000	$41,800	1898, ...	101,225	$156,235
1887, ...	43,183	64,115	1902, ...	103,386	133,682
1888, ...	45,631	66,453	1907,[1] . . .	161,182	176,142

[1] Returns of the Massachusetts department on fisheries and game.

The Oyster Laws.

In submitting a complete report upon the oyster industry, the oyster laws, which have played an important part in the development of the fishery, cannot be totally neglected. However, so important a subject demands separate investigation, and offers excellent opportunities for legal research. Therefore it is not the purpose of this report to give more than a brief account of the present oyster laws and their history.

The shellfish laws of Massachusetts constitute the foundation of the oyster industry, as they have taken a practically extinct native fishery and have built up the present extensive business. So closely are they connected with its welfare that the future of this growing industry depends upon the proper expansion of these laws to meet the new conditions.

A survey of these oyster laws, with an analysis of their merits and defects, is needed. Their defects have brought about the present unsatisfactory situation in certain localities, and should be remedied. Their merits should be strengthened and amplified, as the basis of future expansion. They have come into being from time to time, in response to the immediate need of the hour; consequently they have no unity, and are, indeed, but imperfectly understood. An insight into their perplexing details should bring out many inconsistencies. Again, no comprehensive knowledge of the history of the industry is possible without a study of the laws. The errors once committed need not be repeated to further embarrass the industry, and the lessons learned by experience would be well applied to its future development.

Protective and Constructive Laws. — The oyster laws can be divided into two classes: (1) protective; and (2) constructive. The early laws, which were passed to save the natural supply, were of the first class; while the laws establishing the present system of oyster culture come under the second heading. The beginnings of all legislative enactment arose in the treatment of the natural oyster beds. These beds were fast becoming exhausted, when laws were passed to protect their important natural resources. This measure was only partially successful. It did succeed in preserving the remnant of those old beds from destruction, but it was powerless to build up an industry of any extent. When it became clearly evident that no possible fostering of native resources could supply the growing demands of the market, legislation quite logically directed itself toward the artificial propagation of oysters. From this step arose a series of problems which long proved baffling, and still engross a great deal of public attention. The artificial propagation of oysters necessitated the leasing of grants in tidal waters. This giving up of public property to private individuals aroused the opposition of rival shellfish industries, who saw in this measure a curtailment of their resources. Numerous other difficulties of minor significance arose from time to time, all demanding attention at the hands of the Legislature.

Apart from the general supervision of the oyster industry, there have been two other sources of legislative enactment. First, special laws have been called for to regulate the fishery in certain waters under the oversight of the State Board of Health. Secondly, during the past few years the attention of the Legislature has been directed towards the development of the oyster fishery as an important asset of the Commonwealth, and laws authorizing various experiments, both scientific and practical, have been passed in order to devise methods of increasing and developing the industry.

I. *Protective Laws.* — The history of the oyster laws of Massachusetts is a history of the industry itself. The rise and decline of the fishery are distinctly traceable in the development of the legal machinery which regulates it. From the time of the Pilgrims the oyster beds of the coast had been regarded as inexhaustible mines. The fallacy of this view gradually became apparent, as these beds began to be depleted through overfishing. As early as 1796 a general law, entitled "An act to prevent the destruction of oysters and other shellfish," was passed by the Legislature. Prior to 1869 the town of Harwich adopted this old law. Shortly after, Swansea followed suit, and restricted the exploitation of her native oyster beds in the Lee and Cole rivers. In 1870 Wellfleet inaugurated an innovation, in the nature of a permit to take oysters, which was required of all citizens of the town. The idea of this permit was to regulate the fishery, centralize control in the hands of the selectmen and add to the income of the town. In 1873 Sandwich passed a law enforcing a close season on all her native beds, to last for a period of one year. In 1875 Brewster followed the lead of Wellfleet, in demanding permits of all outsiders and also from all citizens taking more than 3 bushels at any one time, although an unlimited amount might be taken for food.

The aim of all this legislation was not to develop the industry directly, but indirectly by preserving and fostering the native beds. This theory, while excellent in motive, did not work out well, as the native beds could not by any possible protection be brought to produce an annual yield at all adequate to the growing demands of the market.

The utilization of purely natural resources proving unequal to the demands of the occasion, the creation of other resources became necessary, and an entirely new epoch in the history of the oyster fishery was inaugurated. This epoch marked the beginning of the production of oysters by artificial means, and the establishment of this new industry and the perplexing complications which grew out of it have been the source of legislative strife for many years.

II. *Constructive Laws.* — The first legislation authorizing the present system of oyster culture was instituted at Swansea, in 1869. This was the beginning and the foundation of a broad movement of oyster culture which spread rapidly along the southern coast of the State. This curious law allowed the selectmen to sell, by public or private sale, the oyster privilege of Swansea outright to any person or persons who were citizens of the town. The measure, although apparently designed to restrict the exhaustion of the native resources, did not tend to develop the industry. It possessed one element of value, *i.e.*, it increased the revenue of the town. Apart from its interest as the forerunner of artificial propagation of oysters, this old law is noteworthy, as it forms the basis of the system which to-day regulates the industry in that section of the country. The custom of selling an extensive oyster privilege, as apart from the system of leasing grants, first clearly outlined in the law of 1869, still holds throughout this section. It remains the usual custom to sell either the whole of a township's available oyster territory, or else an extensive part of it, to one man for a lump sum per year.

In 1874 an important step occurred in the evolution of the oyster industry. Swansea and Somerset were given the privilege of granting any of their bays, shores, banks and creeks for the propagation of oysters. This act was far more sweeping and advanced than any of its predecessors, but it was in one respect too sweeping. It interfered with the rights of the property owners along the shore, and was therefore contrary to the general underlying principle of the State law, which allows the cultivation of oysters only in so far as such cultivation does not interfere with the vested rights of all citizens alike. The measure proved untenable, and was promptly repealed. Its repeal was on general principles a thing to be desired, but nevertheless a blow to the industry. The tidal waters along the coast have always been the most valuable part of the oyster territory, as they have proved to be the best adapted for obtaining "oyster set." This measure was therefore designed to aid the oyster growers, and give them valuable privileges which belonged originally to the adjoining property owners. Even to the present day the dividing line between the rights of property owners and oystermen has remained an unsettled question.

It was about this time that the close season proved a failure in Buzzards Bay, and the towns of Wareham, Bourne and Marion turned their attention toward the establishment of an oyster industry. This attempt became a settled policy of these towns about 1875.

In 1878 a peculiar act was passed, making it unlawful for any person to remove oysters from any grant, even his own, between the hours of sunset and sunrise. This act was necessary for the protection of the oyster planters, by preventing the stealing of oysters from the grant at night. Various efforts had been made to protect grants from such attacks, but the extreme difficulty of detection was always an insuperable obstacle to proper enforcement, and it was deemed expedient to prohibit all fishing at night. That this problem had become an important one is shown by the title of the law, which was styled "An act for the better protection of the oyster fisheries in this commonwealth.

In 1884 an important act was passed, enlarging the limits of that territory which might lawfully be used for the cultivation of oysters. Practically all communal waters outside the jurisdiction of adjacent land owners was thrown open for oyster grants.

In 1885 the institution of a public hearing was inaugurated. This was a concession to the hostile quahaug element, and allowed the public the opportunity of protesting against the granting of territory for oyster culture; nevertheless, the final power really remained in the hands of the selectmen. A further concession to this element was the law which called for the revoking of grants within two years if unimproved. The interests of the oystermen were also kept in sight, and legislation passed which was designed to protect grants still more from the depredations of outsiders. Provision was likewise made for the proper enforcement of these laws, and the penalties attached were increased.

In 1886 an act was passed which was designed to do away with all possible outside monopoly. The danger of organized capital acquiring control of a large tract and excluding small individual planters had become apparent, and this means was taken to guard against it. The act prohibited the transfer of grants in any township to any person not a citizen of that township; thus, if any monopoly did exist it would be restricted to only one township. The limits during which fishing on grants might be carried on was lengthened two hours, so that it read from "one hour before sunrise to one hour after sunset."

In 1892 the town of Yarmouth obtained a law requiring a permit for citizens to take oysters from native beds, not exceeding 2 bushels per week, from September 1 to June 1. This is now the only town in the Commonwealth to require such a permit from citizens.

In 1895 legislation was passed relative to the proper definition of the boundaries of grants. This was rendered necessary because of the haphazard methods hitherto pursued in giving grants with very indefinite boundaries. Mean low-water mark was fixed as the shoreward boundary of grants, while mean high-water mark was defined as the limit to which shells might be placed to catch the set. This, however, was dependent upon the owners of the adjacent property, and their consent was held necessary before this territory between high and low water could thus be utilized.

In 1901 special legislation was passed, restricting the catching of oysters in contaminated waters except for bait.

In 1904 authority was granted to proper officials to develop the oyster industry by planting shellfish, or by close season.

In 1905 the Fish and Game Commission was authorized to expend a sum not exceeding $500 per annum for the investigation of the oyster, by experiment or otherwise, with a view to developing the industry.

The development of the oyster laws has been by a process of evolution. They have kept pace with the growth of the industry, and have been in fact the logical outcome of that expansion. The various acts which go to make up the bulk of this legislation have been passed from time to time to fill the immediate demands of the hour, and consequently lack that unity and consistency which might otherwise characterize them. Changing conditions have called for alterations in the legal machinery, as the industry has expanded, to meet new requirements. These additions have frequently been dictated by shortsighted policy, and the Commonwealth as a whole has often been lost sight of in the welfare of the community.

Of all the shellfisheries, the oyster industry is most hampered by unwise legislation. It is the most difficult to handle, because it presents many perplexing phases from which the others are free. Clams, quahaugs and scallops flourish in their respective territories, and legislation merely tends to regulate their exploitation or marketing. With the oyster, however, other problems have arisen. The areas in the State where oysters grow naturally are few in number and relatively of small importance. The clam, quahaug and scallop grounds are to be compared with wild pastures and meadows, which yield their harvests without cultivation; while the oyster grants are gardens, which must be planted and carefully tended.

With this distinction arises another question, of far-reaching significance, — the question of private ownership. The quahaug, clam and scallop fisheries demand that the tidal flats and waters be held in common as communal interests, and freely open to all citizens of the town; the oyster fishery requires that certain portions of these flats and waters be set aside for private ownership. With the economic questions involved in this discussion it is not the purpose of this report to deal. There is one fact, in any case, which cannot be argued away. The oyster industry is dependent solely upon private ownership of grants. If, therefore, the oyster industry is to be encouraged at all, — and it certainly has very great possibilities, — this fact of private ownership must be accepted at once. If, as some assert, it is an evil, it is a necessary evil, and it has come to stay. The questions remaining for legislation on this subject are the proper regulation of this private ownership, so as to give the maximum of encouragement to the oyster fishery, and the minimum of danger to the rival shellfish industries.

The oyster and quahaug industries openly clash. This is an unfortunate occurrence, but it cannot be avoided, since the ground suitable for the culture of oysters is almost always the natural home of the quahaug. Therefore, when portions of this ground are given out to private individuals for the production of oysters, the available quahaug territory is necessarily reduced. Over this question endless disputes have arisen. The problem is undoubtedly one requiring delicate adjustment; but there is no reason why these two industries should not flourish side by side, as there would be plenty of room for both if all the available territory were properly utilized.

There is one important feature of this problem, however, which the present laws have wholly failed to recognize. Wherever practicable, the best of the quahaug territory should not be granted; and as far as possible, the oystermen should utilize only those tracts of territory which are not naturally very productive of quahaugs.

The Oyster Industry.

For the benefit of those who perhaps are not familiar with the methods employed in the oyster industry, the following brief account is given: —

I. *Selecting the Grant.* — The oysterman, in selecting a grant, has to consider first the nature of the soil; and secondly, the location as influencing the growth of the oyster. Not less important is the quality of the oyster, which means not only a good price, but also readiness of sale, as the oysters produced in certain localities are especially desirable in appearance and flavor.

As the oyster will not grow on all kinds of bottom, but demands a firm soil, free from soft mud and shifting sand, the oyster area of the State is naturally limited. Usually but part of an oysterman's grant is suitable for the cultivation of oysters, and he is forced to let the rest of the territory lie idle, unless he can, with shells or gravel, artificially change this waste area into suitable ground. Shifting sand perhaps can never be made suitable for oysters; but many acres of soft mud can be made productive, if the oysterman only has a reasonable guarantee that he would receive the results of his labor.

While the oyster culture is limited by the nature of the bottom, it is also restricted by other conditions. The salinity of the water has much to do with the rapidity of growth, and the oysters seem to thrive in localities where a slight amount of fresh water enters. The amount of food in the water is the principal factor in the rate of growth, and to this is due the fact that the rate of growth varies considerably in different localities. As a rule, the beds with good circulation of water (*i.e.,* currents) show the more rapid growth.

II. *Collecting the "Seed."* — The term "seed" is applied to one, two, three and even four year old oysters which the oystermen plant on their grants. These grants are in reality salt-water gardens, requiring constant supervision; and the obtaining of the "seed" for planting is a most important consideration. The gathering of the oyster "seed" is a simple process, but one which requires much research.

Early in the summer, usually during the months of June and July in these waters, the Massachusetts oyster spawns. Both sperm from the adult male and the eggs from the adult female oysters are extruded in considerable quantities into the water, and there the eggs are fertilized. As fertilization is somewhat a matter of accident, undoubtedly the great majority of eggs never develop. The fertilized eggs pass rapidly through various changes in the course of a few hours, and emerge as microscopic embryos, with thin, transparent coverings. At this period these forms are free swimming, and are found in great numbers in the water. They are extremely delicate, and great quantities are destroyed by natural agencies, such as cold storms, sudden changes in temperature, etc. They likewise are subject to the depredations of all sorts of marine creatures, and comparatively few in proportion survive. The survivors, after leading this free-swimming existence for several days, settle to the bottom, where they attach themselves by a calcareous fixative to stones, shells, pieces of wood, etc. Here, unless buried by silt and soft mud or killed by exposure, poisonous pollution, etc., the young oyster rapidly becomes of a size suitable for planting.

The economic utilization of this scientific knowledge is as follows: shells offer a very good surface for the attachment of the young oyster, and many thousand bushels are annually strewn over the bottom previous to the spawning season. Considerable judgment is needed in choosing the right time to plant these shells, which after a few weeks in the water become so coated with slime that fixation of the "spat" becomes impossible. In Massachusetts the area between high and low water mark has been found by experiment to be the most valuable territory for this purpose, as shells planted here collect the heaviest set and can be handled with the least expense. A projecting sand bar or point with a current is also well adapted for catching oyster spat.

The scallop shell is the most serviceable in spat collecting, because it is more brittle, and the clusters of oysters when attached are readily broken apart. After the oysterman has obtained a successful set, he allows the young oysters to obtain a suitable growth before he makes a final planting, either in the spring or fall.

III. *Size of the "Seed" used for Planting.* — While many oysters are raised from native spat in the Buzzards Bay district, the greater part of the seed is purchased in Connecticut and Long Island, and is carried in schooners or steamers to Massachusetts waters. The usual price ranges from 35 cents to $1 per bushel, according to size and quality. The oystermen cannot always choose the size of "seed" they desire for planting, as the set of any one year is very uncertain, and several seasons may pass before a large quantity of "seed" can be obtained. Thus the oyster planters are forced to take whatever size they can obtain, whether it be two, three or four year old "seed." As a rule, the small "seed" is most in demand, as it means relatively faster growth and less money invested. Often, when the ground is most favorable for fattening, large oysters are preferred for planting, and certain oystermen make this line of work a specialty. Certain localities where there is plenty of lime in the water are well adapted for growth, and yet produce poor-"meated" oysters, while in other grounds the reverse is true. The oystermen occasionally by a double transfer utilize both grounds, planting oyster "seed" for the first few years in the rapid-growing localities, and then transplanting the large oysters to the "fattening" ground six months before marketing.

IV. *Preparing the Grant.* — The first step in preparing the grant is to remove all débris. In the deep water, this is usually done by dredging; in the shallow water, by whatever means is the easiest. If the bottom is of firm soil, the grant is then ready for planting; however, if the soil is soft mud, it is necessary to shell the bottom in order to give it greater firmness. The oysterman continually has to keep a sharp lookout in order to protect his grant from enemies such as the starfish and the oyster drill, and to keep it clear of seaweed and other matter which would interfere with the growth of the oyster.

V. *Sowing the "Seed."* — The "seed" oysters are planted on the prepared bed by scattering them with shovels or scoops from the boats and scows. The oysterman, knowing the maximum amount of "seed" the bed will grow to the best advantage, plants the required number, taking care that the oysters are properly scattered, as for the best growth oysters should lie separate and not in crowded masses. The amount of "seed" that can be planted on a given area depends upon the natural conditions of the locality.

VI. *Enemies.* — The oyster, having passed through the countless dangers of his embryonic career, is still harassed by several enemies. Of these, the most destructive is the starfish. This animal, commonly known as the "five-finger," occurs along the entire Massachusetts coast, and is especially abundant in Buzzards Bay. Occasionally whole oyster beds are wiped out by this pest, which sweeps over the ground in vast armies. The method of attack of the starfish is unique. By exerting with its tube feet a steady pull in opposite directions on both valves of the shell of the victim, the starfish tires the contracted muscle of the oyster, and the shells open. The starfish then extrudes its stomach so as to enwrap the prey, and in this curious manner devours the oyster.

A close second to the starfish in amount of damage is the oyster "drill" or "borer" (*Urosalpinx cinerea*). This little mollusk with its rasping tongue drills a small hole through the shell of the oyster, and then sucks out the contents.

A third enemy, according to the oyster planters, is the "winkle" (*Fulgur carica* and *F. caniculatus*). The method of attack is somewhat obscure.

Besides this dangerous trio of living enemies, the oyster is subject to constant peril from inanimate agencies. Probably the greatest of these is shifting bottom. Where oysters are grown on sandy soil, the violent waves of winter storms frequently tear up the bottom, or else the force of currents is such as to kill the oysters by completely burying them in the sand. Again, if the oysters are growing in very muddy bottom they are constantly liable to be smothered in the slimy ooze. Ice in winter frequently tears oysters from their beds and bears them to some unfavorable environment, where they soon die.

VII. *Harvesting the Oysters.* — The oysterman completes his planting about June 1. During the summer months, the growing period of the oyster, the grants remain idle except for the care and supervision of the oystermen. As the oyster takes from three to five years to attain its growth, the oysterman practically harvests but one-fourth to one-third of his entire stock each year, beginning about September 1 and continuing through the winter as the weather permits.

In winter the oysterman, to keep up the market supply, beds "culled" oysters near the shore, where he can tong them through the ice whenever it is impossible to obtain oysters from his grant.

The implements used in gathering the oyster harvest are of three kinds: tongs, dredges and rakes. Tongs are employed principally by the smaller oyster growers, and on ground where the water is comparatively shallow. A pair of tongs is really a pair of long-handled rakes, fastened together like a pair of shears. The pole, corresponding to the blade of the shears, varies from 8 to 16 feet in length. The rakes, some 2 to 2½ feet broad, are so fitted to the end of the poles that when extended by spreading the handles they rest upon the bottom parallel to each other. These tongs are usually worked from skiffs or flat-bottomed boats, the oystermen first separating the tips of the handles and then bringing them together, thus causing a corresponding movement of the two rakes, which with their 2-inch iron teeth gather in all the intervening oysters. The tongs with their burden of oysters are then lifted into the boat, emptied, and the process repeated.

Dredging is a much faster and less laborious method of oystering than tonging, and can be carried on over a much larger territory. The oyster dredge consists of a bag of woven iron rings attached to an iron framework. From each corner of the framework iron rods extend, converging at a point some feet away. At this point the rope is attached, by which the dredge is dragged from either a sail or power boat. The blade, resting horizontally on the surface, is armed with teeth which rake the oysters into the bag. When this bag, which holds from 3 to 8 bushels, is full, the dredge is raised, usually by a windlass worked by steam, gasolene or hand power, as the case may be, its contents dumped out and the dredge lowered for another haul.

Rakes, the third implement in general use, are not employed as extensively as tongs or dredges, but are used in still water, where the bottom is suitable.

VIII. *Marketing.* — The "catch" as soon as it is dredged or tonged is brought in boats to the oyster houses, where men with hatchets or similar implements break apart the clustered oysters and cast aside the empty shells, bits of rock, etc. Three different varieties of marketable oysters are usually sorted out, according to size: (1) large, (2) medium and (3) small. The respective sizes vary somewhat with the locality, demands of the market and the season; but the large oysters commonly count about 900 to the barrel, the medium 1,000 or more, while the small run 1,200 or over.

The different sizes as they are sorted out are packed in barrels and are then ready for shipment. The principal markets are of course New York and Boston, though the demand farther inland is increasing, and shipments to Chicago or places even farther west are frequently made.

General Statistics.

The following facts concerning the oyster industry have been compiled from the written statements of the different oystermen. Complete returns have not been received from Wareham, Barnstable, and Falmouth, while possibly a few oystermen in the other towns have been overlooked. Falmouth raises but few oysters for the market and these returns have been recorded, the remaining oystermen merely planting for their own use. In the towns of Barnstable and Wareham about four-fifths of the oystermen have made returns. The facts given in the following tables are based only on the returns at hand, and therefore do not give a complete report for these two towns.

STATISTICAL SUMMARY.

Town.	Number of Grants.		Area of Worked Grants (Acres).			Number of Men.
	Total.	Worked.	Total.	Suitable.	Unsuitable.	
Wellfleet,	35	23	967	810	157	14
Chatham,	21	21	65	55	10	20
Dennis-Yarmouth,	4	2	10	10	-	3
Barnstable,	29	29	188	121	67	33
Falmouth,	22	6	44	23	21	5
Bourne,	135	42	100	83	17	21
Wareham,	125	70	196	159	37	26
Fall River district,	14	14	810	510	300	36
Nantucket,	2	1	20	3	17	1
Total,	387	208	2,400	1,774	626	159

CAPITAL INVESTED.

Town.	Boats.	Implements.	Shore Property.	Bedded Oysters.	Total.
Wellfleet,	$10,115	$575	$1,200	$19,500	$31,390
Chatham,	1,695	313	1,225	23,300	26,533
Dennis-Yarmouth,	25	50	100	5,000	5,175
Barnstable,	5,269	1,139	4,300	28,850	39,558
Falmouth,	1,525	105	1,000	450	3,080
Bourne,	5,515	483	150	18,300	24,448
Wareham,	9,355	1,120	2,420	27,725	40,620
Fall River district,	19,840	2,000	6,200	68,500	96,540
Nantucket,	518	15	25	800	1,358
Total,	$53,857	$5,800	$16,620	$192,425	$268,702

PRODUCTION OF 1906–07.

Town.	Marketable Oysters.		Seed Oysters.		Total Value.
	Bushels.	Value.	Bushels.	Value.	
Wellfleet,	22,500	$24,850	1,000	$1,000	$25,850
Chatham,	14,550	23,987	-	-	23,987
Dennis-Yarmouth,	1,000	1,500	-	-	1,500
Barnstable,	25,850	48,050	100	100	48,150
Falmouth,	3,012	6,025	-	-	6,025
Bourne,	2,100	4,100	23,000	15,000	19,100
Wareham,	7,770	12,790	22,100	12,090	24,880
Fall River district,	38,000	26,250	-	-	26,250
Nantucket,	200	400	-	-	400
Total,	114,982	$147,952	46,200	$28,190	$176,142

SECTIONAL ARRANGEMENT OF TOWNS.

A. North side of Cape Cod: —
1. Wellfleet.
2. Eastham.
3. Orleans.

B. South side of Cape Cod: —
1. Chatham.
2. Harwich.
3. Dennis and Yarmouth.
4. Barnstable.
5. Mashpee.
6. Falmouth.

C. Buzzards Bay: —
1. Bourne.
2. Wareham.
3. Marion.

D. Fall River district.

E. Nantucket.

Wellfleet.

For the past thirty years there has been an extensive oyster industry at Wellfleet, and many grants have been taken out in the waters of Wellfleet Bay, which possesses some of the best oyster ground in the State. In spite of the success of the past years, the industry is declining, indicating, possibly, that after 1910 no more grants will be leased.

Four parts of the bay are taken up by oyster grants in the vicinity of: (1) Mayo's Beach; (2) Great Island; (3) Indian Neck; (4) Lieutenant's Island.

(1) Nine grants, covering an area of 176 acres of both flats and

deeper water, extend out from Mayo's Beach a distance of 1,500 feet. These grants extend along shore from Commercial Wharf to Egg Island, a distance of 3,500 feet. Seven of these grants have each a shore extension of 200 feet, the other 2 having 600 and 1,500 feet respectively. The principal planting on these grants is done by D. Atwood & Co.

(2) On the west side of the bay, along the shores of Great Island and Beach Hill, there are 7 grants which are now worked. Originally there were 12 grants in this locality, but 5 of them expired some time ago. The area included in these 5 grants is 500 acres, while the entire granted area covers 708 acres. Wright & Willis, R. R. Higgins and L. D. Baker have done most of the planting on these grants in the past few years.

(3) On the east side of the bay, near Indian Neck, are 5 grants, comprising 224 acres. J. A. Stubbs does all the planting here. A single grant of 11 acres of flats is held in Duck Creek Cove by J. C. Wiles. These grants extend along the shore for 2,000 yards and run out into the bay for 1,000 yards.

(4) Off Lieutenant's Island are 8 grants, comprising a total area of 1,062 acres. Only 3 of these, comprising 559 acres, are now worked. Joseph Crosby of Osterville is the principal planter on these grants.

From the statistical returns of the oyster planters it is found that 23 grants are now held for oyster planting, comprising an area of 967 acres; 810 acres, or 83 per cent. of this area, is suitable for oyster culture. There is very little soft mud bottom, only 82 acres, while the shifting sand area is 75 acres.

The total area of grants ever leased at Wellfleet comprises 2,182 acres, of which 1,473 are now held. The average depth of water over these grants at mean low tide is 4 feet, the extremes running from 1 to 12 feet.

Capital invested,	$31,390
Power boats,	4
Value of power boats,	$9,250
Sail boats,	4
Value of sail boats,	$750
Dories and skiffs,	8
Value of dories and skiffs,	$115
Implements: —	
Dredges,	14
Tongs,	12
Value of implements,	$575
Value of shore property,	$1,200
Value of oysters on grant,	$19,500

Most of the oystering is done by dredging, two large gasolene oyster boats, the "Cultivator" and the "Marion," being employed for this purpose. Tongs are also used extensively. Fourteen men are engaged from six to twelve months each year in the oyster business.

The production for 1906–07 was 22,500 bushels of marketable oysters, valued at $24,850; and 1,000 bushels of "seed," worth approximately $1,000. Most of the planted "seed" is obtained from Long Island and Connecticut.

The damage from the natural enemies of the oyster is reported as very slight.

The Wellfleet oyster has a peculiar salty flavor not possessed by other oysters. For some trade this is preferred, while for others it is not so desirable. Before marketing the extreme saltiness is sometimes removed by floating the oysters in Duck Creek, where the water is less salt, using large, scow-like floats, 30 by 15 feet.

Several Boston firms are engaged in oyster culture at Wellfleet, including D. Atwood & Co., J. A. Stubbs and R. R. Higgins.

For years there has been a conflict between the quahaugers and the oystermen at Wellfleet. This is very natural, owing to the rivalry between the two industries and the rapid rise of the quahaug fishery in the last fifteen years. Owing to their greater number, the quahaugers have obtained the upper hand in town affairs, with the result that in 1910, when all the oyster leases run out, it is said that no more will be granted, and the oyster business of Wellfleet will come to an end. This is especially unfortunate for the town, as there is room for both industries, and the destruction of either one would be a great financial loss. It is hoped that some means can be devised to straighten out the difficulties between the opposing factions before either industry is ruined.

But little oyster spat has ever been caught in Wellfleet Bay. That oysters will set there is evidenced by the young "seed" caught on the piles of the wharves and on stones and rocks around the harbor. It is noteworthy that at Wellfleet the spat sets only between the tide lines, and does not catch where water is constantly over the ground. This is directly contrary to the conditions in Long Island Sound, where the set is caught in deep water. E. P. Cook and J. A. Stubbs have tried spat collecting in Herring River for several years, with the results of one or two good sets, the best being caught by Mr. Cook in 1906. The other years have proved failures in this line. There is no question but that oyster spat can be profitably caught if sufficient interest is taken in the matter.

The early laws were as follows: —

In 1772 a law having been enacted by the General Court, regulating the taking of oysters in Billingsgate Bay, an amendment to that act was now asked by the town, namely, that during the summer months oysters shall not be taken to market, nor fished by the inhabitants of the town for their own use during the months of July and August.

In 1773:—

> That, inasmuch as the oyster fishery, which is of great value to the town and of great advantage to the Province, has received detriment from persons taking young oysters, the enactment of more stringent regulations are necessary to prevent their destruction.

These early laws show that the natural oyster beds were highly prized by the inhabitants in colonial days, and that measures, even then, were necessary to prevent their extinction. At the present time Wellfleet has no other regulations than the general oyster laws of the Commonwealth.

The history of the oyster industry of Wellfleet can be divided into three periods: (1) the natural oyster fishery; (2) the "bedding" of southern oysters; (3) oyster planting.

(1) *The Natural Oyster Beds of Wellfleet.* — The first settlers found a natural oyster bed near Hitchin's Creek, or Silver Spring, in 1644, and it is said that oysters were very abundant at that time. Old shells are occasionally dredged or raked up at the present day from these beds. The Rev. Enoch Pratt, in his "History of Eastham, Wellfleet and Orleans," gives the following account of this early oyster industry:—

> Oysters were found in great abundance on the flats at the first settlement [1644], but at this time [1770] the inhabitants had so increased and such quantities were taken for consumption and for the Boston market, that it became necessary, to prevent their entire destruction, for the district to take measures to preserve and propagate them. . . . Shops and stands were opened in Boston, Salem, Portland and other places, where the oysters were sold in quantities to suit the purchaser.
>
> In 1775 all the oysters in the bay died. What caused their destruction is not certainly known, but it is supposed that as, at this time, a large number of blackfish died and came on shore, where their carcasses remained, producing a very filthy condition of the water, it caused this mortality.

A more probable explanation is given by Mr. E. P. Cook of Wellfleet. The early inhabitants, not knowing the value of the natural shell beds for catching the spat, greedily took every shell and burned them into lime as a fertilizer for their farms and plaster for their houses. There was once a fine strip of woods near this original oyster rock, but this was cut down, and the sand gradually washed over the beds, killing the young oysters. To these two causes can be attributed the final destruction of the natural beds in 1775.

(2) *The Bedding of Southern Oysters.* — After the destruction of the natural beds, an important industry arose in the "bedding" of southern oysters for northern trade. Privileges for bedding oysters on the flats were granted to a number of oyster firms. These men hired schooners in the latter part of the winter or the early spring, which went to the southern oyster grounds and brought back loads

of oysters. These oysters were spread or bedded over the leased flats of the harbor, where they remained until the following fall, when they were taken up for market. In this way the oysters gained in size by the summer's growth, and were fattened for market. Considerable trade sprang up in the carrying of oysters, and many vessels were engaged in this traffic. In 1841 Mr. Gould, the conchologist, states that 120 men, with 30 vessels of about 40 tons each, were employed for three months of the year, and brought to the town an annual revenue of $8,000.

In 1841 Capt. William Dill is credited with bringing into Wellfleet the first cargo from Virginia, which started a large trade in Chesapeake oysters. Mr. Ernest Ingersoll makes the following statement concerning the Virginia trade: —

> Nevertheless, it was not until about 1845 or 1850 that the business began to confine itself to Virginia oysters, and a large business to be done. At its height, about 1850, it is probable that more than 100,000 bushels a year were laid down in the harbor; some say 150,000. . . . The favorite ground was at the mouth of Herring River.

The Rev. Enoch Pratt writes, in 1844: —

> The inhabitants of the town tried the experiment of bringing oysters from the south and laying them down on the flats, which succeeded well. In the course of a year they doubled their size and their quality was much improved. This soon became a large business, and a number of vessels have been employed in the spring of every year in bringing them here. The number of bushels which are now [1844] annually brought is about 60,000. Nearly all the oyster shops and stands in Boston, and other cities and towns in this State, are supplied from this place, and are kept by persons belonging to the town. This business affords a living for many families.

Mr. Ernest Ingersoll thus describes the decline of the oyster trade in 1870: —

> The war of the rebellion, however, interfered somewhat with the oyster trade, and it began to decline so far as Wellfleet was concerned. Then the various dealers in northern ports, having learned something, began to bed near home in their own harbors, and so saved freightage. Finally, the steamers from Norfolk and the railways entered into so serious a competition that fully ten years ago [1870] Wellfleet Bay was wholly deserted by the oystermen as a bedding ground, though her vessels still continue to carry cargoes in winter from Virginia to Boston, Portland, Salem, Portsmouth and the Providence River, to supply the active trade and fill the new beds, which the dealers at these various ports had learned could be established at home. The reader thus discovers how important a part Wellfleet has played in the history of the oyster trade of New England. A hundred thousand bushels of the bivalves once grew fat along her water front, and thousands of dollars were dispensed to the citizens in the industry they created. Now [1880] a little experimental propagation, to the value of a few hundred dollars, and about 6,000 bushels of bedded oysters

from Virginia, worth perhaps $5,000 when sold, form the total active business. The oyster fleet, however, remains, though greatly diminished, and carrying its cargoes to Boston, Portland and elsewhere, instead of bringing them to be laid down in the home harbor. It will be long before Wellfleet, and its neighbor, Provincetown, lose the prestige of old custom as oyster carriers.

(3) *Oyster Raising.* — In 1876 the first attempt to raise oysters from "seed" at Wellfleet, is said to have been made by E. P. Cook, who obtained a grant from the town of about 30 acres, on which were planted 500 bushels of "seed" from Somerset, Mass. The "Oysterman" of Dec. 20, 1906, gives the following account of oyster planting at Wellfleet: —

In 1876 our informant, Mr. E. P. Cook, conceived the idea that these waters could grow "seed" oysters as well as fatten big stock. He went to Somerset, Mass., and got a carload of 500 bushels and planted them. A few had previously been planted but with ill success. The people laughed at him for dumping his good money overboard. He was the first man to lease a piece of oyster ground from the State, and of course had his pick, which was 600 feet on the shore next to the Silver Spring, the original spot of the natural rocks. Mr. Cook here showed his acumen as a culturist. The next spring they had made a remarkable growth, and all had lived. Then there was a stampede of the fellows who laughed, to get some ground, too. Soon every inch of available ground had been taken up. We mention the following who took up plats: Solomon Higgins, I. C. Young, Benjamin Oliver, Daniel Oliver, Edward Oliver, Cornelius Rogers, William Smith, S. B. Rich, Theodore Brown, Stephen Young. These men did not all plant. The next year Mr. Cook bought 500 bushels more, and now he had 1,000 bushels on his grounds. These were two-year-old plants, and when they had laid there three years he sold these primitive beauties for $5 per barrel. Some time after this he bought Mr. Rich's plot. Subsequently Mr. Cook sold 400 of his 600 feet to R. R. Higgins, the founder of the famous oyster-packing house by that name. This same man bought the 200 feet of Solomon Higgins. Now this house had 600 feet of shore ground. R. R. Higgins was the first wholesaler with capital invested in the culture of the Cape Cod oysters. Finally, this house absorbed all the ground Cook had. Eight years after this the Wright & Willis firm came on the scene; that period had elapsed since the first cargo of "seed" had been freighted here. They bought the remainder of the Solomon Higgins grant. Then Mr. Cook took out another grant below Smalley's Bar. Capt. Albert Harding and Capt. D. A. Newcomb took out leases. In 1892 Mr. Cook sold his lease to the D. Atwood Company. Then Mr. Cook bought the Capt. Albert Harding lease and sold the right to plant on it, the law then not allowing the lessee to turn over the grant in toto. Then H. & R. Atwood became interested here. About this time some friction between the planters and clammers existed, but it should be remembered that the planters occupied only about 200 of the 2,400 acres involved in this dispute. Then it was that J. A. Stubbs came on the stage of activity, and Mr. Cook secured a lease for this wholesale concern.

Eastham.

The oyster industry of Eastham is closely associated with the Wellfleet industry, and practically all the business is carried on by Wellfleet firms.

The grants extend along the western shore from the Eastham-Wellfleet line south, running out into the bay a distance of 1 mile. The average width of these grants is 900 feet. Twenty-four grants have been given out by the selectmen, but only 12 of these are in existence at the present time, the others having lapsed for non-payment of dues. (The town charges $3 for the original grant, and $1 each year thereafter). The area of the grants is 800 acres, of which only 125 acres are under cultivation. As all the business, which is but small, is done by Wellfleet firms, the statistics of the industry are included in the Wellfleet report. All the grants, as at Wellfleet, expire in 1910.

Orleans.

There are 5 grants on the west coast of the town, but practically nothing is done in the oyster business. The oyster industry of Orleans is a dead issue, and quahaugers dig at will over all the granted territory.

The grants are all eight to nine years old, and will not be renewed, as they are said to be unconstitutional, since the waters of Eastham and Orleans are common, and the consent of Eastham was not obtained when they were granted. The real reason for not renewing them will be because they are not profitable. The sand shifts on a good deal of the territory, and where the water is too deep for shifting, oyster culture does not seem to pay.

Four years ago 15,000 bushels of two-year-old "seed" was sent here from Connecticut. The greater part of this "seed" died in transportation, and much of the remainder was killed by the shifting sand. Two years ago (1905) 3,000 bushels of marketable oysters were shipped from Orleans; but little has been done since then. No set has ever been caught here, although spat catches readily on the rocks which lie between the tide lines.

Chatham.

The oyster furnishes an important industry for the town of Chatham, which ranks next to Wellfleet and Cotuit in the production of "Cape" oysters.

The oyster grants are all situated in Oyster Pond and Oyster Pond River, covering an area of 65 acres of excellent bottom. Of this, 55 acres is hard bottom; 6 acres, soft mud; and 4 acres of coarse shifting sand. The whole of Oyster Pond River and the most of the shore waters of Oyster Pond are taken up by grants. The central part of Oyster Pond possesses a soft bottom, and is therefore unsuited for oyster culture. The depth of water over the grants varies from dry to 6 feet at low tide.

Records show that a natural oyster bed once existed in Oyster Pond, as in 1802 "excellent oysters, but scarce," were reported. Even now old shell heaps are found, which contain extremely large oyster shells, and indicate that the Indians used these oysters for food. Indeed, the name, Oyster Pond, was given long before grants were issued, and doubtless received this name because of these natural oysters.

No natural oysters remained in 1877, when the first grants were issued to George S. Atwood, John Vanhise, Jonathan Small, Stephen Gould and Frank Lanpier. The last three named held together one grant in Oyster Pond River; Atwood's grant was in Oyster Pond; while Vanhise's grant was partly in Oyster Pond and partly in Stage harbor, where oyster culture was a failure. The planting was not very successful at first, owing to a lack of proper methods.

These grants were issued in 1874 for a term of twenty years. The next series of grants were issued for ten years, and in 1893 the first grants were renewed for the same length of time. Since the period of the twenty-year grants there have been two ten-year leases, and the present leases will expire in 1911.

A town regulation restricts the oyster grants to the southern waters of the town, and allows no grants to be given in the waters of Pleasant Bay, where there is considerable territory which might be suitable for oyster raising. As all the available territory is now taken up in Oyster Pond, no more grants can be issued.

The method of obtaining a grant by a resident of the town is to choose the locality, stake out the grant and report the same to the selectmen, who will grant a license if the bounds are satisfactorily described, and no part of another grant is included. The price of the license, which runs for a period of ten years, is $2, and 50 cents is charged for recording it. No regular survey of the grant is made. Taxes are paid yearly on stock and working capital.

Capital invested,	$26,533
Power boats,	1
Value of power boats,	$300
Sail boats,	2
Value of sail boats,	$500
Dories and skiffs,	8
Value of dories and skiffs,	$105
Scows,	12
Value of scows,	$790
Implements: —	
Dredges,	10
Tongs,	34
Value of implements,	$313
Value of shore property,	$1,225
Value of oysters on grant,	$23,300

Owing to the shallow water, most of the work is done by tonging. Flat scows, 25 by 10 feet, are generally used for this work, as they afford excellent footing for the oysterman in tonging and plenty of room for the oysters. These scows, which have a capacity of 100 bushels, can be anchored by stakes or iron piping, and definite areas covered by the tonger. In the fall the oystermen make their "culls" on these scows. Chatham is the only town in Massachusetts where scows are in general use. Dredging is done only to a limited extent by 3 oystermen, the others all using tongs. Twenty men are engaged from four to six months of the year in the oyster business at Chatham.

The production for 1906–07 was 14,550 bushels, valued at $23,987. The oyster industry has been increasing every year, the production for 1906–07 being one-third more than the 1905–06 output. The oystermen are unanimous in saying that the oyster business of Chatham is steadily improving.

No "seed" oysters are raised in Chatham, as no large set has ever been caught, and all attempts in this line have proved unsuccessful. All the "seed" oysters are brought from Greenport, L. I. These run from two to four years old, the larger oysters being preferred. As a rule, oystermen are forced to take what they can get when they buy seed.

The only natural enemy which infests the Chatham oyster is the oyster drill (*Urosalpinx cinerea*). The damage done by this pest is slight, amounting to nearly $800 annually.

Harwich.

No oyster industry is now carried on in the town of Harwich. A natural oyster bed once existed in Herring River, and occasionally a few oysters can be picked up at the present time; but the bed is practically fished out. This bed once extended a distance of three-quarters of a mile in the lower part of the river.

In 1824 an act was passed to prevent "the wilful destruction of oysters and other shellfish in the town of Harwich," which shows that even as early as 1824 the natural bed in Herring River was on the verge of depletion.

Dennis and Yarmouth.

The oyster industries of Dennis and Yarmouth are so connected that they will have to be considered as belonging to one town.

Four grants have been leased in the two towns, but only 2 of these are worked. Three grants are situated in Bass River, while the fourth, which is not operated, owing to the shifting sand, lies outside Dog Fish Bar. The 2 grants which are worked are situated in Bass River, and comprise an area of 10 acres of hard bottom, all of which is suitable for oyster culture. The Bass River grants, which are taxed at the valuation of $1,000 apiece, expire in 1914.

Mill Creek, in West Yarmouth, one of the most valuable shellfish areas in the town, originally contained a natural oyster bed which extended from the mouth of the creek up for 1,000 feet, comprising an area of 2⅓ acres. Nevertheless, this was granted in 1895 for a period of ten years. Two years ago the lease expired, and it is said that the oysters have come in again in abundance.

All along the south shore of the two towns "seed" oysters, which have been washed out of Mill Creek, can be picked up. A small amount of "seed" is raised on the grants, but this is not enough to furnish the requisite amount required for planting purposes, so about 2,500 bushels is annually brought into the town from Oyster Bay, L. I.

No damage is done in these waters by the natural enemies of the oyster, as both the starfish and oyster drill are very scarce.

One thousand bushels of marketable oysters, valued at $1,500, were shipped in the season of 1906–07.

Three men are engaged for a period of seven and one-half months in the oyster industry.

Capital invested,	$5,175
Dories,	2
Value of dories,	$25
Tongs,	5
Value of implements,	$50
Value of shore property,	$100
Value of bedded oysters,	$5,000

The oysters are taken by tonging from dories, as the water is comparatively shallow. No dredging is done.

Yarmouth is the only town in the State which requires a license for taking oysters from a natural bed.

Barnstable.

Barnstable is the great oyster town of the Commonwealth, as it has the twofold distinction of possessing the most extensive industry and producing the finest quality of oysters. The causes which have brought the cultivation of oysters in this town to so flourishing a condition have been fourfold: first, Barnstable has a long coast line, much cut up by bays and rivers, which give it a very large available area; secondly, this area is remarkably suited for the cultivation of oysters, as it is for the most part hard, clean bottom, in comparatively shallow water and well sheltered from storms; thirdly, there is little damage from the enemies of the oyster, — the starfish, winkle and drill, fourthly, the waters of the township are notably pure, free from contamination, and well adapted for the production of a rapid-growing oyster of excellent quality.

Barnstable township contains several villages, three of which, Cotuit, Marston's Mills and Osterville, are prosperous centers of the oyster fishery. Hyannis, a fourth village, once maintained a business of this nature, which proved unprofitable and has now practically disappeared. Oyster grants are scattered along the shores of Popponesset River and Bay, in Cotuit harbor, Bluff Channel, South Bay, Osterville Narrows and at Marston's Mills. In addition, a large but indefinite territory along the southern shore, as indicated on the map, is maintained as experimental grants.

Cotuit is by far the most important center of the industry. Here the fishery is conducted on an extensive scale. The white, clean sandy bottom and the remarkably pure waters of the bay produce an oyster with a bright, clear shell, which distinguishes it from oysters grown elsewhere. This Cotuit oyster is much sought for by hotels and fancy dealers, and is universally considered par excellence among Massachusetts oysters.

Barnstable, though supporting an immense industry, has by no means exhausted her latent resources. Extensive experiments to increase the productive area of the town have been carried on for the past few years. A strip of territory along the southern coast, some 4 miles long and 3 miles wide, has been granted. This territory is of doubtful utility, as the bottom is largely shifting sand exposed to the full force of southerly gales. These grants have hardly been in force long enough to demonstrate their possibilities, but it is probable that a large territory may be thoroughly suitable for the future expansion of the oyster industry.

Unfortunately, several oystermen did not make statistical returns, thus rendering a complete record for the Barnstable oyster industry impossible. The majority of the oystermen willingly responded, and the present report comprises only those returns which have been sent in.

The total area comprised by the grants, 29 in number, is 188 acres, of which 121 acres are of hard bottom, suitable for oyster culture. There is very little shifting bottom. The usual Cotuit bottom is a clear sand, which is especially favorable for the production of fine oysters.

Thirty-three men are employed from six to eight months each year in the industry, which gave in 1906–07 a production of 25,850 bushels of marketable oysters, valued at $48,050. Except for a small natural oyster bed at Centerville, no "seed" is caught in Barnstable, and is all brought from Long Island and Connecticut. Several firms plant only large oysters, bedding them in the spring and taking them up the following fall, when they have acquired the Cotuit flavor.

Capital invested,	$39,558
Power boats,	4
Value of power boats,	$3,900
Sail boats,	3
Value of sail boats,	$800
Dories,	22
Value of dories,	$413
Scows,	7
Value of scows,	$156
Implements: —	
Dredges,	23
Tongs,	45

Value of implements,	$1,139
Value of shore property,	$4,300
Value of oysters on grant,	$28,850

Mashpee.

The oyster industry of Mashpee is rather limited. Five grants exist in the west channel of Popponesset River, covering practically all the territory. Only about 5 to 10 acres of this territory is suitable for oyster culture. The ground granted for oysters is used indiscriminately for quahauging and scalloping, and seems to be almost public property.

But one man is engaged in the oyster business, and he rarely ships any, but peddles them around the community. No "seed" is caught. Starfish and oyster drills are very scarce. A cat boat, dory and tongs constitute the capital invested, which is valued at $200. The annual production is valued at $100.

Falmouth.

The oyster industry of Falmouth is conducted on the south side of the town, in the waters of Waquoit Bay. There are no oysters on the Buzzards Bay side of the town.

According to the town records, there are 22 grants in existence. These grants are mostly small, not averaging more than 2 to 10 acres, and are but little cultivated. Returns from 6 of these grants, which comprise all the territory worked for market, are alone used for the statistical figures.

The best oyster territory is in Waquoit Bay and Child's River. In Waquoit Bay 6 acres are granted, 4½ acres of which is hard bottom, suitable for oyster culture. In Child's River the grants comprise 20 acres, two-thirds of which, or 13 acres, is hard bottom. Altogether, some 44 acres are granted, and, although a good deal of the surface is muddy, there are 23 acres of very fair oyster ground.

No business is made of raising "seed," but from two to three year old "seed" is shipped from Greenport, L. I., and replanted.

In 1906–07, 3,012 bushels of marketable oysters, valued at $6,025, were shipped. Many of the grants are leased to men who raise oysters for their own use only, while but few make a business of shipping oysters.

The only enemy is the oyster drill, which does but slight damage here.

Three men are engaged for nine months each year in the oyster industry at Falmouth; while 5 or more run grants for their own use.

Capital invested,	$3,080
Power boats,	1
Value of power boats,	$800
Sail boats,	1
Value of sail boats,	$250
Dories,	4
Value of dories,	$75

Scows,	1
Value of scows,	$400
Implements: —	
Dredges,	2
Tongs,	6
Value of implements,	$105
Value of shore property,	$1,000
Value of bedded oysters,	$450

Buzzards Bay District.

The Buzzards Bay oyster industry is in a state verging on chaos. In some specially favored localities it is in a flourishing condition; in others hardly less favorable it is almost completely stagnant. Great natural advantages exist, which if properly utilized would create a business of immense proportions. These resources are for the most part but poorly improved, and in many cases are neglected altogether. A spirit of uncertainty, which discourages confidence and checks initiative, seems to pervade the business atmosphere. Amid this uncertainty and conflicting forces, one fact, at once the starting point of the whole difficulty and at the same time the sole solution of the problem, stands out vividly clear. This is the need of proper *legislation.*

The troubles which beset the Buzzards Bay oyster industry are directly traceable to defects in the present legislative system. These defects are both active and passive. In some cases unwise and illogical laws are in operation, which hamper business activity; in other cases laws for which there is a crying need are laid aside or neglected. A reform in certain aspects of town supervision is the demand of the hour. Until the present system receives an overhauling, it is doubtful if the industry will ever experience full prosperity.

In order to gain a clear insight into the difficulties which darken the immediate outlook in this region, it will be necessary to take a brief survey of the history and present status of the industry.

The beginnings of the oyster fishery in Buzzards Bay arose from the exploitation and subsequent depletion of the natural beds. These beds, of which there are several scattered along the coast from Bourne to Mattapoisett, furnished for a long time a large annual output of oysters. In the early '70's the supply began to decrease rapidly, and the fear of total extermination caused the selectmen of Marion, Wareham and Sandwich (Bourne) to attempt a strict supervision of the fishery. These attempts were in all cases unsatisfactory, and about 1875 the artificial culture of oysters began almost simultaneously in the three towns by the issue of licenses or grants to private individuals. The measure was popular from the first. Almost all the available land was speedily appropriated, and a flourishing but exotic industry, stimulated by a considerable outlay of capital, burst into life.

At Marion the new business lasted precisely fifteen years. The industry was largely a losing venture. The oysters did not grow well, and were of inferior quality. In time, doubtless, when the causes which produced these effects had been studied, a stable and well-ordered industry would have resulted. It is but natural to assume that where oysters grew in a " wild " state, cultivated ones could likewise be grown. Such an outcome, however, was not destined to follow. The grants had been so given that they all expired at the same time. When this date arrived, the majority of the inhabitants of Marion were of the opinion that the oyster grants would yield far better returns if utilized merely for the quahaugs which grew naturally on them, and the whole harbor was consequently thrown open as common ground. From that date the quahaug fishery has waned almost to the point of extinction, but no efforts have been made to resurrect the old oyster industry, which has practically disappeared.

At Bourne the industry began with bright prospects. The present business, though somewhat impoverished, still possesses those inherent resources which are capable of developing a more extensive industry.

At Wareham the business was of slower growth and more logical development, and it has continued to increase, until at present the town possesses an important industry. It has struggled with many problems which have retarded its growth, and which still embarrass it. These are primarily problems of legislation, as the industry stands in need of better regulations before it can attain its maximum development.

In all these difficulties, which have been briefly outlined and hinted at, the main source of annoyance has been the strife between two rival factions, — the oyster and quahaug interests. These interests have ever been at war, and the result has been almost fatally destructive to both. The questions at stake in this controversy have been broad in their general interest. The quahaug industry is essentially democratic, representing roughly labor as against capital, and demands that tidal flats and waters be kept as common property for general use. The oyster industry, on the other hand, is essentially exclusive, representing organized capital, and maintains that oyster grants are as much the subject of private ownership as farms and city lots. The whole aim of legislation has been to reconcile these wholly opposite theories. The problem has been complex and many-sided, and it is not strange that the selectmen of the towns in question have been unable to harmonize the two factions or pass regulations suitable to both parties. Certain it is that in trying to benefit both they have benefited neither, and the present confusion has resulted.

The matter is one certainly of sufficient importance to merit attention from the State. It is not merely local. The whole Commonwealth is interested vitally in the development of its industries, and it is unwise to allow so important an industry as the oyster fishery to remain solely in the hands of local authority, especially when local authority has shown itself unable to cope with the problem.

The present system in vogue in the Buzzards Bay district is perhaps unfair to both parties in its policy. The selectmen may lease an unlimited number of grants, of an unlimited area, to any citizen or number of citizens of the town in question. Theoretically at least they may grant all the available area in sight to one man. There must of course be the formality of a hearing, and sufficient pressure may be and is frequently brought to bear upon the selectmen to retard them from exercising the full extent of their authority; but nevertheless the system is unjust to the majority, and it is small wonder that the quahaug fishermen feel aggrieved that some of their former privileges are thus curtailed. Furthermore, the clause which demands that these grants should be used for the cultivation of oysters is oftentimes openly evaded, and a good portion of the granted area, though not used for oysters, is closed to the quahaugers.

On the other hand, the oystermen, while apparently enjoying great privileges, in reality are severely handicapped. An oysterman obtains a grant perhaps with great difficulty, owing to opposition from the quahaug men. He can carry on no extensive business without the expenditure of considerable capital. If he "seeds" his grant, the first two or three years are spent in the maturing of the first harvest. The grant is given only for ten years; consequently, when it has run for seven or eight years the owner is in doubt whether to plant any more "seed," as he does not know that his license will be renewed and naturally does not wish to plant a bed for his unknown successor. Again, if he is fairly successful and wishes to expand his business, he cannot without great risk invest in the costly equipment necessary for such an enterprise, as he has no certainty of getting a sufficient amount of territory or of keeping it any length of time. Furthermore, additional complications arise from the disputes with owners of adjoining shore property. This is particularly unfortunate, as this tidal area along the shore is most valuable for the collection of oyster set or "seed."

From the foregoing statements it appears that the oyster and quahaug factions are in the position of two combatants who continue to fight, while the object of the strife is lost to both. It is impossible to handle so grave a problem by merely theorizing, but a few ideas might be suggested as bearing favorably on the subject. It would seem wise to refrain as far as possible from granting the best portions of quahaug territory, for there is sufficient room for both industries to flourish. Then, too, grants might be rented at so much per acre as long as the owner desired within certain time limits, assuming that he paid his annual rental and improved his grant. These and other suggestions might be made which would seem an improvement over the present circumstances; but it is doubtful if conditions can be much bettered until some motive force and centralized authority is supplied by proper legislation.

Bourne.

Bourne has long supported a promising oyster industry. In some respects it has greater advantages for the extension of this business than Wareham, but the invested capital, the annual product and the resulting revenue are all overshadowed by those of its neighboring rival. The great natural resources which Bourne possesses, its extensive available area, its multiplicity of bays, inlets, islands and rivers, — these and a variety of other causes combine to make it a most favorable locality for the growth of oysters; and it is indeed an unfortunate circumstance both for the shellfish interests of the community and the broader interests of the State that so great a source of economic wealth should be so little improved. The vexing questions which harass the oyster planters of Wareham and hamper their efforts are present here in even greater force. In many places where a flourishing business was once carried on the industry is at a standstill, while nowhere does it evince that life and activity which its decided advantages warrant.

The town books contain records of 135 grants in force to-day. No accurate system of charting is in vogue except in the Monument River, and no absolutely reliable data concerning the total area is available, but the combined territory comprised in these grants aggregates nearly 600 acres. Of this territory, however, only a portion, and a relatively small portion, is really improved; the remainder is either allowed to lie dormant or is worked merely for the quahaugs which it produces. The oyster territory of Bourne is divided into five distinct sections: the Monument River section, the region about Mashnee Island, Toby Island and vicinity, Basset's Island and the neighborhood of Wing's Neck, and Pocasset and the Red Brook harbor or Cataumet district. Of these five regions, the Monument River ranks first, both in the total area and also in importance, and it is here that most of the business is carried on.

The statistical returns of the Bourne oystermen show that only 42 grants comprising 100 acres are worked. Of this 83 acres is hard bottom suitable for oyster raising while the remaining 17 acres is mostly soft mud.

Capital invested,	$24,448
Power boats,	3
Value of power boats,	$3,000
Sail boats,	8
Value of sail boats,	$1,900
Dories and skiffs,	29
Value of dories and skiffs,	$615
Implements: —	
Dredges,	99
Tongs,	38
Value of implements,	$483
Value of shore property,	$150
Value of bedded oysters,	$18,300

Twenty-one men make a living from the industry. The production for the year ending Aug. 1, 1907, amounted to 2,100 bushels of marketable oysters, valued at $4,100, and 23,000 bushels of "seed," worth $15,000. The methods employed in oyster culture here are similar to those in use at Wareham. Thousands of bushels of shells, preferably those of the scallop, are strewn over the bottom to collect the set, which is then taken up and transferred to the proper grant or shipped for sale. The two great enemies of the oyster, the borer or drill, and the starfish, flourish here. The borer seems more destructive in those sections which are comparatively sheltered, the starfish in more exposed localities.

The history of the industry is one of picturesque variety. The beginnings of the industry were bright with promise; the sudden growth which followed was spectacular but erratic; and the difficulties which soon arose plunged it into complications from which it emerged much shattered and greatly declined. Originally there were three good natural beds, — in Monument River, Barlow's River and Red Brook harbor, respectively. These beds long supplied all the oysters produced, and when in 1834 they began to be depleted, legislation was enacted regulating them until 1863, when the town surveyed a number of grants in the Monument River, each with an average area of 1½ to 10 acres, and allowed one of these grants to every citizen desiring it, on the payment of $2.50. These old beds still linger as rather uncertain assets of the communal wealth. The Monument River grounds still supply a fairly large harvest, the Barlow River has declined much more, while the Cataumet beds are nearly extinct.

The shellfish laws of this region are of vital importance, as it is their province to inaugurate order from chaos, put a stop to wasteful methods, and take such steps as appear necessary for the proper development of the industry. How greatly these laws fail in their mission is abundantly shown by the present conditions of the fishery. The whole situation is on the threshold of a change. What this change will be, whether for better or worse, depends upon the legislation of the future.

Wareham.

Wareham is the second town in the State in the production of oysters, being excelled in this respect by Barnstable alone. Its commanding position at the head of Buzzards Bay, the numerous indentations of its coast line, and the three rivers which lie partially within its borders, give it a wide expanse of available territory exceptionally favorable for the development of this shellfish industry.

The substantial success which has attended the oyster business at Wareham has been attained by slow but steady growth. Many problems have been encountered, — problems of local prejudice, opposition from rival industries and the like; but these problems have simply hampered the industry, — they have not sufficed to check its growth. At present the business seems firmly established, and can enter on its future career of prosperity as soon as the barriers which block its progress shall have been removed.

The town records show a total of 125 grants in operation today. These grants are poorly described and for the most part unsurveyed, but their total area approximates 1,000 acres. According to the statistical returns of the oystermen, 70 grants, comprising 196 acres, are under cultivation. Of this, 159 acres are of hard bottom, suitable for oyster planting, while the waste area is equally soft mud and shifting sand.

Capital invested,	$40,620
Power boats,	4
Value of power boats,	$3,800
Sail boats,	17
Value of sail boats,	$4,485
Dories and skiffs,	50
Value of dories and skiffs,	$820
Scows,	2
Value of scows,	$250
Implements: —	
Dredges,	120
Tongs,	84
Value of implements,	$1,120
Value of shore property,	$2,420
Value of bedded oysters,	$27,725

The catching of oyster "seed" at Wareham is more important than the raising of marketable oysters; 22,100 bushels of seed, valued at $12,090, were exported last year (1906–07). Thousands of bushels of shells, chiefly those of the scallop, are planted yearly in shallow water, to catch the set. The territory where these shells may be planted to the best advantage is on the fringe of tidal flats which skirt the coast. This area, however, which is consequently of considerable value, is of doubtful ownership, being claimed both by the oystermen and also by the owners of the adjacent shore property. The dispute arising over this question has been most harmful to the industry.

The marketable oysters raised at Wareham are of very good quality. There were 7,770 bushels of these oysters, valued at $12,790, produced in 1906–07, and shipped mostly to New York and Boston. Altogether, there are 26 men depending on this industry for a living.

Besides the grants, there are two native beds, one each in the Wareham and the Weweantit rivers. These beds comprise nearly 80 acres, and, though now greatly reduced, they still yield a considerable amount of seed oysters.

The laws governing the industry here are similar to those at Bourne. The ten-year grant prevails, with all its attendant evils to the oysterman; while the quahaugers have abundant cause to complain, from the fact that practically all the available territory has been granted to the oystermen. While it is true that scarcely a third of this land is utilized for the cultivation of oysters, it is likewise true that the rights of the oystermen are by no means strictly observed by the quahauger. There can be but one result of this policy, — endless wrangling and confusion, and, in the end, loss to both parties. The unfortunate thing about the whole matter is that most of this wastefulness is entirely needless; but this is a problem for future legislation.

Marion.

The oyster industry at Marion is practically dead. The last grants expired some ten or twelve years ago, and were never renewed. Of the two original natural beds, that in Blankinship's Cove is now almost entirely depleted, while the larger and more important bed in the Weweantit River has greatly declined in importance. This bed, however, still supplies all the marketable oysters produced within the town, though the annual production is insignificant. From twenty-five to thirty years ago the oyster industry had its beginning, and for a time flourished. Almost all the available territory, both in the harbor and in the Weweantit River, was granted. The older grants were leased for fifteen years, and those of later date were arranged to run out at the same time; so it followed that all the leases expired simultaneously, and the industry came to an abrupt end. These old grants were not renewed, for two reasons: first, they had not paid very well; and, secondly, the growing quahaug industry promised more lucrative returns. The scallops, too, began to be abundant, and the old oyster business gave way before its newer and more prosperous competitors.

Fall River District.

The Fall River district, comprising the six towns of Fall River, Freetown, Berkley, Dighton, Somerset and Swansea, may best be treated as a geographical unit. The oyster industries of the individual communities overlap to a considerable extent, and make distinct separation difficult, while, as the same methods of culture everywhere obtain and the same problems and difficulties are encountered, a brief survey of this whole region may be comprehensively discussed in one article.

The beautiful shores of Mount Hope Bay and its tributary streams, the Cole, Lee and Taunton rivers, furnish an extensive territory for a large oyster industry. The best of this area is now included within the confines of the bay itself, though the Cole and Lee rivers furnish a small but valuable addition. The Taunton River, however, which thirty years ago produced the finest oysters in the State, and was the main source of supply for this district, has become utterly worthless for the growth of marketable oysters. In fact, this river, with its curious history, and the difficulties which it now presents to the carrying on of an important and profitable industry, furnishes the most interesting problem of this whole region. This river embraces the entire oyster territory of Freetown, Berkley and Dighton and portions of Somerset and Fall River, — certainly half of all the available territory of the whole section; and yet it is an indisputable fact that this large and formerly profitable area is now altogether unsuitable for the production of edible shellfish.

The causes for this transformation of a river which once supplied a large annual revenue to the prosperous communities which lined its banks, into a stream unwholesome and unfit for the proper maturing of its shellfish, have been much discussed. The prevailing opinion seems to lay the blame to the impurities discharged into the river by the Taunton factories. Other theories, ingenious but far less worthy of weight, have been urged; but the burden of evidence strongly points to the sewage of the city of Taunton as the probable main factor in the decline of the industry.

While greatly impaired as a favorable territory for the propagation of oysters, the river, however, is still largely utilized. Extensive grants are sold by the towns of Dighton, Berkley and Freetown to oystermen, who bed them with "seed," which is allowed to remain until it is from two to three years old, when it is taken up and replanted in some other locality where the waters are uncontaminated, and here left for a certain time until it becomes "purified" and ready for shipment to market. By this method the old grants are still worked, though greatly declined in value, as oysters can no longer be sold to market direct, and the process of transplanting entails considerable expense.

In the other towns of this region the industry is carried on much the same as in Buzzards Bay or Barnstable. A great deal of attention is paid to the enemies of the oyster, particularly the starfish. This animal is combated chiefly with "mops" of cotton waste which are dragged over the bottom, and the starfish, becoming entangled in the strands, are removed and destroyed. As this fairly effectual warfare is being constantly waged, the numbers of this pest are kept well reduced, and the grounds maintained in very good condition.

By a peculiar local custom, which would be decidedly unpopular in some coast communities, the towns of this section usually sell their entire oyster privilege to some individual or company, ordinarily the highest bidder. In this manner, aided by the fact that some persons purchasing such rights re-sell them to others, the oyster industry of this entire region is owned and controlled by a very few men. This arrangement, however, does not seem to be unpopular, the only difficulty arising from those clammers who are accustomed to dig clams under water, and sometimes find a bed located on an oysterman's grant. In such cases the owners usually waive their rights, and allow the clammers to dig undisturbed.

As has been said, the oyster industry in this district, while it has by no means attained its maximum development, has indeed reached very considerable proportions. The entire amount of area granted aggregates 810 acres. Of this total, some 510 acres are suitable for oyster culture, the remainder being soft mud, shifting sand, or otherwise unfit for utilization. The entire output for 1907 exceeded 38,000 bushels, valued at $26,250. Thirty-six men depend partially upon the business for a livelihood.

Capital invested,	$96,540
Power boats,	9
Value of power boats,	$19,500
Dories and skiffs,	17
Value of dories and skiffs,	$340
Implements: —	
Dredges,	12
Tongs,	18
Value of implements,	$2,000
Value of shore property,	$6,200
Value of oysters on grant,	$68,500

Nantucket.

The oyster industry of Nantucket is of recent origin, and the oysters are as yet raised only for home consumption.

Two grants have been leased by the selectmen, but only one of these is now planted. These grants are situated in the east and west bends of Polpys harbor. The cultivated grant in the west bend comprises some 20 acres, only 3 of which are of hard bottom and suitable for oyster culture, the remaining 17 having a soft mud bottom.

The "seed" planted on the grant is obtained at New Haven. In the last few years the oysters on this grant have thrown a large quantity of spawn, which has caught on piles and stones at various places around Nantucket harbor.

The only enemy to the Nantucket oyster is the oyster drill.

The production of marketable oysters for 1906–07 was 200 bushels, valued at $400. These were sold for home trade on the island.

One man is engaged in the oyster business for a period of three months each year.

The oysters are taken both by dredging and with tongs.

Capital invested,	$1,358
Power boats,	1
Value of power boats,	$500
Dories,	1
Value of dories,	$18
Implements: —	
Dredges,	2
Tongs,	1

Value of implements,	$15
Value of shore property,	$25
Value of oysters on grant,	$800

Clam (*Mya arenaria*).

Mya arenaria, commonly known as the "soft" or "long-neck" clam, is found along the entire Massachusetts coast, wherever there is afforded a sufficient shelter from the open ocean. Exposed beaches with open surf are never inhabited by this mollusk, which is usually found on the tide flats of bays, inlets and rivers, and on the sheltered beaches between high and low tide lines. The clam occurs in various kinds of soil, from rocky gravel to soft mud, but grows best in a tenacious soil of mud and sand, where it lies buried at a depth of from 6 to 12 inches.

As Cape Cod marks the dividing line between a northern and a southern fauna, it also divides the clam flats of Massachusetts into two distinct areas. The same clam is found both north and south of Cape Cod, but the natural conditions under which it lives are quite different. In comparing these two areas, several points of difference are noted.

(1) The clam areas of the north coast are mostly large flats, while those of the south shore are confined to a narrow shore strip, as Buzzards Bay and the south side of Cape Cod for certain geological reasons do not possess flats, but merely beaches.

(2) The rise and fall of the tide is much higher on the north shore, thus giving an extent of available flats nearly six times the clam area south of Cape Cod.

(3) Clam growth as a rule is much faster on the north shore. This is due to the great amount of tide flow over the river flats of the north shore. Current is the main essential for rapid clam growth, as it transports the food. The average south shore flats possess merely the rise and fall of the tide, and as a rule have not the currents of the north shore rivers.

(4) The temperature of the northern waters is several degrees colder than the waters south of Cape Cod. This affords, as has been shown experimentally, a longer season of growth for the southern clam. The north shore clam in the Essex region only increases the size of its shell through the six summer months, while the south shore clam grows slightly during the winter.

The present advantages lie wholly with the north shore district, as through overdigging the less extensive areas of southern Massachusetts have become in most parts commercially barren. Overdigging has not occurred to the same extent on the north shore, owing to the vast extent of the flats. Nevertheless, many acres of these, as at Plymouth, Kingston, Duxbury, and even Gloucester and Essex, have become wholly or partially unproductive. The only important clamming in Massachusetts today is found in the towns bordering Ipswich Bay. The south shore and a good part of the north shore furnish but few clams for the market.

In view of restocking the barren areas through cultural methods, the north shore possesses two advantages over the south shore: it has a larger natural supply at present, which will make restocking easier; it has larger areas of flats, which can be made to produce twenty times the normal yield of the south shore flats. Although, compared with the north shore, the clam area of the south shore seems poor, it is above the average when compared with the clam areas of the other States south of Massachusetts, and when properly restocked the clam flats of southern Massachusetts should furnish a large annual production.

If the clam industry is not properly cared for, it will be totally ruined before many years. The clammers do not realize this, because of a mistaken impression that nature will forever furnish them with good clamming, and they have little thought for the future; while, on the other hand, the consumer is indifferent from lack of knowledge.

Scope of the Report. — The object of this report is to present in brief form the condition of the clam fishery in Massachusetts. For this purpose facts showing the present extent of the industry have been compiled, with the view of furnishing both the clammer and consumer with certain desirable information.

The report will consider: (1) general conditions of the industry of 1907; (2) a survey of the clam-producing area, illustrated by maps; (3) a plan of clam culture which will make productive many acres of barren flats; (4) the history of the clam industry, a comparison being made between the industries of 1879 and 1907; (5) a description of the industry.

Methods of Work. — The same methods as used with the other shellfish were pursued in obtaining the statistical data for the clam industry. The clam-producing areas were examined and the observations recorded. Town records, which were of some assistance with the other shellfish, furnished practically no clam data, compelling the Commission to rely upon the estimates of the clammers and clam dealers. While this method made it difficult to secure accurate detailed information, the statistics for each town were checked up in a variety of ways, thus furnishing as nearly correct figures as can be obtained.

In making an historical comparison of 1879 and 1907, the report of Ernest Ingersoll on the clam fishery of the United States, and the report of A. Howard Clark on the fisheries of Massachusetts, as published in the United States Fish Commission Report, Section V, volume 2, and Section II., respectively, were of great use, as practically all of the statistics for 1879 were obtained from these two reports.

In making the survey of the clam areas, records were made of: (1) soil; (2) food (*a*) in water, (*b*) on surface of soil; (3) rate of currents; (4) abundance of clams and localities of set; (5) barren flats that can be made productive. In the present report only the kind of soil, abundance of clams and area of barren flats will be given, the food problem being reserved for later publication.

Summary. — In the following summary the seacoast towns are arranged in geographical order from north to south. The number of men includes both regular and intermittent clammers who dig for the market; all others are excluded. In determining the production of any town it is impossible to obtain exactly correct figures, as the amount dug for home consumption is an unestimable quantity, and the clams are marketed in a number of ways, rendering it almost impossible to get complete statistics. The production statistics have been obtained in a variety of ways, and the final estimates have resulted from careful consideration of all facts. The invested capital includes the clammer's outfit and boat, but does not include personal apparel, such as boots and oil skins.

The clam flats are divided into two main divisions: (1) productive; and (2) barren. The barren areas are those where at present no clams grow at all, not even scattering; and areas yielding even a few clams are still considered productive flats, though to all practical purposes barren. It was necessary to make the division thus, as otherwise no decisive line could be drawn. The barren flats are divided into those sections that can be made productive and those that can never be made to grow clams. The productive flats, on the other hand, are divided into areas of good clamming and areas of scattering clams which do not support a commercial fishery. The normal production of the clam flats has been carefully estimated, in view of the previous experiments of the Fish and Game Commission, and the different classes of flats have each been given a certain valuation in computing the total for each town. The areas given of the clam flats are based upon calculations, as no engineering survey was made.

The price of clams varies in different localities, and chiefly depends upon the quality of clams and the method of marketing. In certain towns clams are "shucked" (removed from the shell), — a process which greatly increases their market value; while in other places they are sold only in the shell. These two facts account for the apparent variation in the value of the production in different localities, as each town is given its own market price.

The following production table does not include an important factor, — the amount of clams dug by the summer people. An unestimable quantity is annually taken from the flats in this way, and is not included in the production statistics. Indeed, summer people have affected the clamming interests of several towns, as the selectmen have refused to place closed seasons, etc., on certain depleted flats in order to cater to the summer residents, who desire free clamming near their cottages. The total number of licenses issued by the boards of health of Boston and New Bedford for taking shellfish in their respective harbors are given as representing the number of clammers. In reality, however, only a few of these licensees make a regular business of clamming.

Summary of the Clam Industry.

TOWN.	Number of Men.	Capital invested.	1907 Production.		Total Area.					Productive Area.		Barren Area possibly Productive.	Waste Barren Area.	Possible Normal Production.
			Bushels.	Value.	Sand.	Mud.	Gravel.	Mussels and Eel Grass.	Total.	Good Clamming.	Scattering Clams.			
Salisbury,	66 [1]	$625	15,000	$16,500	34	216	-	-	250	150	100	-	-	$70,000
Newburyport,	175	2,700	55,500	61,000	150	930	-	-	1,080	800	280	-	-	250,000
Newbury,	6	75	300	250	110	250	-	-	360	-	100	260	-	40,000
Rowley,	15	800	2,000	1,500	250	150	-	-	400	20	80	300	-	60,000
Ipswich,	136 [1]	7,500	25,000	18,750	390	500	55	25	970	400	420	125	25	200,000
Essex,	50	1,200	15,000	12,750	500	125	-	25	650	150	150	325	25	120,000
Gloucester,	31	600	6,000	8,000	250	200	-	100	550	75	100	275	100	70,000
Manchester,	-	-	100	100	10	10	-	-	20	-	5	10	5	2,000
Beverly,	-	-	100	100	30	20	-	-	50	-	10	30	10	5,000
Salem,	7	75	200	200	75	25	-	-	100	5	10	70	15	11,000
Lynn,	7	100	1,000	1,000	90	300	5	5	400	10	30	160	200	26,000
Saugus,	10	100	1,000	1,000	100	150	-	-	250	10	40	100	100	22,000
Nahant,	-	-	300	300	50	100	100	-	250	-	50	150	50	25,000
Boston,	350 [2]	2,250	7,500	6,000	525	3,325	1,380	1,095	6,325	100	1,180	1,000	4,045	376,000
Cohasset,	-	-	200	200	50	50	-	-	100	-	10	40	50	6,000
Scituate,	-	-	200	200	50	45	5	-	100	-	20	40	40	8,000
Marshfield,	-	-	200	200	40	50	10	-	100	-	30	30	40	9,000

Duxbury, ...	5	60	700	600	800	-	-	2,700	3,500	5	10	800	2,685	83,000
Kingston, ...	4	50	500	450	150	-	-	450	600	5	5	150	440	18,000
Plymouth, . . .	6	60	3,000	2,500	400	100	-	1,100	1,600	10	50	440	1,100	58,000
Barnstable, . . .	25	200	700	550	200	150	-	50	400	10	10	330	50	39,000
Yarmouth, . . .	5	40	600	500	25	15	10	-	50	5	10	25	10	6,000
Orleans, ...	30	200	3,000	3,000	125	50	20	5	200	25	50	75	50	27,000
Eastham, ...	36	250	4,000	4,000	100	50	30	20	200	25	50	100	25	30,000
Wellfleet, ...	11	300	800	640	450	5	150	-	605	3	12	250	340	28,000
Truro, ...	1	2	50	60	50	-	-	-	50	1	2	47	-	5,000
Provincetown, . . .	5	15	400	320	400	-	-	-	400	3	3	200	194	21,000
Chatham, ...	10	400	1,500	1,200	330	10	20	-	360	10	50	300	-	44,000
Harwich, ...	-	-	100	80	10	10	10	-	30	1	5	10	14	2,400
Dennis, ...	-	-	50	45	25	15	10	-	50	1	4	30	15	4,200
Mashpee, ...	2	20	50	45	20	5	20	5	50	2	8	30	10	5,400
Falmouth, . . .	-	-	200	175	40	5	5	-	50	2	8	40	-	6,400
Bourne, ...	-	-	100	100	5	5	30	-	40	-	30	-	10	6,000
Wareham, . . .	6	100	800	800	15	10	75	-	100	-	50	-	50	10,000
Marion, ...	1	15	100	100	-	-	10	-	10	-	10	-	-	2,000
Mattapoisett, . . .	1	15	100	100	-	5	5	-	10	-	10	-	-	2,000
Fairhaven, . . .	-	-	100	100	-	25	25	-	50	-	25	25	-	7,500
New Bedford, . . .	320 [2]	-	300	225	5	5	15	-	25	-	15	-	10	3,000
Dartmouth, . . .	4	50	200	160	15	10	5	-	30	5	15	-	10	5,000

1 Licenses.

2 Licenses for bait.

Summary of the Clam Industry — *Concluded.*

TOWN.	Number of Men.	Capital invested.	1907 Production.		Total Area.					Productive Area.		Barren Area possibly Productive.	Waste Barren Area.	Possible Normal Production.
			Bushels.	Value.	Sand.	Mud.	Gravel.	Mussels and Eel Grass.	Total.	Good Clamming.	Scattering Clams.			
Swansea, . . .	25	$250	5,000	$5,000	100	100	-	-	200	20	30	100	50	$24,000
Somerset, . . .	-	-	50	50	-	25	25	-	50	-	10	20	20	4,000
Dighton, . . .	-	-	40	40	-	5	5	-	10	-	2	8	-	1,200
Berkley, . . .	-	-	25	25	-	5	5	-	10	-	4	6	-	1,400
Freetown, . . .	-	-	100	100	-	10	15	-	25	-	15	-	10	3,000
Fall River, . . .	-	-	100	75	-	20	5	-	25	-	10	15	-	3,500
Nantucket, . . .	4	40	400	350	150	25	25	-	200	5	15	130	50	18,000
Edgartown, . . .	7	50	1,200	1,000	150	-	50	-	200	20	100	50	30	33,000
Total, . . .	1,361	$18,142	153,865	$150,440	6,269	7,111	2,125	5,580	21,085	1,878	3,233	6,096	9,878	$1,801,000

Decline of the Natural Clam Supply. — The decline of the clam supply is a matter of general knowledge. People who live along the seashore realize that they can no longer gather the amount of clams they once could dig with ease from the same flats. On the southern shore of the State especially it is oftentimes difficult to obtain even enough for family use. The consumer also realizes the loss of the clam, as he is forced to pay higher prices.

If specific cases of this decline are demanded, the following instances should show the exact depletion in the various localities. Even in the best clam-producing town of the State, Newburyport, where the clam production, according to statistics, has apparently increased during the last twenty-five years (as a result of more men entering the fishery), the supply has shown signs of failing. Essex now possesses many acres of flats formerly productive which now lie in a practically barren condition. Gloucester can no longer boast of her former clam industry, as the flats in Annisquam River are in poor condition. Hardly 30 men now make a business of clamming in that town, whereas 92 men were engaged in the fishery in 1879. Passing south of Gloucester, we find great evidence of decline in the Boston harbor flats. Even before the edict closing the harbor from clammers was in force, the production did not by any means equal that of 1879. Plymouth harbor, including the three towns of Duxbury, Kingston and Plymouth, furnishes an excellent illustration of this decline. Here an area of flats as extensive as all the other flats of the State combined now lies practically barren, whereas in former times great quantities of clams were taken. These flats had already become depleted to a marked extent by 1879, and to-day practically no clams are shipped to market from the Duxbury flats, although you can still read "Duxbury clams" on the menus of the hotels and restaurants, showing how important a clam industry this town once possessed. Buzzards Bay district lies at present unproductive except for supplying home consumption and the demands of the summer people. The shores of Cape Cod no longer yield their former supply of clams, and the most striking example of the extinction of a flourishing fishery is found in the town of Chatham, which now does not produce one-tenth part of its production in 1879. The Fall River or Narragansett Bay district does not come up to its past productiveness, and now chiefly yields clams which in former times would have been considered as too small to use.

As can be seen by the following table, which gives a comparison between the industry in 1879 and 1907, the localities south of Gloucester all show a decline in their production, and there is no town on the coast which has not shown some depletion in the natural clam supply. The localities of the north shore, while indicating by their statistics a gain in production, nevertheless have not their former abundance, and the actual diminution of the supply is concealed by the fact that more men have entered the industry.

LOCALITY.	1879.			1907.		
	Men.	Bushels.	Value.	Men.	Bushels.	Value.
Ipswich,	75	11,500	$4,600	136	25,000	$18,750
Salisbury and Newburyport,	60	28,800	11,520	241	70,500	77,500
Essex,	75	11,500	4,500	50	15,000	12,750
Gloucester,	92	13,978	5,200	31	6,000	8,000
Boston harbor,	90	40,000	20,000	350 [1]	7,500	6,000
Duxbury,	– [2]	5,000	2,500	5	700	600
Plymouth,	– [2]	5,000	2,500	6	3,000	2,500
Harwich,	15	1,125	400	–	100	80
Chatham,	150	35,000	12,250	10	1,500	1,200
Nantucket,	– [1]	2,253	872	4	400	350
Edgartown,	– [2]	4,000	1,570	7	1,200	1,000
New Bedford district,	– [2]	5,800	2,900	332 [1]	1,600	1,685
Fall River district,	– [2]	3,375	3,121	25	5,315	5,290

[1] Licenses. [2] Statistics of the number of men engaged were unobtainable.

Causes of the Decline. — The same cause which has been stated in the general report has contributed to the decline of the clam supply, *i.e.,* the increasing demand which has led to overfishing. Thus the decline can be directly attributed to the exploiting of natural clam resources by man, although it must be admitted that natural agencies, such as geographical changes, destroy the clam flats of certain localities and build up others.

This decline has become possible through the indifference of the towns to the welfare of their clam fishery, and by not restricting, through town laws, the extermination of the clams in time to allow nature to replenish the flats. Some towns, such as Ipswich, have regulated this matter by placing closed seasons on portions of the flats, which has been the partial means of preserving their natural supply. Thus the town laws have proved inadequate, as most towns have no laws at all, or have such unwise ones that they often defeat their own object.

It is again necessary to emphasize the need of reform in the clam industry. This Commonwealth once possessed an extensive supply of clams, and still possesses part of its former abundance; but the present supply is diminishing at such a rate that it will not be a quarter of a century before the natural clam fishery will be commercially extinct. On the south shore clams are now commercially extinct, and it is only a question of time, if the present methods are allowed to remain, before the north shore clams will also disappear. The experiments of the Massachusetts department of fisheries and game and the work of men who have planted this shellfish all show that thousands of dollars can be brought into the State by utilizing the waste clam areas, and that the production can be so increased as to even exceed that of former years. Immediate action is necessary, if this important industry is to be saved.

The Remedy. — The remedy is comparatively simple, and abundant proof of its success is at hand. By restocking the barren and unproductive areas of the Commonwealth the present production can be increased many times. Experiments have shown that clams can be readily, successfully and economically transplanted, and that it is a completely practical undertaking. Not only can the barren areas be restocked, but the yield of the productive areas can be much increased. Clam farming is the only practical method of restocking these areas, and only through such means can the clam flats be made to yield their normal harvest.

Clam Farming.

The subject of clam farming has received a good deal of attention the past few years, and much has been said concerning the enormous profits which would result from the cultivation of this shellfish. While the newspaper statements have been for the most part correct, there has been considerable exaggeration and many details have been inaccurate. To remove any misapprehensions, the following account of clam farming is given.

The value of clam farming has been perhaps overestimated. While no fabulous returns are ever to be expected, the yield is large in proportion to the labor, and steady returns are sure. The methods used are simple, the capital required is small, the area suitable for raising clams is extensive, and clam farming gives promise of becoming one of the most prominent and remunerative shore industries. The profits derived from such a system should furnish steady employment for hundreds of men on the Massachusetts coast.

Massachusetts possesses thousands of acres of tidal flats which are capable of producing clams. Most of these flats are practically barren, *i.e.,* produce no clams in paying quantities, and yet if planted with small clams will yield in from one to two years large quantities of marketable bivalves. This large area of barren flats should be divided into small farms, which should be leased to individuals for the purpose of planting and raising clams.

The Necessity of Clam Farming. — It is a well-known fact that the natural supply of clams is becoming rapidly exhausted, and that this important fishery will become commercially extinct unless steps are taken to check its decline. The only practical means known at the present time is *clam farming.* In the past, methods such as close seasons and restricting the catch have been used, but with poor results, as these have been economically wrong. The correct method in such cases is not to restrict the demand, but to increase the supply. Clam farming offers the only means of increasing the natural production, and not only checking the decline, but establishing a large industry.

Is Clam Farming Practical? — Clam farming is not a theory but an *established fact*. Clams will grow if planted in suitable places, and will yield large returns. For three years the Commission of Fisheries and Game have made numerous experiments in clam farming in many seacoast towns. They have not only proved its complete practicability, but have also shown that large profits result from successful planting. Records are on file at the State House showing the exact results of these experimental farms, which indicate the future success of clam farming.

Besides the experiments of the Commission on Fisheries and Game, *successful clam farming* is now being carried on in several towns of the State. The leading town in this line is Essex, where at least 15 grants are held by the clammers. The only protection given is based upon public sentiment, which, however, is sufficient to insure the success of the enterprise. All these grants were staked out on flats which were producing no clams when granted, although part of this area was once very productive. So far these grants have proved most successful, thus proving by actual experience that clam farming is a worthy rival of agriculture.

Historical Attempts at Clam Farming. — Clam farming has been in existence for years. The first record of any legislation upon this subject is found in an act to regulate the clam fishery in and around the shores of Plymouth, Kingston and Duxbury in 1870, whereby a license was granted for a term not exceeding five years to any inhabitant of these towns to plant, cultivate and dig clams. This license cost $2.50, and gave the exclusive use of the flats and creeks described to the licensee and his heirs during the time specified, and also the right in an action of tort to recover treble damages from any person who, without his consent, dug or took clams from said grant. Evidently nothing was done to follow out this law, which was soon forgotten.

In 1874 an act was passed to regulate the shellfisheries (including clams) in the waters of Mount Hope Bay and its tributaries. The terms of this act were practically the same as the Plymouth act, the only difference being the substitution of the word *shellfish* for *clam*.

In 1888 an act was passed by the town of Winthrop, authorizing the planting of clams on the shores of that town. The grant was to consist of not over 2 acres of *barren* flats, situated more than 500 feet from high-water mark. The other provisions of this act were the same as those of the Plymouth act of 1870.

The most important clam culture law was passed in 1888. This authorized the planting of clams on the shores of Essex. Here the provisions of the law were followed out, and the first energetic attempt at clam farming started. The law, the provisions of which were nearly the same as the previous laws, reads as follows: —

Acts of 1888, Chapter 198.

An Act authorizing the planting of clams, in and around the shores of Essex.

Be it enacted, etc., as follows:

Section 1. The selectmen of the town of Essex may by writing under their hands grant a license for such a term of years, not exceeding five, as they in their discretion may deem necessary and the public good requires, to any inhabitant of said town, to plant, cultivate and dig clams upon and in any flats and creeks in said town now unproductive thereof, not exceeding two acres to any one person, and not impairing the private rights of any person.

Section 2. Such license shall describe by metes and bounds the flats and creeks so appropriated and shall be recorded by the town clerk before it shall have any force, and the person licensed shall pay to the selectmen for the use of said town two dollars and to the clerk fifty cents.

Section 3. The person so licensed and his heirs and assigns shall for the purposes aforesaid have the exclusive use of the flats and creeks described in the license during the term specified therein, and may in an action of tort recover treble damages of any person, who, without his or their consent digs or takes clams from such flats or creeks during the continuance of the license.

Section 4. Said town of Essex at any legal meeting called for the purpose may make such by-laws, not repugnant to the laws of the commonwealth, as they may from time to time deem expedient to protect and preserve the shellfisheries within said town.

Section 5. Whoever takes any shellfish from within the waters of said town of Essex in violation of the by-laws established by it or of the provisions of this act shall for every offence pay a fine of not less than five or more than ten dollars and costs of prosecution, and one dollar for every bushel of shellfish so taken.

Section 6. This act shall take effect upon its passage. [*Approved April 9, 1888.*

In the report of the United States Commissioner of Fish and Fisheries for 1894 Mr. Ansley Hall gives the following account of clam culture under this act: —

During the first two years (1889–90) the people were slow to avail themselves of the privilege of planting, for fear that after they had spent their time and labor they would not be able to secure protection from trespassers; but in 1891 and 1892 lots were obtained and planted. In 1892 there were 25 acres that were quite productive, about one-third of the entire catch of the section being obtained from them. The catch from these lots is not definitely known, but is estimated at about 2,500 barrels.

Cultivated clams possess some advantage over the natural growth, from the fact that they are more uniform in size, and are as large as the best natural clam. They bring $1.75 per barrel, while the natural clams sell for $1.50 per barrel. This is the price received by the diggers. One acre of these clams is considered to be worth $1,000, if well seeded and favorably located so as not to be in danger of being submerged with sand. This valuation would be too high for an average, since all the acres are not equally well seeded and located. The clammers are generally impressed that the industry can be extensively and profitably developed, and their only fear is that they will not be able to secure lots permanently. The greater part of the land available for this purpose is covered by the deeds of people owning farms along the river, and the consent of the land owners has to be obtained before lots can be taken up. It seems probable, however, that the business will continue to progress unless checked by complications that may arise relative to the occupancy of the grounds.

The result of this first practical attempt at clam culture was a complete failure, and after a few years' trial the clam farms were all given up. The main reason for this failure was lack of protection both from outsiders and from one another. Nevertheless, this attempt proved that with proper protection a most successful industry could be made of clam farming. The following statement by Prof. James L. Kellogg, in the United States Fish Commission Bulletin for 1899, describes the failure of clam culture at Essex: —

It is not difficult to determine the reasons for the failure of the culture experiment at Essex. The areas upon which clams were planted were those which were at the time unproductive. The beds still containing clams — the "town flats" — were free to any native of Essex. The one thing which was absolutely necessary to the success of any planter was that the clams on his leased ground should not be disturbed by other diggers. This protection was apparently not given in any case by the town authorities, and, as no person lived within sight of the majority of the beds, it was quite impossible for any man to guard his property much of the time.

As to what followed it is not easy to obtain definite testimony from the clammers themselves. Other citizens of the town, however, and some few clammers, intimate that most of the men began to take clams from any property but their own, and that in this way the full result of no man's labor in planting was ever realized. Others who did not make clam digging a regular business, but only dug occasionally, are said to have had no respect for the rights of those who had leased property. It was said that at times when vessel builders and the shoe factory released employees, many of them, for lack of other occupation, turned their attention to clam digging, with the result that too many clams were at the time taken from the flats.

Another reason for the failure of the Essex experiment is that a number of short-sighted clammers began to fear, after the clams had been planted, that the production might suddenly become so great as to glut their market, and, as a consequence, force prices down. Some few individuals, inspired by this fear, are reported to have said and to have done everything in their power to prevent the success of the experiment. In all cases, it is said, the selectmen of the town, who issued the leases, refused their aid in the prosecution of trespassers.

In spite of the fact, which had been demonstrated in the experiment, that when properly planted the clams grew much more rapidly and became much larger than on the natural beds, no applications for a renewal of the leases were made when the first ones expired. No change in the condition at Essex may be hoped for until there is some evidence that a law protecting the planter will be strictly enforced. With proper protection, a great industry might, and probably would, be quickly established, not only in Essex, but in any region where clam flats are now unproductive because of excessive digging.

Protection Necessary. — The same lack of protection which ruined the Essex clam experiments has been the cause of similar failures in other shore towns. As long as no protection is given, clam farming can never become possible, as the whole success of the enterprise depends wholly upon the planter's having complete control of his land. The present law gives absolutely no protection, as according to the old free beach law a person has a right to dig a mess of clams anywhere between the tide lines, no matter whether natural or planted. This practically discourages clam farming, however profitable, as no clammer is going to the labor and expense of planting clams, if the next person who comes along has a legal right to dig as many as he pleases. Until a law is passed which gives to the clam planter absolute protection from this sort of trespassing, and does away with the antiquated free fishing law, clam culture can never become a successful industry.

Present Clam Culture. — In 1906 grants of barren flats were again issued for the purpose of clam culture in Essex, and this time the attempt seemed successful. Two things encouraged this: the excellent results of the experiments in Essex River by the Commission on Fisheries and Game, and the possible results indicated by the experiments of 1888. The only protection for these clam grants is by public sentiment, and the mutual agreement of all the clammers to respect the rights of the individual. So far there has been no trouble from trespassing and the lack of protection, which caused the failure of first attempts. It is hoped that these clam farms will become permanently successful, despite the lack of protection, as they will greatly increase the production of the Essex clam flats.

Clam Farming and Agriculture. — The comparison between clam farming and agriculture is very close, and both possess many common features, though there are several points of difference. The clam obtains its sustenance entirely from the water, while agricultural products obtain their nourishment chiefly from the soil. The nitrogenous waste products of the land washed into the streams furnish the nourishment to the little marine plants (diatoms) on which the clams feed.

Rate of Growth of the Clam. — The report of the Commission on Fisheries and Game for the year 1906 contains the following statements: —

What is the natural growth of the clam per year?

There is great diversity in the growth of the clam, owing to the location in respect to three essential conditions, — current, length of time submerged, and soil. The following figures give briefly the general trend of results from numerous experimental beds under great variety of conditions. For simplicity, a 1-inch clam is taken as the standard.

A 1-inch clam will grow in one year to a size between 2 and 3 inches. Under fairly favorable conditions, with a moderate current, a 1-inch clam will increase to 2½ inches, or a gain of 900 per cent. in volume. For every quart planted, the yield in one year will be 9 quarts. For beds without current, 1-inch clams average about 2 inches, or a gain of 500 per cent.; *i.e.*, five quarts for every quart planted. Beds under exceptionally fine conditions have shown the amazing return of 15 quarts for every quart of 1-inch clams planted. Clams increased in these beds from 1 to 3 inches in length. Therefore, by planting clams 1 inch or over, under *favorable* conditions a *marketable* clam can be produced in *one year.*

What is the maximum production per square foot?

The number of clams per square foot that can be raised to the best advantage depends upon the location of the flat in respect to natural conditions. Clams thickly planted (15 to 20 per square foot) in favorable locations may show a greater growth than when thinly planted (5 per square foot) in less favorable locations; therefore, no definite statement can be made which will apply in all cases. The only rule that can be given is that a flat with a current will produce a greater number of clams per square foot than one without a current. On good flats clams can be planted conveniently and economically from 10 to 15 per square foot, or even a larger number.

What results can be obtained by planting on barren flats?

There are two groups of flats which come under the term barren: (1) flats which once produced clams in great numbers, but now are practically barren, except for an occasional clam here and there; (2) flats which never have produced clams, and on which for physical reasons clams can never grow. The first group of flats is alone considered in this answer.

Experimental beds were planted on certain flats in the Essex River which come within the first group of barren flats. These once productive flats had been cleaned out in the past, and for some reason had not seeded naturally. Forty beds were laid out under all kinds of conditions, with the object of finding a way to make these once more productive. Results have been all that could be hoped for. Only 4 poor beds were found, out of the 40 laid out; 36 beds were in thriving condition. It should be noted that no attempt was made to choose the best places, but all conditions were tried. Over two-thirds of the clams were re-dug, the increase averaging, in terms of 1-inch clams, over 1,000 per cent., or 10 quarts for every quart planted the year before.

If many acres of Massachusetts flat, idle at present, are capable of such a yield, should such economic waste be allowed? Why should not the towns, by the expenditure of a little money, restock flats such as these for the benefit of their inhabitants? I do not say that all flats can be made productive in this way, as I know of many cases where the mere sowing of seed clams will not restock a flat; but I do say that Massachusetts possesses enough flats of the former nature, which should be made a profit to her clammers. Clam set occurs, as Mr. Stevenson shows in his report, in large quantities; the transportation of seed clams is easy; planting requires little labor, the practical way being to sow the clams, which burrow readily; while the yield in proportion to the labor is enormous.

What sized clams are best for planting?

The size best adapted must be determined for each flat. Shore flats with little current will allow the planting of any size, from ¼ inch up; flats with a swift current necessitate a larger clam (1 to 1½ inches), as the smaller will be washed out of its burrow; soft mud also demands a larger clam, as the smaller will be stifled by the oozy silt.

What are the physical conditions that influence the growth of clams?

There appear at least three essential conditions for rapid growth of clams: (1) a good current; (2) low and level flat; and (3) a tenacious soil, relatively free from decaying matter.

A low flat gives the clams longer feeding periods, as the water remains over them longer, therefore there is a greater growth. This has been experimentally shown by Dr. A. D. Mead.

According to Prof. J. L. Kellogg, clams cannot do well in a soil which contains much decaying organic matter, as the acids eat away the shells. Soils of this description also facilitate the spread of infection from one clam to another.

Current is the chief essential for successful clam culture. The term "current" does not imply a rapid flow of water, but rather a good circulation of water over the flat. In the Essex and Ipswich rivers the clam flats have a continuous current. On such flats the growth is more rapid than on flats which have no circulation of water, in addition to the mere rise and fall of the tide. The current performs the work of (1) keeping the flats clean and carrying away all contamination, but its most important work is as (2) *food carrier.*

Value of a Clam Farm. — The value of an acre of clam flats, if properly cultivated, is about $450 per year for the average clam flat. Many of the more productive flats will yield a far greater amount, while others will not yield as much. It has been often erroneously stated that an acre of clam flats would produce $1,000 per year. This is a decided overestimation, as it would be hardly possible for the most productive flat to yield that amount. It is possible, however, for a good flat to yield about $750 per year, but this is only under the most favorable conditions. Such yields as these are large for the clammer, whose average yearly income is only $400 (a few of the more expert clammers make possibly $700 to $750), and a man possessing a clam farm of 1½ to 2 acres would make a good living.

Method of operating a Clam Farm: choosing the Ground. — In choosing a grant, the planter should have in mind three things: (1) the accessibility of the grant, for his own convenience, and nearness to the market, as much of the success of clam farming depends upon the expense of marketing the product, and the ease with which it can be disposed of; (2) the length of time allowed for labor by the exposure of the flat (flats vary greatly in the amount of time exposed each tide, the low flats being submerged nearly all the time, and the high flats having a much longer exposure), — a high flat possesses the advantage of allowing a longer working period for the clammer; (3) the natural facilities of the flat itself as regards the growth of clams. Moreover, the flat should be chosen in regard to (1) soil; (2) current; (3) tide. A good flat should have a soil which is tenacious and compact, affording at the same time easy digging. Probably the best soil is a mixture of fine sand and mud in a ratio of one-third mud to two-thirds sand, as this amount of mud gives the right degree of tenacity.

The growth of a clam depends upon the circulation of water over the flat, as the current carries the food, and, therefore, the more current the more food for the clams. Current also keeps the bed clean, and prevents contamination and disease from spreading among the clams. Then, again, the growth of a clam depends upon the amount of water over the bed; *i.e.*, length of time covered. The clam can only feed when the tide is over the bed, and thus the feeding time is limited for the higher flats. While experiments have shown that clams grow faster when continually under water than when exposed part of the time, the question of tide is not so great a factor as that of current in regard to clam growth, and can be almost disregarded.

The best flat for clam planting is a *fairly high flat* with a *good current* over it, as it gives nearly as rapid growth and a much longer period to dig than a flat which is exposed only a short period. This flat must have the right kind of soil, which must not be shifting sand or too soft mud, but a compact, tenacious mixture.

The Seed Clams. — Nature has provided the means of stocking these farms. The set of clams is usually restricted to certain localities, which, however, vary from time to time, and heavy sets are found in limited areas. These sets run as thick as 2,000 per square foot of surface, occasionally covering an area of 3 acres. From these natural set areas the natural clam flats are partially restocked by the washing out of the small clams. More often these whole sets are wasted, as the clams, instead of washing on the good flats, are carried to unproductive places and consequently perish. Thus there are areas of heavy set which are of no use to any one, as practically all the clams perish before they become adults. These areas of heavy set occur in nearly every harbor of the coast to a greater or less extent, and are available for nearly every town.

The problem now is to make use of these large sets, and not allow them to go to waste. It has been shown that these clams when transplanted will grow much faster, and will not perish; therefore, clam farming offers both the possibility of saving these natural sets and utilizing barren ground.

Methods of spat collecting have been constantly referred to in connection with clam farming, especially by the Rhode Island Fish Commission, and the impression has been given that clam farming can never become a success until some practical method of spat collecting has been found. With the soft clam there is no need of any method of spat collecting, as the natural set is more than sufficient for restocking the barren flats. All that is necessary is to utilize the enormous natural sets. If this is done, the barren flats of Massachusetts can be made productive.

The main difficulty is in devising some method of obtaining the small clams with sufficient rapidity. As the nature of the soil and the size of the clams vary, no one method can apply to every case, and it depends upon the ingenuity of the clammer. The methods used at present are: (1) digging with an ordinary clam hoe, which is slow work; (2) digging in shallow water, so that the clams may be washed out; (3) digging a series of trenches across the heavy set area, and scooping out the clams washed in these trenches; (4) carrying both sand and clams by the dory load; (5) by using a sieve, in the form of a cradle, which washes the clams out in the water. This last method is the most successful for small clams, and has been used by the commission in obtaining seed clams for their experimental beds. By using a cradle 3 by 2 feet, covered with sand wire netting, clams which ran 3,000 per quart, were obtained by 3 men at the rate of 2 bushels an hour, — an amount sufficient to plant from 1/25 to 1/10 of an acre.

Another problem of importance is the transportation of seed clams, as in many instances the clams will have to be carried some distance. The best method of shipping seed clams is to pack them dry in damp sea weed, putting them in small packages, so they will not be crushed by their own weight. The best though most expensive method is to pack the clams in crates, such as are used for strawberries. It has been found that clams kept in water are not in such good condition as those shipped dry, and it is of the utmost importance that the clams be in good condition when planted.

The length of time a clam will live out of its natural element depends upon the temperature; in cold weather it will keep for several days, and even weeks; while in warm weather the seed clam will be in poor condition after one day's exposure.

Preparing the Grant. — Usually the ground needs no preparation, and the clams can be planted at once. It is a good plan to remove any mussels and any of the enemies of the clam from the grant.

Planting the Clams. — The planting of the seed clams is perhaps the easiest work of the clam culturist, as it necessitates merely the sowing of the seed on the surface of the flat. The small clams when left this way burrow into the ground as soon as the water is over them, and require no planting on the part of the culturist.

Working the Farm. — This style of farming requires no cultivation for the growth of the clams. Once planted, the farmer has no further work until the time when he is ready to dig them. The clams grow better when undisturbed than when the soil is upturned by frequent digging. Protection from man and the natural enemies of the clam demand the attention of the owner at all times.

Harvesting the Clams. — The time of digging will vary as to the size of clam desired and the rate of growth on the grant. The clam farmer can cater to a particular trade by regulating the size of the clams marketed. He may find it more profitable to market a small clam after a short period of growth, or *vice versa,* on the same principle that a farmer raises hogs for the market.

North of Boston, in localities favorable for fast growth, such as the Essex and Ipswich rivers, by planting large seed of at least 1½ inches in the spring, marketable clams of 2½ to 3 inches can be obtained in the fall after six months' growth. Here the clams grow only during the summer months, and nothing would be gained by leaving them over winter. In this way a crop each year can be raised on these farms. In other localities of slower growth it will take from eighteen to twenty-four months to raise a crop. The clam farmer will have to regulate the size of the seed and length of growth to best suit the needs of his farm.

Advantages of Clam Farming. — Clam culture possesses several advantages over the old free-for-all digging: (1) steadier returns; (2) easier work; (3) better pay; (4) more clams per man. If the clammers of the Commonwealth only realized these facts they would make a united effort toward clam culture.

History.

I. *Early History.* — The history of the Massachusetts clam industry began in obscurity. Even before the time of the earliest settlers the native Indians depended largely upon this abundant mollusk for their food supply, as is clearly indicated by the scattered shell heaps which mark their ancient camp fires. Upon the arrival of the Pilgrims, clam digging was incorporated among the most time-honored industries of the Commonwealth, and in times of want the early colonists depended largely upon this natural food supply. With the arrival of the colonists really began the first epoch of the clam fishery as an economic factor in this Commonwealth, a period which lasted nearly two hundred years. This period marked the exploitation of clam grounds merely for home consumption. Money was scarce, inland markets were practically unknown, and the importance of this shellfish was confined merely to local quarters.

II. *Rise of the Bait Industry.* — Early in the last century a growing demand for clams as bait for the sea fisheries became apparent. Clams had always been utilized for this purpose more or less, but an increased demand called for the development of an important industry in this line. Various centers of activity were established, particularly at Newburyport, Essex, Ipswich, Boston harbor and Chatham. The clams were mainly shucked, that is, removed from the shell, and shipped either fresh or salted in barrels to the fishermen at Gloucester, Boston and Provincetown. This industry opened up new fields of employment for many men and boys, and brought considerable ready money into various coast communities.

III. *The Development of Inland Markets.* — The consumption of clams for food in the coast towns continued throughout the rise and gradual decline of the bait industry, but the creation of inland markets did not begin to be an important factor until 1875. It was about this time that the clam came to be generally looked upon throughout the State as an article of food, and consequently an important industry was gradually evolved to meet this growing demand. This step marked the beginning of the extensive fishery of the present day.

The mistaken policy of the average shellfish community, which regarded clam grounds as natural gardens of inexhaustible fertility, still persisted even after the fallacy of this policy had long proved apparent through the depletion of extensive tracts. The same ill-advised methods were pursued to the ultimate ruination of much valuable territory. All wise regard for the future was overshadowed by the immediate needs of the present; local legislation fostered the evil; State legislation was conspicuous by its absence; and, left to the mercy of unsystematic overdigging, these natural resources rapidly wasted away.

The disastrous tendencies which have lurked in the ruling policy of the clam fishery have been shown in the rise and fall of the industry in certain localities. Forty years ago Duxbury and Plymouth ranked as the greatest clam towns of the coast. Their supply has long since become insignificant. Newburyport and Ipswich have become the chief producers of the State clam harvest; but Essex and Gloucester, in the same fertile regions, have greatly declined, and the industry at Rowley has become nearly extinct. In the Fall River district the digging of small seed clams for food has brought the fishery to the verge of ruin. The few resources of Buzzards Bay have become nearly exhausted, while on Cape Cod the industry has shown here and there a temporary increase, overshadowed by a far more extensive decline, such as at Chatham. Furthermore, the sewage contamination of coast waters in the harbors of Boston and several other large cities have closed extensive regions for the production of food.

IV. *Attempts to develop the Industry.* — Various efforts have been made to restrain overdigging the clam flats, by local regulations, particularly by "close" seasons. These attempts have been productive of little good. Other efforts, designed to develop extensive tracts made barren by wasteful methods of fishing, have been put in operation. These efforts have been along two independent lines: the first, an effort on the part of the community to seed in common flats by the appropriation of money for that purpose, as in the case of Wellfleet; the second, an attempt to arrive at the same end by leasing private grants to individuals, as at Essex and Plymouth. These efforts, while tending in the right direction, have not as yet yielded the results that might be wished for. Within the past three years the State has taken hold of the problem, and by an extensive series of experiments is endeavoring to devise practical means of developing the great inherent possibilities in this extensive industry.

CLAM PRODUCTION TABLE FOR MASSACHUSETTS, OBTAINED FROM THE REPORTS OF THE UNITED STATES FISH COMMISSION.

YEAR.	Bushels.	Value.	Price per Bushel (Cents).
1880,	158,626	$76,195	41.73
1887,	230,659	121,202	52.54
1888,	243,777	127,838	52.44
1889,	240,831	137,711	57.14
1892,	191,923	133,529	69.57
1898,	147,095	102,594	69.74
1902,	227,941	157,247	68.98
1905,	217,519	209,545	96.19

The Clam Industry.

Methods of Digging. — The ordinary method of taking clams is so simple as hardly to need explanation. Although simple, clam digging requires considerable skill, and it takes years of experience to become a good clammer.

There are two methods of clam digging used in Massachusetts, — the "wet" and the "dry" digging. Wet digging is carried on when water is over the clam beds; dry digging, which is the common method, takes place when the flats are left exposed by the tides. The only places in Massachusetts where wet digging is carried on regularly are Eastham, Chatham, Swansea, and in Katama Bay, Edgartown. In the lower end of Katama Bay is found a submerged bed of clams which is one of the most productive beds of this class in Massachusetts. These submerged clams are taken with what is known locally as a "sea horse," which is an enlarged clam hoe, with prongs 12 to 14 inches long, and a strong wooden handle four feet in length. This handle has a belt attachment which is buckled around the clammer. Two men are required for this work. The sea horse is worked deep into the loose sand and is dragged along by one man, who wades in the shallow water over these submerged flats, while his partner follows, gathering the clams which the sea horse roots out. Another method of wet digging is called "churning," and is based on the same principle as the above method, only the clams are turned out under water by long forks or hoes. This method is not used in Massachusetts to any extent. Excellent results are usually obtained from wet digging.

The methods used in dry digging depend upon the nature of the soil. The difference lies only in the kind of digger. The clam hoe of the south shore, where the soil is either coarse sand or gravel, has broad prongs, some even being 1¼ inches across. The usual number of prongs is four, but occasionally three broad prongs suffice. The clam hoe of the north shore, often called "hooker," has four thin, sharp prongs and a short handle. The set of this handle is a matter of choice with the individual clammers, some preferring a sharp, acute angle, and others a right angle. This style of clam hoe is best suited for the hard, tenacious clam flats of the north shore. At Essex spading forks are used for clamming, but not as extensively as the hooker. For sand digging the forks are said to be better, while for mud digging the hooker is preferred.

Outfit of a Clammer. — The outfit of a clammer does not require much outlay of capital. A skiff or dory, one or two clam hoes and three or four clam baskets complete the list. Occasionally, as at Ipswich, where the clam grounds are widely scattered, power dories are used, and this necessitates the investment of considerable capital; but the investment of the average clammer does not exceed $26. Personal apparel, such as oilskins and boots, are not considered under this head.

CLAMMING OUTFIT.

Skiff dory,	$22 00
Two clam diggers,	1 50
Four clam baskets,	2 00
Total,	$25 50

The boats most often used by the north shore clammers are called "skiff dories," and in construction are between a dory and a skiff. These boats are especially adapted for use in rivers.

Marketing. — Clams are shipped to market either in the shell or "shucked out." Two rules are followed by the clammers in making this distinction: (1) small clams, or "steamers," are shipped in the shell, especially during the summer months, while the large clams are "shucked;" (2) the fine-appearing sand clam is usually sold in the shell, while the unprepossessing mud clam is shucked, *i.e.,* the shell and the external covering of the siphon or neck are removed. This causes on the north shore a division by locality. The Ipswich and Essex clams, except for a few individual orders, are mostly shipped to market in the shell, while the Annisquam River and Newburyport clams are usually shucked in the winter. Little if any shucking is done by the south shore clammers.

Shucking almost doubles the value, as a bushel of clams, worth in the shell 75 cents, will furnish, when soaked, about 10 quarts of shucked clams, which bring about 50 cents per gallon, or a total of $1.25 when marketed. The shucked clams are put through a process of soaking in the same way the scallop "eyes" are treated before marketing. They absorb a sufficient quantity of fresh water, after soaking six hours, to increase their bulk about one-third and give a plump appearance to the clams.

While many clammers do not soak their clams, it seems to be a universal tendency, wherever clams are shucked, to gain by this method.

Soaking of any sort impairs the flavor of the clam, and for this reason such a practice is to be deplored, but as long as the consumer is satisfied to take second-rate goods, this practice will continue, and it can be stopped only by the united demand of the shellfish dealers.

Shipment. — Second-hand flour and sugar barrels are used for the shipment of clams in the shell, while kegs and butter tubs hold the shucked clams. In winter clams can be shipped inland without perishing; but in hot weather they will spoil in a few days, unless iced.

Maine Clams. — Massachusetts annually consumes many thousand barrels of Maine clams. If the demand of the Boston market were not partially met by the influx of Maine clams, the clam flats of Massachusetts would be subject to a greater drain.

Market. — The principal market for the clam industry of Massachusetts is Boston. Gloucester, Newburyport, Salem and Lynn draw part of the clam trade of the north shore, but the greater portion goes to Boston, whence it is distributed throughout the State. In recent years shipments have been made from the Ipswich Bay region direct to New York, Baltimore and Philadelphia.

Price. — The price of clams is fairly constant, varying but little in summer and winter. Naturally, this seems curious, when winter and summer clamming are compared. The production in winter is much smaller than in summer, which is due to (1) fewer clammers, because of the severe work in cold weather; (2) less working days, as the clammer is often unable to dig for weeks, and even months, and also cannot work early or late tides, as in summer. In spite of this diminution of supply, the winter price is practically no higher. This is due to a smaller demand in winter, as well as to the influx of the Maine clams at this season. In summer there is an increased demand for clams, caused by the arrival of the summer people at the seashore; and large quantities of this shellfish are used by hotels, cottages, etc. This increase in demand is enough to offset the increase in supply, resulting in a stationary price.

The price varies as to the quality of the clams, whether soaked or unsoaked, small or large, good or poor looking shells, and fresh or stale. The average price as received by the clammer for clams in the shell is 75 cents per bushel; shucked clams, when soaked, 45–50 cents per gallon.

Arrangement of Towns.

Owing to the peculiarities of the different localities, it has been impossible to satisfactorily arrange the towns alphabetically. Therefore, in order to present local comparisons, they have been arranged in geographical order, starting at the northern boundary of the State.

Salisbury.

Salisbury, the most northerly town in the State, has a good clam territory, very similar to that of Newburyport, though much smaller in area.

Almost all the clam ground, and practically all the very good digging, is comprised in a single flat, which extends along the northerly bank of the Merrimac for nearly 2 miles. This flat is about 900 feet wide, on an average, and has a total area of 216 acres. On the eastern end, and skirting the channel, it is sandy; but for the most part it is mud throughout, varying from a hard, smooth surface in the middle portion to a soft, scummy soil on the west.

About 100 acres in the central section of this flat are covered with a thick set of clams, especially from 1 to 2 inches. This territory furnishes the bulk of the good digging, and is being constantly turned over and the larger clams sorted out. Roughly speaking, the main east half of the flat is sandy, or hard mud, with very good clamming, the western half softer mud, with fair or scattering clams. This is an exceptionally fine natural clam flat, and if properly cultivated its production would be immensely increased. At the eastern extremity of the flat a long, narrow cove extends in a general northerly direction into the main land. This cove, including the outer fringing bars, contains some 34 acres of flats, for the most part sandy and rather poorly productive, though no considerable area is anywhere strictly barren. The combined clam flat territory of the town aggregates 250 acres, comprising 150 acres of good clamming and 100 acres of scattering clams; of these, 216 acres are of mud and 34 acres of sand.

While the town records show 66 licensed clammers, only about 50 make clamming their chief occupation. The industry is carried on in much the same manner as at Newburyport; $625 is invested in boats and implements, and some 15,000 bushels of clams, aggregating $16,500, are annually produced.

The clam industry at Salisbury is largely stationary as regards available territory, while the production varies considerably from year to year. There is little or no town legislation affecting the industry, except the issuing of permits by the selectmen. These permits cost 25 cents, and are required from every clammer.

Summary of Industry.

Number of men,	66
Capital invested,	$625
Production, 1907: —	
Bushels,	15,000
Value,	$16,500
Total area (acres): —	
Sand,	34
Mud,	216
Gravel,	–
Mussels and eel grass,	–
Total,	250
Productive area (acres): —	
Good clamming,	150
Scattering clams,	100

Barren area possibly productive (acres),	–
Waste barren area (acres),	–
Possible normal production,	$70,000

Newburyport.

Newburyport is pre-eminently the clam town of Massachusetts. It produces the most clams, gives employment to the most men, and has on the whole the finest flats.

The total clam-growing area of this town comprises about 1,080 acres; of this, some 800 acres are more or less productive, while the balance, 280 acres, is practically nonproductive. Scattering clams exist everywhere, so there are, properly speaking, no truly barren flats.

The flats of Newburyport, broad, level and continuous, are peculiarly adapted to clam culture. The general type of soil is mud, varying from a soft, sticky variety on the west coast, and also along the shores of Plum Island, to a firm, hard surface in the great middle section north of Woodbridge's Island, where clams flourish most abundantly and furnish the best digging within the city limits. Here nearly 100 acres are covered with a heavy set of 1 to 2 inch clams. Altogether there are some 930 acres of this mud. Much of this, especially to the west and south, is apparently unfavorable to clams, being soft and unwholesome, but even here at certain seasons clams are dug extensively.

The sand flats include the shifting Hump sands that fringe the Merrimac channel and the Cove on Plum Island. These and other minor sections comprise about 150 acres. The Hump sands are quite productive. The other sand flats are not entirely barren, but practically unutilized.

The clam industry at Newburyport furnishes employment for about 175 men, although over 200 depend upon it for some portion of their income. The season lasts the year round, though on account of storms and ice the winter's work is rather uncertain. A good fisherman will, under favorable circumstances, dig several bushels of clams at a tide, though the ordinary man will probably not average more than a bushel and a half, taking the whole year into account.

The outlay of capital invested is comparatively small. A flat-bottom boat or dory, a clam hoe or two, and three or four wire-bottom baskets, constitute a clammer's outfit, costing altogether perhaps $15 or $20. As two or more men frequently go in one boat, even this expenditure may be reduced. The shore property in use, consisting of from 8 to 10 shanties, is also inconsiderable. Several power boats are used, however, and their added cost brings the aggregate money invested up to about $2,700.

The flats of Newburyport are a large factor in its economic wealth. During 1907 they produced nearly 55,500 bushels of clams, exceeding $61,000 in value. Nearly two-thirds of these clams were shucked, that is, removed from the shell and sold by the gallon. In this form, usually soaked to increase their volume, they retail for about 45 cents per gallon. As clams in the shell, sold for "steamers," etc., will hardly bring more than 65 cents per bushel, the process of shucking nearly doubles the value to the fisherman, as a bushel of clams in the shell will produce from 2 to 3 gallons of soaked clams. The income of the average clammer will hardly exceed $350 per year, but a really energetic and industrious fisherman may in the same time make from $500 to $700, or even more. Many of the men have individual orders from dealers in Lynn, Haverhill and the neighboring cities, while the local dealers ship largely to Boston.

The regulation of the industry by city ordinance is of very little note. Practically the only legislation pertaining to it is the law which requires every clammer to have a permit, but even this regulation is but indifferently enforced. The Newbury flats are likewise free to the Newburyport clammers, and part of the Newburyport production comes from these outside flats.

The history of the clam industry at Newburyport is one of constant change. Twenty years ago large areas on southwest Joppa were practically barren; now they are quite productive. The reverse is true of Ball's flat on Plum Island, which, though once of great importance, is now almost waste. Though no serious inroads have as yet been made, a slow but steady decline in the industry is distinctly noticeable.

COMPARISON OF 1907 WITH 1879 (SALISBURY AND NEWBURYPORT).

YEAR.	Production (Bushels).	Value.	Men.	Capital.	Price per Bushel.
1879,	28,800	$11,520	60	$750	$0 40
1907,	70,500	77,500	241	3,325	1 10

SUMMARY OF INDUSTRY.

Number of men,	175
Capital invested,	$2,700
Production, 1907: —	
Bushels,	55,500
Value,	$61,000
Total area (acres): —	
Sand,	150
Mud,	930
Gravel,	–
Mussels and eel grass,	–
Total,	1,080
Productive area (acres): —	
Good clamming,	800
Scattering clams,	280
Barren area possibly productive (acres),	–
Waste barren area (acres),	–
Possible normal production,	$250,000

Newbury.

The town of Newbury has in itself no shellfish industry, although there is an extensive area of suitable flats which are worked with equal rights by the Newburyport clammers. These flats comprise some 360 acres, and extend along both sides of Plum Island Sound and Parker River. Over 100 acres of scattering clams occur, though not in sufficient quantities for the most part to make very profitable digging. The remainder, some 260 acres, though almost all suitable for the production of large quantities of clams, is practically barren.

The principal type of soil is mud, and the mud flats comprise about 250 acres. The flats of Parker River and those in its immediate neighborhood, however, are largely sand, and altogether they aggregate about 110 acres. Of these, "the thoroughfare" is practically the only one which furnishes clams in any quantity. Sections of the broad flats which border on Plum Island Sound produce scattering clams of large size. There is, however, no very good digging in town, and no consistent effort seems ever to have been made to utilize the great wealth which lies dormant in the clam flat territory. Six Newbury men dig intermittently in the summer, and furnish some 300 bushels, worth about $250, for town trade. However, this does not take into consideration the amount taken from these flats by the Newburyport clammers.

Summary of Industry.

Number of men,	6
Capital invested,	$75
Production, 1907: —	
Bushels,	300
Value,	$250
Total area (acres): —	
Sand,	110
Mud,	250
Gravel,	–
Mussels and eel grass,	–
Total,	360
Productive area (acres): —	
Good clamming,	–
Scattering clams,	100
Barren area possibly productive (acres),	260
Waste barren area (acres),	–
Possible normal production,	$40,000

Rowley.

Rowley presents a more striking example of the decline in the shellfish industry than any other town in this region.

Four hundred acres of good flats border Plum Island and Rowley River within the town limits, but of these only 20 at most are economically productive. Eighty acres more are not entirely barren, though practically worthless, while the remaining 300, though almost all well adapted for clam culture, are barren.

The main type of soil is sand, and the sand flats, for the most part in Plum Island Sound, comprise some 250 acres. The remainder, 150 acres, is mostly mud in scattered sections along the Rowley River and in patches on the main flats. The only really productive flats are the little coves and creeks of Rowley River and the Knob Reefs in Plum Island Sound. The Knob Reef clam grounds produce very large and fine clams, which lie on the lower edge of the flat and are exposed only a short time every tide. Knob Reefs also has the distinction of possessing probably the finest clam set of its size in the State, which would furnish abundant opportunity for restocking all the barren Rowley River flats, if the town authorities had taken proper measures to transplant this seed. As it is, this extensive set, too thick for good growth, is rapidly wasting away.

The history of the industry is one of steady decline. Reliable evidence exists to show that almost all the flats of Rowley once produced clams, and that large areas now waste were formerly productive. That these immense barren areas, possessing such an enormous latent wealth, should be allowed to remain thus unimproved, is a most conclusive argument for the need of radical action. No settled attempt, however, except for a single closed season in 1906, has ever been made by the clammers or town authorities to better the conditions, or to check the decline in the productive territory that remains.

Summary of Industry.

Number of men,	15
Capital invested,	$800
Production, 1907: —	
Bushels,	2,000
Value,	$1,500
Total area (acres): —	
Sand,	250
Mud,	150
Gravel,	–
Mussels and eel grass,	–
Total,	400
Productive area (acres): —	
Good clamming,	20
Scattering clams,	80
Barren area possibly productive (acres),	300
Waste barren area (acres),	–
Possible normal production,	$60,000

Ipswich.

Ipswich is second only to Newburyport in the production of clams, and has perhaps even greater possibilities of development. The clam territory of the two towns, while nearly equal in extent, is, however, markedly different in general characteristics. The flats of Newburyport, while few in number, are broad, continuous, and have a great degree of similarity throughout. The flats of Ipswich, on the other hand, are divided into a great number of relatively small sections, widely diversified in character, and scattered along an extensive coast line. As these flats are in many respects the most interesting and important of any town in the State, it seems well to examine them in detail.

Four distinct divisions can be distinguished in the clam territory of this town: Ipswich River, Plum Island, Green's Creek and Roger Island, and Essex River flats.

Taken in the order named, the Ipswich River has in itself a great variety of clam ground. Both sides of the river for nearly 3 miles are fringed with bars, mainly of mud though sandy near the mouth. Some of the mud flats are so soft that they are practically barren, or given up largely to mussel beds; while much of the sand, as, *e.g.*, the main portion of the High Sands, is too shifting to be valuable. The larger part of these river flats are, however, productive.

The Plum Island division comprises Lufkins, Point Peter, Appletons, Foresides and several other minor flats. Of these, Lufkins is very important. It occupies a semicircular depression on the coast of Plum Island, and, owing to its peculiar location, the swift current which flows past its outer edge makes a double eddy at both ebb and flood tide. These eddies sweep gently over its broad surface, and deposit a fine silt which has made the characteristic soil a hard, bluish clay. This is the only important clay flat of this region. The total area of Lufkins is 46 acres. The outer border to the north is mud, becoming soft; to the south, sandy. The portion near shore is, as has been stated, a clayey soil, and it is here that clams are found abundantly. An exceptionally good set of 1 to 2 inch clams occupies from 3 to 4 acres of this portion. Though clams are numerous, the exceeding hardness of the soil makes digging rather difficult.

Point Peter, or "P'int" Peter, is also an important flat, comprising altogether 28 acres, though about 7 acres of the outer portion extend far into the current, and are of so shifting and sandy a nature as to be practically worthless. Most of the remainder is mud, varying from sand and hard mud on the outside to soft mud in the creeks that lead into the main land. The central portion of the flat is peculiarly adapted to the culture of clams, however, and is very productive.

Appleton's flat comprises about 6 acres of hard sand, verging into mud, thickly strewn with old clam shells. It lies at the mouth of Perkins and Pine Creeks, which run for about a mile into the main land of Plum Island, and contain nearly 25 acres each of fairly productive mud flats. Appleton's is a valuable flat, and the clams dug here are large.

The Foresides is a thatch island a little over a mile in length, lying in the mid channel of Plum Island Sound. The flats which surround it on all sides are practically all sand, and comprise about 80 acres. The whole western side is more or less productive, though the outer edge, where the strong cross currents of the channel sweep over, is too much rippled to be suitable for clam growth. The strip of sand along the northern and northeastern sides, though rather narrow and limited in area, is productive, while most of the southeastern portion, which projects far into the channel, is barren and totally unadapted for soft clams, though bedded with sea clams. The productive sections of this flat are much dug, and altogether it is one of the most important of the Ipswich clam grounds.

The west coast of Plum Island Sound, comprising the Green's Creek and Roger Island territories, extends from the Ipswich to the Rowley rivers. This division contains the bulk of the waste and barren flats of the town, although there is exceptionally good clamming in Stacy's Creek, Third Creek and the "Nutfield."

The Essex River region is rather remote for most of the clammers, and hard to reach, but furnishes on the whole some of the very best digging. The three main flats of this division are the Essex beach, Wheeler's, and the Spit. Essex beach has a very good set, evenly sprinkled over the ridgy, shifting bars that skirt the channel.

Wheeler's is an irregular sand bar, occupying about 77 acres. Fully one-half of this is very productive, and in the main portion occurs another thick set very similar to that on Essex beach.

The Spit, mainly sand or sandy mud, lies in the three towns of Ipswich, Essex and Gloucester. The whole area is some 300 acres, about a third lying within the town of Ipswich. This whole bar is so liable to change that any calculations based on its precise area or location are decidedly unreliable. Very good digging occurs, however, in limited areas on the north and west sides of the Ipswich territory.

These four divisions comprise the clamming territory of Ipswich, and aggregate 970 acres, of which 390 acres is sand and 500 mud. This also includes 15 acres of mussels scattered along Ipswich River, Plum Island and Green's Creek region, and about 10 acres of eel grass in various localities. Over 800 acres is more or less productive, about half being good clamming.

About 50 regular clammers depend upon these flats for a living, though 136 permits were issued in 1907. Here, owing to the greater distances to be traversed, many power boats are used. Nearly $7,500 is invested in the industry, and 25,000 bushels of clams, at a valuation of $18,750, are annually produced. The relative decrease in price as compared with Newburyport is due to the fact that shucking is not so extensively practised here.

The town laws merely require a permit from every clammer, for which no charge is made. Such permit is issued at the discretion of the selectmen, and requires of the recipient six months' residence in the town and two years in the State. In past years the town has made several by-laws for the protection of shellfish, chiefly in the nature of partial closed seasons; but unfortunately considerable difficulty has been found in enforcing these excellent laws, and the results have been far from satisfactory.

Ipswich has jealously guarded the rights of its clam flats, and has protected them in every way from the invasion of outsiders, which in part accounts for the excellent condition of these flats, which were originally deeded to the Commoners by the Crown, and from them to the town. Ipswich is the only town in the Commonwealth which has thus directly received its clam flats as its own property, and naturally has done more to improve its natural clam resources than any other town in the State.

The history of the industry shows little change; some few flats once considered worthless have been opened and utilized; others once productive have been dug out and allowed to become waste. On the whole, the industry is following the trend of the shellfisheries everywhere, and slowly but steadily declining.

SUMMARY OF INDUSTRY.

Number of men,	136
Capital invested.	$7,500
Production, 1907: —	
Bushels,	25,000
Value,	$18,750
Total area (acres): —	
Sand,	390
Mud,	500
Gravel,	55
Mussels and eel grass,	25
Total,	970
Productive area (acres): —	
Good clamming,	400
Scattering clams,	420
Barren area possibly productive (acres),	125
Waste barren area (acres),	25
Possible normal production,	$200,000

Essex.

Essex, while still ranking as an important clam-producing town, has a very imperfect development of her shellfish resources. The total clam flat area comprises some 650 acres, and, though scarcely more than 25 acres can be considered as unfit for the growth of clams, and consequently barren, only a little more than half the remainder is at all productive, and of this probably less than 150 acres yields any financial return. In other words, 325 acres of good clam flat is allowed to remain practically barren.

The main type of soil is sand, and nearly 500 acres may be properly classed under this head. The remaining 150 acres are mud, and are located in the creeks along the river and in the coves north of Hog Island. The productive sections are scattered for the most part along both sides of the Essex River, and well-developed areas are also found at its mouth and on the Spit. There are several good locations of seed clams. One section of about 25 acres occurs on the west side of the Spit. This is composed of 1 to 2 inch clams, running 10 to 40 per square foot. At the mouth of the river on the north side occurs another set of ½-inch clams, covering about 10 acres. On the flats west of Cross Island is found a third set of ½ to 2 inch clams, comprising about 30 acres. Other smaller patches of set are scattered along the river almost up to its source.

About 50 men derive an income from these flats. Some $1,200 is invested, and the annual product exceeds 15,000 bushels, valued at $12,750.

The town of Essex has realized the importance of the clam problem, and has attempted through legislation to deal with it. The selectmen are empowered to grant to citizens of the town an area consisting of an acre or less on flats already barren, for the purpose of raising clams, and in this manner partially restock the flats. A rental of $2 is charged, covering a period of five years, and an additional fee of 50 cents is required for recording. In spite of inadequate protection, the experiment has been conducted long enough to prove that these flats can be made profitable to the clammers.

The history of the clam industry at Essex is one of extensive decline. There is every reason to believe that the greater part at least of the waste area was once very productive. Prof. James L. Kellogg in the United States Fish Commission Bulletin for 1899, says: —

> We have much evidence that the clam industry in Essex has, in the past, been extensive. . . . Much more testimony of a similar character may be had to show that the flats once very productive have almost entirely failed.

COMPARISON OF 1907 WITH 1879.

	1879.	1907.
Production (bushels),	,500	15,000
Value,	$4,500	$12,750
Men,	75	50
Capital,	-	$1,200
Price (cents),	40	85

SUMMARY OF INDUSTRY.

Number of men,	50
Capital invested,	$1,200
Production, 1907: —	
Bushels,	15,000
Value,	$12,750
Total area (acres): —	
Sand,	500
Mud,	125
Gravel,	–
Mussels and eel grass,	25
Total,	650
Productive area (acres): —	
Good clamming,	150
Scattering clams,	150
Barren area possibly productive (acres),	325
Waste barren area (acres),	25
Possible normal production,	$120,000

Gloucester.

The far-celebrated deep sea fisheries of Gloucester overshadow her humble shellfish industry; but within her tidal flats lie undeveloped resources, which if properly brought out would form no inconsiderable factor in her annual revenue. Even now her clam fishery attains considerable proportions, though by no means what it once was, or what it might be were suitable cultural methods employed.

The main areas of clam-producing territory lie in the Annisquam River and in the Essex River in West Gloucester. The grounds in the Annisquam are the more productive. This river is some 4 miles long, and is bordered for the greater part of this distance with tidal flats. Of these the sand flats predominate, though there are large areas of mud and extensive beds of mussels. On the extreme head of the river, known as the Dumfudgeon region, dredging operations for the Gloucester canal have somewhat impaired the flats, but as a whole the river seems in every way suitable for the production of an abundant harvest of clams.

The flats of West Gloucester, including a portion of the Essex Spit, are largely unproductive. The Spit is the only flat of any extent in this region which is at present of real economic value; the remaining flats, scattered along the south shore of the Essex River and its tributary creeks, are for the most part practically barren.

The total area of clam flats in Gloucester approximates 550 acres. Of this, some 250 acres are sand, 200 mud, while there are about 100 acres of mussels and eel grass, which cannot be considered at all adapted for clam culture. Only a fraction of the whole, 75 acres, more or less, is good clamming; a scant 100 acres produces scattering clams; 275 acres are barren, though capable of producing clams; while 100 acres may never be made productive.

Eight men dig regularly on these flats the year round, and 23 others work intermittently. The capital invested amounts to over $600, and the annual output exceeds 6,000 bushels, valued at $8,000. Most of the clams produced at Gloucester are shucked either for market or bait.

Local legislation has no bearing on the shellfish question, and no effort is being made either to better conditions in the clam industry or to check its steady decline.

The industry has fallen off greatly in the past few years. In 1875 there were 90 regular clammers, and a man could dig 6 bushels to a tide, where now 8 regular and 23 intermittent clammers find it difficult to get from 1½ bushels to 3 bushels per tide.

Comparison of 1907 with 1879.

YEAR.	Production (Bushels).	Value.	Men.	Capital Invested.	Price.
1879,	13,978	$5,200	92	$2,000	$0 40
1907,	6,000	8,000	31	600	1 33

Summary of Industry.

Number of men,	31
Capital invested,	$600
Production, 1907: —	
Bushels,	6,000
Value,	$8,000
Total area (acres): —	
Sand,	250
Mud,	200
Gravel,	–
Mussels and eel grass,	100
Total,	550
Productive area (acres): —	
Good clamming,	75
Scattering clams,	100
Barren area possibly productive (acres),	275
Waste barren area (acres),	100
Possible normal production,	$70,000

Manchester.

Manchester has a coast line so much exposed, and consequently so small a territory of tidal flats, that it is not surprising to find its clam industry of very insignificant proportions. Affairs are in much the same state of apathy as at Beverly, though Manchester does not possess the resources of the former town, and could not, in the nature of the case, carry on any extensive clam business. Its facilities, however, poor as they are, are very imperfectly utilized; hence the present state of depletion, verging on absolute exhaustion.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	100
Value,	$100
Total area (acres): —	
Sand,	10
Mud,	10
Gravel,	–
Mussels and eel grass,	–
Total,	20
Productive area (acres): —	
Good clamming,	–
Scattering clams,	5
Barren area possibly productive (acres),	10
Waste barren area (acres),	5
Possible normal production,	$2,000

Beverly.

Beverly has practically no clam industry. The area of tidal flats, comprising nearly 50 acres, is at present unprofitable and nearly worthless. As at Swampscott, some clams still continue to be dug for bait and for local clam bakes, but any evidence of a systematic business has long ceased to exist. Thirty years ago clams were far more abundant, though there was never an extensive industry. The town authorities require no licenses and make no efforts to revive the industry.

SUMMARY OF INDUSTRY.

Number of men,	-
Capital invested,	–
Production, 1907: —	
Bushels,	100
Value,	$100
Total area (acres): —	
Sand,	30
Mud,	20
Gravel,	–
Mussels and eel grass,	–
Total,	50
Productive area (acres): —	
Good clamming,	–
Scattering clams,	10
Barren area possibly productive (acres),	30
Waste barren area (acres),	10
Possible normal production,	$5,000

Salem.

Salem has far better natural advantages for clam culture than the other towns in its immediate vicinity, and leads in clam production, though the industry is of very inferior proportions. Seven men are at present employed in digging the harbor flats, where the clams have very recently seeded in. Many of these clams, though rather small, are shucked, and the remainder are sold in the local markets. The entire value of the annual production does not exceed $200, and the capital invested amounts to but $75. This is rather poor showing for 100 acres of flats for the most part comparatively good, and capable of yielding $11,000 annually. The Salem clammers dig also in the Danvers River in the town of Danvers.

SUMMARY OF INDUSTRY.

Number of men,	7
Capital invested,	$75
Production, 1907: —	
Bushels,	200
Value,	$200
Total area (acres): —	
Sand,	75
Mud,	25
Gravel,	–
Mussels and eel grass,	–
Total,	100
Productive area (acres): —	
Good clamming,	5
Scattering clams,	10
Barren area possibly productive (acres),	70
Waste barren area (acres),	15
Possible normal production,	$11,000

Lynn.

The city of Lynn has within its tidal flats the latent resources of an important industry. Its clam grounds could, if properly utilized, yield a great increase over their present inconsiderable return. No legislation on the part of the city authorities has intervened to improve the shellfish production or to prevent the depletion of valuable territory which has been allowed to gradually lapse into an unsanitary desert. While at low tide about 400 acres of flats spread over the broad harbor or border the banks of the Saugus River, but 40 acres of this wide expanse yield any appreciable revenue. The principal part of the digging is done on the mud flats of the Saugus River. Here 7 fishermen work intermittently to supply the local market during the summer months. There is some good territory at the mouth of the river toward the north, and scattering clams occur along the eastern shores, but the main flats of the harbor are for the most part barren.

The deposit of sewage from the city drainage has undoubtedly had a prejudicial effect on much of this area, as the unpleasing scum which covers the soft, sticky mud and eel grass bears abundant witness. Whether measures undertaken to reclaim this lost area would in the long run yield profitable returns is an undecided question, but much might be done, by the employment of judicious cultural methods, to increase the yield of those flats which are properly productive. No exact returns of the annual clam harvest for this region are obtainable, as most of the output is disposed of at retail, but it cannot exceed 1,000 bushels, and probably falls far short of that figure; $1,000, then, or thereabouts, represents the total monetary income from this fishery.

SUMMARY OF INDUSTRY.

Number of men,	7
Capital invested,	$100
Production, 1907: —	
Bushels,	1,000
Value,	$1,000
Total area (acres): —	
Sand,	90
Mud,	300
Gravel,	5
Mussels and eel grass,	5
Total,	400
Productive area (acres): —	
Good clamming,	10
Scattering clams,	30
Barren area possibly productive (acres),	160
Waste barren area (acres),	200
Possible normal production,	$26,000

Saugus.

At Saugus conditions in many respects parallel those at Lynn. The clam grounds, while they by no means equal those of the neighboring city in area, are on the whole better, as they are freer from contaminating sewage. Of the 250 acres which comprise the normal tide flat area, only 100 acres, or 40 per cent., can be said to be strictly barren. The remaining 150 acres is an undeveloped asset, as its value lies far more in its prospects than in its present productivity. While scattering clams occur throughout, no more than 25 acres can be accounted paying property. This remunerative territory lies chiefly in the Saugus River and in the vicinity of the Point of Pines. Here 10 men dig quite regularly, particularly in the summer, though none of them depend wholly upon this source of revenue for a livelihood. The annual output equals that of Lynn, both in amount and valuation. To these flats, with their undeveloped resources, local legislation gives practically no attention.

SUMMARY OF INDUSTRY.

Number of men,	10
Capital invested,	$100
Production, 1907: —	
Bushels,	1,000
Value,	$1,000
Total area (acres): —	
Sand,	100
Mud,	150
Gravel,	–
Mussels and eel grass,	–
Total,	250
Productive area (acres): —	
Good clamming,	10
Scattering clams,	40
Barren area possibly productive (acres),	100
Waste barren area (acres),	100
Possible normal production,	$22,000

Nahant.

Although Nahant has a large area of tidal flats, it is not on the whole favorably located, and much that would otherwise be available is necessarily waste. The territory which borders the western coast is not barren, but most of it is not productive enough to be profitable.

A few scattered sections repay the clammer for his labor, and from these sections perhaps 300 bushels a year are dug for home consumption. Four or five men are employed at intervals in the summer months, but no one of them depends upon this source of income for more than transient employment, as the entire value of the yearly harvest does not exceed $300. As there are nearly 250 acres of flats in Nahant, this would be a revenue of $1.60 per acre, on an average. However, this is not a fair comparison, for much of the territory apparently available is, as has been stated, properly waste. Nevertheless, an industry of far greater proportions than at present could be attained if wise legislation were directed to that end.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	300
Value,	$300
Total area (acres): —	
Sand,	50
Mud,	100
Gravel,	100
Mussels and eel grass,	–
Total,	250

Productive area (acres): —	
Good clamming,	–
Scattering clams,	50
Barren area possibly productive (acres),	150
Waste barren area (acres),	50
Possible normal production,	$25,000

Boston Harbor.

Owing to the danger arising from sewage contamination the State Board of Health, on Dec. 6, 1906, requested the Department of Fisheries and Game to prohibit the digging of clams for market in Boston harbor. The region closed by this law lies to the west of an imaginary line running from Point Shirley through Deer Island to the northeastern end of Peddocks Island; thence in a southwesterly direction to the extreme point of Hough's Neck. This territory includes Winthrop, Chelsea, Charlestown, Everett, Somerville, Cambridge, Boston, East Boston, South Boston, Dorchester, Neponset and Quincy. For convenience all the prescribed territory is treated under the head of "Boston harbor."

The action of the State Board of Health in closing Boston harbor was necessitated by a due regard for the public health, as it seemed inexpedient to allow clams dug from this territory and subject to sewage contamination to be marketed for food. Necessary as this act may have been, the closing of 5,000 acres of flats for the production of edible shellfish made valueless an important source of revenue, and threw a large number of clammers out of employment. Some alleviation of these conditions has resulted through the granting of permits to take shellfish for bait from the prescribed waters, thus furnishing a number of men with transient employment. The value of the law, however, is almost completely nullified, for the danger to the public health is actual, and not imaginary. Under present conditions it is well-nigh impossible to make the necessary surveillance so complete as would be necessary to prove that clams "dug for bait" are not used as food. Further, even in the digging and handling of shellfish in polluted waters there is positive danger of transmitting the germs by hands of the digger to his own mouth or to other persons.

The nature of the flats permit the division of Boston harbor into three sections: (1) the north shore, (2) the south shore, (3) and the islands.

(1) The northern coast of the harbor has extensive mud and sand flats, covered for the most part with eel grass or scattered mussel beds. Much of the surface is a variety of pebbly gravel, while but little of it appears to be good clam ground. The mud flats are mostly covered with a sewage scum which renders them unsuitable for clams. Scattering clams are found throughout the entire region.

The immediate vicinity of Snake Island in Winthrop and the cove on Point Shirley furnish fairly good clamming, while clams are found in a greater or less degree upon the extensive flats of Winthrop harbor.

The flats of the Mystic River, which are of a tenacious mud rather unwholesome in appearance, in so far as they have not been encroached upon for building purposes, possess scattered patches of very good digging, and furnish transient employment to 20 or more men. The flats in the Charles and Chelsea rivers likewise furnish fair clamming.

(2) The south shore of the harbor is much like the north, except that the mud type of soil predominates. The large flats, mainly mud, are not entirely barren though most of the clams are found in a narrow strip of beach along the shore. At South Boston as well as in Dorchester Bay clams are found in considerable numbers, though nowhere are there any large areas of good clamming.

(3) The islands in the harbor are fringed with pebbly beach, where scattering clams are usually found. Apple Island and Governor's Island are surrounded with quite extensive flats, which are, however, but sparsely productive. Much digging for bait is carried on constantly on these pebbly beaches.

History. — Boston harbor has been in the past a good clamming region, as the magnitude of its available flats has rendered possible an extensive production. Naturally, the closing of the harbor by the State Board of Health has limited the annual production of clams from this vicinity, as now the only legal digging is for bait. Owing to this partial closed season the clams are said to have been on the increase during the last two years. Nevertheless, before the passage of this act the fishery had already greatly declined. The decline of the clam industry has been going on for years, as even in 1879 Mr. Ernest Ingersoll mentions: —

In Boston harbor clams are much depleted, owing to the fact that they are remorselessly dug the year through, chiefly by a class of ignorant foreigners who go down the harbor for the purpose. July and August are the most productive months, there being a large demand for the "clam bakes" which picnic parties from the cities indulge in on the various beaches. All the clams got in Boston harbor are very small, because they are allowed little chance to grow; in March and April they are hardly worth eating.

COMPARISON WITH 1879.

	1897.	1907.
Number of men,	90	350
Annual production: —		
Bushels,	40,000	7,500
Value,	$20,000	$6,000
Number of dories,	50	–
Capital invested,	$1,350	$2,250

In 1879 A. Howard Clark states: —

The towns around Boston usually charge a license fee of $2 a year for the privilege of taking clams. The clams are in some cases bought up by small operators, who team them into the city, though the diggers sometimes bring them to the city and sell them to the dealers direct from their boats at the wharves.

SUMMARY OF INDUSTRY.

Number of licenses,	350
Capital invested,	$2,250
Production, 1907: —	
Bushels,	7,000
Value,	$5,500
Total area (acres): —	
Sand,	500
Mud,	2,500
Gravel,	1,000
Mussels and eel grass,	1,000
Total,	5,000
Productive area (acres): —	
Good clamming,	100
Scattering clams,	1,000
Barren area possibly productive (acres),	900
Waste barren area (acres),	3,000
Possible normal production,	$330,000

Weymouth.

Weymouth, with its two rivers, possesses an area of flats aggregating 250 acres. The shores of Fore River are stony, but in spite of the hard digging clams are found in fair numbers. The shores of Back River are similar, except for the mud flats on the channel, which are either barren or but sparsely productive. A few clams are dug for bait and home consumption.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	150
Value,	$150
Total area (acres): —	
Sand,	–
Mud,	150
Gravel,	80
Mussels and eel grass,	20
Total,	250
Productive area (acres): —	
Good clamming,	–
Scattering clams,	30
Barren area possibly productive (acres),	50
Waste barren area (acres),	170
Possible normal production,	$11,000

Hingham.

Hingham has an area of tidal flats comprising nearly 650 acres. The characteristic soil is of two kinds: a marginal strip of pebbly beach extending the full length of the shore, and the broad flats of Hingham harbor and Weir River, with their extensive areas of mud, eel grass and mussels. The clamming territory is confined for the most part to this narrow strip fringing the shore, though scattering clams are found in diminished numbers on the mud flats.

The shellfish industry of the town consists mostly in procuring clams, mussels and cockles for bait. Clams are dug to some extent for home consumption and for the hotels at Nantasket; but the fishery is carried on in a desultory manner by a few men who dig when other work fails, and who do not wholly depend on clamming for a livelihood.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	250
Value,	$250
Total area (acres): —	
Sand,	25
Mud,	450
Gravel,	100
Mussels and eel grass,	75
Total,	650
Productive area (acres): —	
Good clamming,	–
Scattering clams,	100
Barren area possibly productive (acres),	–
Waste barren area (acres),	550
Possible normal production,	$20,000

Hull.

The stony shores of Hull offer but little suitable clam area, though fair digging is found in the vicinity of Hog Island and in Weir River. The usual type of flat is a pebbly or gravel beach, while near White Head and Weir River there are large mud areas. Clams are dug only for home consumption or for bait.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	100
Value,	$100

Total area (acres): —	
Sand,	–
Mud,	225
Gravel,	200
Mussels and eel grass,	–
Total,	425
Productive area (acres): —	
Good clamming,	–
Scattering clams,	50
Barren area possibly productive (acres),	50
Waste barren area (acres),	325
Possible normal production,	$15,000

Cohasset.

Cohasset, though possessing sufficient suitable area to support a clam fishery, has no industry of any importance. The greater part of the tidal flats are barren, while the remainder are far from fertile. The region immediately about White Head and the territory opposite extending along Barson's beach are the most productive, while scattering clams are found in Little Harbor.

The total acreage of available flat exceeds 100 acres. Of this, 90 acres are wholly unproductive, and the remainder, 10 acres, is not very valuable. The main type of soil is sand, though areas of mud are found in the coves. There are no regular clammers, though many clams are dug by the citizens of the town for their own use. There has never been a clam industry worthy of the name at Cohasset, and the present state of apathy appears to be normal. No local regulations of any kind govern the fishery.

Summary of Industry.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	200
Value,	$200
Total area (acres): —	
Sand,	50
Mud,	50
Gravel,	–
Mussels and eel grass,	–
Total,	100
Productive area (acres): —	
Good clamming,	–
Scattering clams,	10
Barren area possibly productive (acres),	40
Waste barren area (acres),	50
Possible normal production,	$6,000

Scituate.

There is no clam industry at Scituate. The selectmen of the town have forbidden all exportation of clams for market, and consequently the few clams dug are utilized for home consumption.

The possibilities of a future clam industry at this town, while not alluring, give indications of some promise. Occasional clams are found on the shores of Scituate harbor, as well as its tributary creeks. The main undeveloped resource lies, however, along the broad flats of the North River. These flats undoubtedly constitute a considerable asset in the communal wealth, and the action of the selectmen in maintaining a close season will tend to the restocking and consequent utilization of this territory.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	200
Value,	$200
Total area (acres): —	
Sand,	50
Mud,	45
Gravel,	5
Mussels and eel grass,	–
Total,	100
Productive area (acres): —	
Good clamming,	–
Scattering clams,	20
Barren area possibly productive (acres),	40
Waste barren area (acres),	40
Possible normal production,	$8,000

Marshfield.

Affairs at Marshfield are in practically the same state of inactivity as at Scituate. The town has considerable natural advantages, since the North River, which formerly made a wide sweep to the south before emptying into the ocean, has opened a new channel within the last ten years, forming many acres of excellent clam ground. A close season is maintained, although there has been considerable discontent on the part of certain individuals relative to this policy of the selectmen. A considerable quantity of clams, probably not exceeding 200 bushels per annum, are dug for home consumption. There are no shipments for market.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	200
Value,	$200
Total area (acres): —	
Sand,	40
Mud,	50
Gravel,	10
Mussels and eel grass,	–
Total,	100
Productive area (acres): —	
Good clamming,	–
Scattering clams,	30
Barren area possibly productive (acres),	30
Waste barren area (acres),	40
Possible normal production,	$9,000

Duxbury.

The clam industry at Duxbury has a peculiar interest, owing to the many perplexing problems which it presents. A vast extent of tidal flats, far exceeding in area those of any other town in the State, and in a measure suitable for the production of clams, lie almost wholly barren. The enormous territory comprised in these flats exceeds 3,500 acres, or, roughly, 5½ square miles. This is greater than the combined clam area of Salisbury, Newburyport, Ipswich, Essex and Gloucester, which is the finest territory in the State, and produces most of the Massachusetts clams. Duxbury, with a greater area than all these towns, dug in 1907 about 700 bushels of clams, — an amount which could well have been produced from 2 acres of ground. An investigation into the history of the town shows us that this state of barrenness has not always existed. There was a time when Duxbury was justly celebrated for her shellfish, as is still shown by the allusions to Duxbury clams on the menus of many hotels and restaurants. The dealers at Taunton, Fall River and other Massachusetts cities formerly sent to Duxbury large orders for clams, which were always forthcoming. Now, as far as can be ascertained, not a single barrel is shipped out of the town from year to year.

This transition from a state of prosperity to one of almost total barrenness is replete with interest, and is difficult of solution. Doubtless several causes may have contributed to this general decline. In the first place, it is evident that the Duxbury flats were never in so flourishing a state of production as those of the Cape Ann district. This assumption is amply supported by historical records, and it is also supplemented, at least, by the fact that a great per cent. of the present territory is largely unfit for the production of clams in any quantity. As these flats have changed scarcely at all for many years, is it unreasonable to suppose that they ever have been very suitable since the first settlement of the country?

As for the historical records referred to, the weight of evidence everywhere tends to prove that many years ago there was a fairly large output of clams yearly from Duxbury. But while this output was large in itself, it was, in proportion to the possible area, exceedingly small. Mr. Ernest Ingersoll states that in 1879 there were yearly exported from Duxbury 5,000 bushels of clams. At that time, he says, the industry had declined. Clamming was then prosecuted with no such vigor as at the present time, for the price was low, and the demand, except for bait, by no means excessive. Clams had not yet come to be looked on as such important articles of food as at present, and the business of digging them as carried on then could have made little inroad on well-stocked flats. The great probability is that only a small percentage of the whole territory was ever very productive. An observer at the present time, viewing from an eminence the flats of Duxbury at low tide, could not help being struck with the singular appearance which they present. He would see spread out before him a broad expanse apparently of green meadows, with long, narrow streams of water winding in and out among them. These seeming meadows, stretching on mile after mile, broken here and there by a patch of clear sand, are the tidal flats of Duxbury, more than 2,700 acres of which are covered with a thick growth of eel grass.

How many years this eel grass has covered the flats no one knows. It shifts somewhat, as the ice in winter sometimes plows up an immense surface, stripping it of its green covering. For the most part it seems to grow steadily year after year, until the roots, decaying stalks and the fine sediment which they have collected build up a spongy crust over the true bed of the flat. It is this spongy, clayey soil which is the predominant type in the eel-grass region, though a large area is soft mud with little patches of hard sand. It does not seem surprising that clams are not abundant in this soggy medium, covered with its thick matting of grass. Clams do exist, however, for occasionally when the ice in the winter storms has scraped bare a section of these flats, scattering large clams can be found.

Whether anything can be done with these eel-grass flats on a sufficiently large scale to render the undertaking profitable, and whether they would prove good ground for clam culture if the eel grass were removed, is a problem. However, the sand flats free from eel grass comprise nearly 800 acres, — an area sufficient in itself to furnish a very large industry for the town. Smooth, hard and unshifting, they have the appearance of being in every way suitable for the production of an enormous amount of shellfish. Yet, barring cockles, mussels and razor clams, shellfish are rare on most of these flats, which, in spite of their inviting appearance, are practically barren.

The only places where clams are dug in any quantity is along the shore. Here little scattered patches, remnants perhaps of the former large supply, repay the clammer's toil with a scant return. Little or no effort is made to dig them on the main flats, and few are so dug unless they happen to be unearthed by accident when the men are searching for razor clams for bait. The supply is hardly adequate for home consumption and the demands for bait by local fishermen.

Whether all the great tidal territory of Duxbury can ever be reconstructed into profitable clam ground is a difficult question. There exist, however, no known reasons why a fishery at least as flourishing as that of twenty years ago could not be re-established and indefinitely developed. A great industry was once in evidence here. Outside the boggy eel-grass marshes (doubtful territory at best) are wide expanses of clean sand flats, suitable in every way for the cultivation of clams. That the ingenuity of man properly administered can build up an enormous industry on these sand flats alone, no thoughtful person can doubt, and then utilization of these great barren Duxbury wastes will partially, at least, be accomplished.

Comparison of 1907 with 1879.

YEAR.	Production (Bushels).	Value.
1879,	5,000	$2,500
1907,	700	600

Summary of Industry.

Number of men,	5
Capital invested,	$60
Production, 1907: —	
Bushels,	700
Value,	$600
Total area (acres): —	
Sand,	800
Mud,	–
Gravel,	–
Mussels and eel grass,	2,700
Total,	3,500
Productive area (acres): —	
Good clamming,	5
Scattering clams,	10
Barren area possibly productive (acres),	800
Waste barren area (acres),	2,685
Possible normal production,	$83,000

Kingston.

The condition of the clam industry at Kingston is in many respects parallel to that at Duxbury. The clam flat area (some 600 acres) is very much smaller, but the character of the soil is essentially the same, consisting for the most part of clay, soft mud and eel-grass marshes, with a relatively small proportion of really suitable ground.

The two main flats of the town are Egobert's and Gray's. Egobert's, the larger of the two, has an area of about 275 acres. Most of this is practically waste, owing to a thick growth of eel grass; but a triangular piece on the mid-southern section is bare. This portion of smooth, unshifting sand comprises about 80 acres. A few patches of clams are scattered along the outer edge, near the channel, but hardly any of these patches produce clams enough to make it profitable to dig them. The great bulk of this territory is entirely barren.

Gray's flat is of an entirely different type. It is a long flat, with a fairly uniform width of about 100 yards. It runs through its entire length parallel to the shore, while on the other side it is separated from Egobert's by a 300-foot channel. Like Egobert's, it is covered for the most part by eel grass, but it is essentially different in the nature of its soil, which is mud throughout. Although the total area of the flat is about 115 acres, an irregular section of bare mud on the southeastern side, comprising 30 acres, is the only available clam territory. This section is composed of soft mud on the north and south, rather poorly suited for clam culture; but the mid section contains several acres of hard mud, which seems well adapted, and here clams are found in sufficient quantities to keep several men digging intermittently through the summer months.

Along the shore a few clam grants have been given to individuals by the local authorities. These are managed with fair success, though no business other than that of supplying the local demand is carried on. The possibilities of forming a clam industry here of importance is evident, though through lack of available territory it could never give promise of such a development as might be looked for from Duxbury or Plymouth.

SUMMARY OF INDUSTRY.

Number of men,	4
Capital invested,	$50
Production, 1907: —	
Bushels,	500
Value,	$450
Total area (acres): —	
Sand,	150
Mud,	–
Gravel,	–
Mussels and eel grass,	450
Total,	600

Productive area (acres): —	
Good clamming,	5
Scattering clams,	5
Barren area possibly productive (acres),	150
Waste barren area (acres),	440
Possible normal production,	$18,000

Plymouth.

The clam industry at Plymouth is at a low ebb. The same problems which baffle progress at Duxbury and Kingston are present here with all their complications. The combined available territory, exceeding 1,600 acres, save for a few unimportant sections, is wholly barren. While it is true that fully two-thirds of this great area is eel-grass waste, and in its present state of little value for the production of clams, there remains over 500 acres of good flats, for the most part sand well adapted for shellfish culture. It is certain that a flourishing industry has existed here in former times. From the earliest history of the colony, records tell of the excellent clam flats at Plymouth; and we learn that the Pilgrims during the darkest hours of the early settlement depended in large measure upon these flats for support. As late as 1879 Ernest Ingersoll reports an annual output of 5,000 bushels of clams, and states that the industry had then greatly declined. It appears to have gone down steadily ever since, until now it merely furnishes transient employment to 4 or 5 men, who dig at rather uncertain intervals for local markets.

The best clamming, probably because the most inaccessible, is around Clark's Island. Scattering clams occur on Wind flat, the Oyster grant, and in patches along the shore. But no considerable extent of good clamming occurs anywhere, and the bulk of the territory is wholly barren.

The town of Plymouth has endeavored in several ways to develop the industry. It has appropriated money to restock the flats, a close season has been tried, and an attempt made to solve the problem by the giving of private grants. While these grants have not always been run in as energetic a manner as could be desired, the experiment has proved conclusively that there are great possibilities in such a system. In short, there can be little doubt that in the proper administration of private grants lies the key to the solution of the problem which confronts this whole region. As clams were once abundant in Plymouth harbor, and as no apparent causes other than excessive digging appear to have brought about the decline, there seems to be no logical reason why this amount of territory (500 acres) should not yield its proper harvest. As for the vast extent of eel-grass flats, with all their undetermined possibilities, they can well afford to wait until the more immediate and pressing problems of the flats already available for clam culture have been solved.

Comparison of 1907 with 1879.

YEAR.	Production (Bushels).	Value.
1879,	5,000	$2,500
1907,	3,000	2,500

Summary of Industry.

Number of men,	6
Capital invested,	$60
Value of shore property,	–
Production, 1907: —	
Bushels,	3,000
Value,	$2,500
Total area (acres): —	
Sand,	400
Mud,	100
Gravel,	–
Mussels and eel grass,	1,100
Total,	1,600
Productive area (acres): —	
Good clamming,	10
Scattering clams,	50
Barren area possibly productive (acres),	440
Waste barren area (acres),	1,100
Possible normal production,	$58,000

Barnstable.

The clam industry at Barnstable, while not so extensive as at Ipswich or Essex, is nevertheless of special interest. The immensely long coast line, stretching for many miles on both the north and south shores of Cape Cod, gives the town a shellfish area both in Cape Cod Bay and Vineyard Sound which renders it unrivalled throughout the State for variety of marine life and diversity of natural environment. These conditions, as they affect clam culture, are best suited on the northern or bay side of the town, where the clam industry flourishes more extensively, as the southern shore is almost wholly given up to the rival quahaug, oyster and scallop fisheries.

On the northern shore a large harbor, nearly 5 miles long and about 2 miles broad at its widest part, extends in a general westerly direction, ending in a vast waste of salt marshes interwoven with a network of creeks. Up this harbor the tides rush with great velocity, and when they sweep out to sea leave a broad expanse of flats, sandy on the north and central portions and muddy on the south. These flats cover an aggregate area of 400 acres, comprising 200 acres of hard sand and 150 acres of soft mud. Large stretches of these mud flats on the south are waste, and covered for the most part with eel grass. Other sections elsewhere are likewise waste for various causes, and are to be excluded as unprofitable or barren; yet the total available area remaining after making these deductions exceeds 350 acres. This is the theoretical condition, — the real condition is far otherwise: 20 acres at the most yield clams, and of these only 10 acres produce them in marketable quantities.

The explanation of these conditions is interesting. In the winter the ice and the force of storms tear out great pieces of the tough marsh surf, and the tides sweep them down the harbor. Some of these huge masses are torn to pieces and washed away, others find lodgment on the broad surface of some tidal flat; these, becoming stationary, accumulate sediment; the grass grows upon them through the summer, and gradually a little island is formed. Surrounding these islands and oftentimes growing over their entire surface, bedded in among the roots of the marsh grass, we find a very thick set of clams. In short, all the digging of any kind is in the immediate vicinity of these islands.

The deductions to be made from these facts are apparently simple. In the spawning season, when the microscopic clam larvæ are in their floating stage, they are carried here and there by the currents. Later, when they tend normally to settle in some fertile tract of flat, they are prevented from so doing by reason of the remarkable swiftness of the tides, which sweep strongly over the broad, smooth flats, and give the little clams no opportunity of lodgment. Only in the firm thatch of low-lying islands can they find anything to cling to, and here, with their slender byssus threads attached to unyielding grass or roots, they are able to withstand the wash of the current. Thus the clams are gathered in great numbers in these natural collectors, later are washed on the neighboring flat, and finally a little colony grows up about every island of this sort.

That this is actually what happens is largely borne out both by observation and facts. It makes little difference where these islands are located; clams grow nearby, while all about may stretch smooth, hard flats, perfectly adapted for clams, yet altogether barren. In view of the somewhat incomplete investigations made in this region, it is perhaps too sweeping to point out any single factor as the sole cause for these waste areas; but undoubtedly the swift tides and smooth, hard flats, which offer no resting place for the young larvæ, constitute the main causes.

Another odd circumstance in connection with the Barnstable clam industry is the local regulations which control the industry. Almost all digging is carried on in the winter, as a local by-law forbids the digging of clams in summer in any quantity exceeding 6 bushels per week for family use. This somewhat curious by-law is designed wholly for the benefit of the majority of the clammers, and to give them employment in that season of the year when work is most difficult to obtain. While interfering somewhat with summer clam bakes, the law appears to meet the approval of the townspeople.

The south shore of Barnstable possesses many of the features of Buzzards Bay, and produces clams only in numbers sufficient for home consumption.

SUMMARY OF INDUSTRY.

Number of men,	25
Capital invested,	$200
Value of shore property,	–
Production, 1907: —	
Bushels,	700
Value,	$550
Total area (acres): —	
Sand,	200
Mud,	150
Gravel,	–
Mussels and eel grass,	50
Total,	400
Productive area (acres): —	
Good clamming,	10
Scattering clams,	10
Barren area possibly productive (acres),	330
Waste barren area (acres),	50
Possible normal production,	$39,000

Yarmouth.

The clam industry at Yarmouth, never extensive, has steadily declined, until now it barely supplies the demands of home consumption. Barnstable bar on the northern coast twenty years ago produced clams in considerable quantities, but the soil was never well adapted for this shellfish. Scattering clams are now found there, but the grounds are very much exposed, and cannot properly rank as clam-producing area. Sea clams abound there at certain seasons, and furnish a transient business; also razor clams, which are used extensively for bait.

The best clam territory is in Mill Creek, on the south shore of the town. Scattered patches of clams also occur along the shore of Bass River, but the whole area really available does not exceed 50 acres, and this is not at all well improved. There are no regular clammers, but intermittent digging produces about 600 bushels of clams annually, which are used either for home consumption or for bait.

No effort has been made on the part of the town authorities to better conditions, although the advisability of giving clam grants, at least on the northern or bay side, has been discussed. No permits are required, and local legislation does not in any way concern itself with the clam industry.

SUMMARY OF INDUSTRY.

Number of men,	5
Capital invested,	$40
Value of shore property,	–
Production, 1907: —	
Bushels,	600
Value,	$500
Total area (acres): —	
Sand,	25
Mud,	15
Gravel,	10
Mussels and eel grass,	–
Total,	50
Productive area (acres): —	
Good clamming,	5
Scattering clams,	10
Barren area possibly productive (acres),	25
Waste barren area (acres),	10
Possible normal production,	$6,000

Orleans.

Orleans is one of the few towns in the State which shows an advance in the clam industry. This is largely due to an increased production on the rich flats of Nauset harbor, as the remaining available territory in the town is declining in value. The output of 1907 is an increase of nearly 40 per cent. over the yield of the previous year, which shows an encouraging development.

The clam flat area of the town is divided into four rather distinct divisions, three on the east or Atlantic side and one on the Bay or western side. The grounds which have been dug for the longest time and yielded uniformly the best results lie in the waters of Town Cove. Here a strip of gravelly sand and mud about 30 feet wide extends along the shores of this cove for 2 or 3 miles. Clams are scattered throughout this strip, and are dug constantly.

The second division includes the bars of Nauset harbor, which at present furnish the best digging in town. The increased value of the town's industry is largely due to the recent development of these flats. Clams have seeded in abundantly during the past two or three years, and now furnish very good digging.

The third section comprises that portion of the clam flat area bordering the coast of Pleasant Bay which crosses the town boundaries on the southeast. Here clams are rather scarce, though dug occasionally. This section is economically the least important of the four.

The fourth section extends along the western coast, on a belt of sand bars well out in Cape Cod Bay. Clams are found on a strip about a quarter of a mile in width, and lying over half a mile from shore. This is a very exposed location. Billingsgate Point, projecting out from the

Wellfleet coast, offers some protection from northwest winds, and the hills of the Cape break the force of the easterly gales; but the full force of storms from the west and southwest sweeps these bars, and would seem to render them unsuitable for the growth of clams. Clams are here, however, in considerable numbers, though not so numerous as three or four years ago, and are dug to some extent.

The greater part of the digging is done by intermittent clammers, who obtain perhaps 2½ bushels per day. No permits are required, as there are no town by-laws regulating the industry.

SUMMARY OF INDUSTRY.

Number of men,	30
Capital invested,	$200
Value of shore property,	–
Production, 1907: —	
Bushels,	3,000
Value,	$3,000
Total area (acres): —	
Sand,	125
Mud,	50
Gravel,	20
Mussels and eel grass,	5
Total,	200
Productive area (acres): —	
Good clamming,	25
Scattering clams,	50
Barren area possibly productive (acres),	75
Waste barren area (acres),	50
Possible normal production,	$27,000

Eastham.

The town of Eastham is a sparsely settled community, and the clam fishery, while not large, plays a rather important part in its business activity. Six men depend quite largely upon it for a livelihood, while some 30 others dig intermittently through the summer. The same peculiar condition as at Orleans exists on the western coast. Here far from shore clams are found in considerable numbers on the shifting bars. The main source of supply, however, comes from the productive sand flats of Nauset harbor.

These flats have seeded in only in the past two or three years, but they have already shown latent possibilities of a future increase. In the so-called "Salt Pond" 2 men are employed nearly the year round in digging clams under water by a method of "churning," locally known as "rootling."

The total available area in Eastham is about 200 acres. More than half of this is sand, which includes almost all the good digging, while the mud flats are interspersed with stretches of gravel and scattering patches of eel grass.

The same abuses which have nearly ruined the Swansea fishery have begun here. Small seed clams are exported in considerable quantities to supply the summer demand of the New Bedford and Fall River districts. While this system has not yet made its ravages apparent, a glance at the Swansea report will serve to convince the most casual reader that unless some steps are taken to check this evil, the practical annihilation of the Eastham clam industry must follow. As it is, local legislation seems powerless to cope with the problem, and no laws of any kind relating to the clam fishery are in force.

SUMMARY OF INDUSTRY.

Number of men,	36
Capital invested,	$250
Value of shore property,	–
Production, 1907: —	
Bushels,	4,000
Value,	$4,000
Total area (acres): —	
Sand,	100
Mud,	50
Gravel,	30
Mussels and eel grass,	20
Total,	200
Productive area (acres): —	
Good clamming,	25
Scattering clams,	50
Barren area possibly productive (acres),	100
Waste barren area (acres),	25
Possible normal production,	$30,000

Wellfleet.

Although possessing extensive flats, Wellfleet produces at present a relatively small amount of clams. The inhabitants realize that these flats are capable of producing a large harvest of clams if properly planted, and that in this way an extensive industry can be developed, and have undertaken to restock the flats, appropriating in 1906 for this purpose the sum of $1,000.

At Billingsgate Island there are fair clam flats, but they are not easily accessible, as they lie at a distance of 5 miles from town. Clams can also be obtained in more or less abundance in the thatch which borders the flats of Blackfish Creek, Herring River and Duck Creek. A few clams are scattered over the flats of Blackfish Creek, particularly toward the head of the creek. Two patches of clams covering perhaps an acre are on the flats in front of the town: one in the stone and gravel east of Commercial wharf; the other, a more extensive area, just west of Mercantile wharf.

Wellfleet possesses many acres of flats which, though now barren, are capable of excellent production if properly planted. Wellfleet flats extend from Duck Creek to Herring River and from Herring River along the shores of Great Island for a distance of 4½ miles, and cover an area of 400 acres. The Great Island flats are not especially adapted for clams, and only parts of these can ever be successfully cultivated, while possibly all the area between Duck Creek and Herring River can be reclaimed. South Wellfleet flats, which comprise an area of 200 acres, are much poorer flats, consisting for the most part of mud and shifting sand. Only the firmer portions, about 50 acres, can be made productive by planting with clams.

At Wellfleet the soft clam fishery can hardly be styled an industry. In the winter a few men go clamming when there is nothing else to do. The majority prefer razor clamming, which is a considerable winter industry, owing to the demand for this bait at Provincetown. Three men clam during the summer, doing practically all their digging at Billingsgate, while 8 others are in this work during the winter.

The flats of Wellfleet were never very productive, but formerly were capable of furnishing a far greater production than at present. This decline is only accounted for by overdigging, which has brought about the present scarcity.

Summary of Industry.

Number of men,	11
Capital invested,	$300
Production, 1907: —	
Bushels,	800
Value,	$640
Total area (acres): —	
Sand,	450
Mud,	5
Gravel,	150
Mussels and eel grass,	–
Total,	605
Productive area (acres): —	
Good clamming,	3
Scattering clams,	12
Barren area possibly productive (acres),	250
Waste barren area (acres),	340
Possible normal production,	$28,000

Truro.

The clam flats at Truro are confined principally to the Pamet River. At the mouth of this river near the head of the harbor bar is a sand flat comprising several acres, where the bulk of the clams are produced. In South Truro, Stony Bar and other similar patches of rocky beach are fairly well bedded with clams. Scattering clams are found over the shifting bars which skirt the main land on the bay side, but nowhere are clams sufficiently abundant to warrant any serious attempt at exportation. Fifteen to twenty years ago clams were everywhere much more abundant in this region than now, and in those days some market digging was carried on. At present the needs of the home market are with difficulty supplied from the local production, and 100 bushels per year would cover all clams dug both for food and bait. No effort has at any time been made by the town authorities to increase the industry, though the clam fishery, at least in the sheltered coves of Pamet River, is not without possibilities of development.

Summary of Industry.

Number of men,	1
Capital invested,	$2
Production, 1907: —	
Bushels,	50
Value,	$60
Total area (acres): —	
Sand,	50
Mud,	–
Gravel,	–
Mussels and eel grass,	–
Total,	50
Productive area (acres): —	
Good clamming,	1
Scattering clams,	2
Barren area possibly productive (acres),	47
Waste barren area (acres),	–
Possible normal production,	$5,000

Provincetown.

For the last five years the flats of Provincetown have produced only a small amount of clams. Wherever clams have set in abundance they have been quickly dug by fishermen for bait, thus checking their natural propagation.

Clams are found in the drains among the thatch beds on the southwest side of the harbor and in Race Run, while a considerable set is scattered between the wharves of the town. All the extensive flats at the southwest end of the harbor are entirely barren of clams, owing chiefly to the shifting nature of the sand, although on certain parts of these, especially near the thatch, clams would grow if planted. As it is, the shifting sand makes it impossible for the young clams to set on this area.

Summary of Industry.

Number of men,	5
Capital invested,	$15
Production, 1907: —	
Bushels,	400
Value,	$320

Total area (acres): —	
Sand,	400
Mud,	–
Gravel,	–
Mussels and eel grass,	–
Total,	400
Productive area (acres): —	
Good clamming,	3
Scattering clams,	3
Barren area possibly productive (acres),	200
Waste barren area (acres),	194
Possible normal production,	$21,000

Chatham.

Chatham can no longer be considered as the best clam-producing town of southern Massachusetts. In 1879 Chatham produced a greater quantity of soft clams than all the rest of the Cape; to-day all has changed, and the annual output is far less than several other towns of the Cape district.

The town of Chatham is situated in the southeastern portion of Cape Cod, and includes that part which is commonly called the "elbow" of the Cape. It is surrounded on the north, east and south sides by the ocean, while on the south the peninsula known as Monomoy Island extends for 9 miles.

The clamming territory of Chatham is situated in Stage harbor, Pleasant Bay and at Monomoy Point.

In Stage harbor clams are found along the sides of the Mill Pond, comprising possibly an acre, and in the eastern end of the harbor toward the dike, where about 3 acres of flats are thickly set.

An extended area of sand flats are found in Pleasant Bay. But small parts of this area furnish good clamming, and the Common Flats on the inside of Monomoy Island, where once there were acres of good clams, now lie entirely barren except for a small patch of set just north of Brant Island, comprising about 1/5 of an acre. Here are about 100 acres of barren flats which only need planting to be made productive.

The commercial clam fishery of the town is carried on at Monomoy Point, where 5 acres of the best clamming in Massachusetts is found. The Powder Hole flats, formed of coarse, clean sand, are thickly set with clams of all sizes, and furnish excellent digging. A good clammer can obtain from 5 to 6 bushels per tide from these flats.

Clams are dug at Chatham during the fishing season chiefly for bait. Such digging lasts through the fall and winter. In the summer, clams are dug only for food, as no cod fishing is conducted in the warm months. From 10 to 15 men were engaged in clamming during the summer of 1907, travelling from Chatham to Monomoy Point in power or sail dories. Practically all the clams dug came from the Powder Hole flats at Monomoy Point. These were purchased at Chatham wharf by fish firms at the price of $2 per barrel.

The winter clam fishery of Chatham was once an important industry, which started in 1875 when clams were in great demand as fish bait. The following table shows how this industry has declined: —

	1879.	1907.
Number of men,	150	10
Annual production (bushels),	35,000	1,500
Value of production,	$12,250	$1,200
Price per bushel (cents),	35	80
Capital invested,	$2,000	$400

Owing to the large amount of clams dug by fishing vessels, the following restrictions were incorporated in 1881 as a State law, which reads as follows: —

No fisherman or any other person shall take from the towns of Chatham and Nantucket any shellfish, for bait or other use, except clams and a shellfish commonly known by the name of horse feet, and no quantity exceeding seven bushels of clams, including shells or one hundred of said horse feet shall be taken in one week for each vessel or craft, nor in any case without a permit being first obtained from the selectmen of the town.

Summary of Industry.

Number of men,	10
Capital invested,	$400
Production, 1907: —	
Bushels,	1,500
Value,	$1,200
Total area (acres): —	
Sand,	330
Mud,	10
Gravel,	20
Mussels and eel grass,	–
Total,	360
Productive area (acres): —	
Good clamming,	10
Scattering clams,	50
Barren area possibly productive (acres),	300
Waste barren area (acres),	–
Possible normal production,	$44,000

Harwich.

The town of Harwich possesses but little clam area. A few clams are obtainable on the shores of Pleasant Bay and Mud Creek in limited localities, while in the southern waters of the town there is some digging in Wychmere harbor and in Herring River. The total area of clam flats is not more than 1½ acres.

There are no regular clammers engaged in the business, all the clams dug being used only for home consumption.

In 1905 there was a town law restricting the digging in Wychmere harbor, except for bait, to one day in the week.

COMPARISON OF 1907 WITH 1879.

YEAR.	Production (Bushels).	Value.	Men.
1879,	1,125	$400	15
1907,	100	100	-

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	100
Value,	$80
Total area (acres): —	
Sand,	10
Mud,	10
Gravel,	10
Mussels and eel grass,	–
Total,	30
Productive area (acres): —	
Good clamming,	1
Scattering clams,	5
Barren area possibly productive (acres),	10
Waste barren area (acres),	14
Possible normal production,	$2,400

Dennis.

As the town of Dennis has mutual fishery rights with the town of Yarmouth, the clam flats of Bass River, which lie between the towns, are free to any inhabitant of Dennis. A few clams are also dug in Swan Pond River.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	50
Value,	$45
Total area (acres): —	
Sand,	25
Mud,	15
Gravel,	10
Mussels and eel grass,	–
Total,	50
Productive area (acres): —	
Good clamming,	1
Scattering clams,	4
Barren area possibly productive (acres),	30
Waste barren area (acres),	15
Possible normal production,	$4,200

Mashpee.

The clam fishery at Mashpee is of hardly sufficient proportions to rank as an industry. The shores of the Popponesset River furnish perhaps favorable conditions for the growth of this shellfish, but the available territory is small, not exceeding 50 acres, and of this only a small percentage, comprising scattered patches of gravel-mud, produces clams in any abundance.

No effort is made at exportation for market, and under the present circumstances it is doubtful if a greater yield than that required to supply home consumption could be expected. No effort is made on the part of local legislation to control the industry or foster it in any way.

SUMMARY OF INDUSTRY.

Number of men,	2
Capital invested,	$20
Production, 1907: —	
Bushels,	50
Value,	$45
Total area (acres): —	
Sand,	20
Mud,	5
Gravel,	20
Mussels and eel grass,	5
Total,	50
Productive area (acres): —	
Good clamming,	2
Scattering clams,	8
Barren area possibly productive (acres),	30
Waste barren area (acres),	10
Possible normal production,	$5,400

Buzzards Bay.

The section of Massachusetts bordering the shores of Buzzards Bay supports a flourishing quahaug, oyster and scallop fishery, capable of great development. The clam industry, however, never very extensive, is of very slight significance at present, and can never attain the same degree of importance as the other shellfisheries, owing to the limited area available for clams. To those familiar with the harbors of Newburyport and Duxbury and their vast tidal flats with their latent possibilities, the shores of Buzzards Bay present indeed a notable contrast. Bluff and hilly for the most part, and frequently rocky, nowhere do they show extensive flats suitable for clam culture. That clams grow wherever opportunity permits is evident, for they are found on gravelly stretches or among rocks all along the coast, except in those localities openly exposed to the full force of the sea. But allowing for all possible favorable features, the lack of any considerable territory is a disadvantage that will forever act as a barrier to any expansion. Falmouth and Dartmouth on the east and west sides of Buzzards Bay respectively differ materially from the remaining towns of the district, in the fact that the characteristic soil of their clam grounds is sand; while the other towns have little in the shape of available territory except gravel stretches along the shores of coves, small areas of mud, and the rocky beaches of points and headlands. The yearly output hardly anywhere suffices for the needs of home consumption. Nowhere is any attempt at exportation possible. The business, such as it is, is carried on in a very intermittent fashion, chiefly in the summer, with but a small investment of capital.

Special local regulation seems to remain aloof from the problem of insuring a future clam supply. That the combined area of all the towns of Buzzards Bay does not equal that of a single town in the Cape Ann district is an undeniable truth; but the fact nevertheless remains that an industry far more considerable than exists at present could be supported, and it is truly to the interest of the towns of this region to make the best possible use of their limited advantages.

Falmouth.

Falmouth has a long coast line not only on Buzzards Bay but also on Vineyard Sound. The flats at North and West Falmouth on the bay side are similar to those of Wareham and Bourne, though there are several small patches of quite good digging. On the southern shore there are clams scattered along the coasts of the various indentations, particularly at Waquoit Bay.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	200
Value,	$175
Total area (acres): —	
Sand,	40
Mud,	5
Gravel,	5
Mussels and eel grass,	–
Total,	50
Productive area (acres): —	
Good clamming,	2
Scattering clams,	8
Barren area possibly productive (acres),	40
Waste barren area (acres),	–
Possible normal production,	$6,400

Bourne.

The clam industry at Bourne is practically extinct. Scarcely any clamming is carried on by the inhabitants of the town, even for their own use, as clams have become so scattering that it hardly pays to dig them. The territory is much the same in extent and general character as that of Wareham, but it has been overdug to a greater degree, and has become nearly barren.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	100
Value,	$100
Total area (acres): —	
Sand,	5
Mud,	5
Gravel,	30
Mussels and eel grass,	–
Total,	40
Productive area (acres): —	
Good clamming,	–
Scattering clams,	30
Barren area possibly productive (acres),	–
Waste barren area (acres),	10
Possible normal production,	$6,000

Wareham.

Wareham leads the towns of Buzzards Bay in the production of clams, although its annual output is only 600 bushels. This clearly shows the low ebb to which the industry has fallen in this region.

There are no true tide flats in Wareham, but the total area of the mud-gravel and rocky bottom between high and low water mark where scattering clams are found is nearly 100 acres. There are no regular fishermen, but some half dozen quahaugers dig clams from time to time, chiefly during the summer, to supply the home market.

The industry, such as it is, appears to be about stationary at present, though in production it has declined notably during the last twenty years. The town officials have attempted no measures to revive the failing fishery, and no town laws affect it in any way.

SUMMARY OF INDUSTRY.

Number of men,	6
Capital invested,	$100
Production, 1907: —	
Bushels,	800
Value,	$800
Total area (acres): —	
Sand,	15
Mud,	10
Gravel,	75
Mussels and eel grass,	–
Total,	100
Productive area (acres): —	
Good clamming,	–
Scattering clams,	50
Barren area possibly productive (acres),	–
Waste barren area (acres),	50
Possible normal production,	$10,000

Marion.

The wealthy summer residents at Marion create a demand for clams at a very substantial price. In spite of the increased price, there is little inducement to engage in this industry as a livelihood, and only 1 man digs steadily through the summer months, though intermittent digging is done by others to supply the local market.

The best clamming is on the east coast of Great Neck and in Wing's Cove. These grounds are difficult of access, and consequently have not been so much overworked as the nearer shores of Ram's Island, Allan's Point and Blankinship Cove. The total area does not exceed 10 acres, and this for the most part is very poor territory; while the clams coming from these rock and gravel beaches are not of very good quality, the shells being usually gnarled and crooked.

There is no town legislation relating to this industry, and though it is becoming of less consequence every year, nothing is done to revive it.

SUMMARY OF INDUSTRY.

Number of men,	1
Capital invested,	$15
Production, 1907: —	
Bushels,	100
Value,	$100
Total area (acres): —	
Sand,	–
Mud,	–
Gravel,	10
Mussels and eel grass,	–
Total,	10
Productive area (acres): —	
Good clamming,	–
Scattering clams,	10
Barren area possibly productive (acres),	–
Waste barren area (acres),	–
Possible normal production,	$2,000

Mattapoisett.

The coast of Mattapoisett, more open and exposed than that of Fairhaven, does not offer equal advantages to the cultivation of clams. A similar strip of gravel-mud or sand occurs along the more sheltered portions of the coast, and wherever an indentation in the mainland offers shelter clams may be found, though never in sufficient quantities to make digging profitable. There is really no industry at all; the few clams that are dug go for home trade or are used as bait, and the prospects of any decided improvement appear to be slight.

SUMMARY OF INDUSTRY.

Number of men,	1
Capital invested,	$15
Production, 1907: —	
Bushels,	100
Value,	$100
Total area (acres): —	
Sand,	–
Mud,	5
Gravel,	5
Mussels and eel grass,	–
Total,	10
Productive area (acres): —	
Good clamming,	–
Scattering clams,	10
Barren area possibly productive (acres),	–
Waste barren area (acres),	–
Possible normal production,	$2,000

Fairhaven.

The clam industry at Fairhaven suffers from the unsanitary condition of the flats, though in a lesser degree than at New Bedford. The finest clam grounds of this town lie in the proscribed district of the Acushnet River, and handling or eating shellfish from this area is a positive menace to the public health.

A strip of gravel-mud about 100 feet in average width fringes the shores of Priest's Cove, and this strip furnishes at present the best digging. Scattered patches of clams occur along the indentations of Sconticut Neck, around West Island and along the coast of Little Bay. No men are regularly employed in digging clams, though a rather inefficient attempt is made at times to supply the local demand.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	100
Value,	$100
Total area (acres): —	
Sand,	–
Mud,	25
Gravel,	25
Mussels and eel grass,	–
Total,	50
Productive area (acres): —	
Good clamming,	–
Scattering clams,	25
Barren area possibly productive (acres),	25
Waste barren area (acres),	–
Possible normal production,	$7,500

New Bedford.

The clam industry at New Bedford was never of any great importance, but the unwise methods of sewage disposal of the city, whereby the effluent enters the harbor in close proximity to the clam flats, renders the taking of shellfish a positive menace to the public health. The action of the State Board of Health in closing the Acushnet River and Clark's Cove to the clam digger virtually annihilated the remnant of the industry. Now practically all the available territory of the city is proscribed, and no clams are allowed to be taken from this area except for use as bait. Licenses are also required to take clams even for bait from this proscribed territory. Three hundred and twenty of these licenses have been issued since the passage of the act in 1904. The annual yield of clams for this purpose cannot be accurately ascertained, but probably does not exceed 250 bushels. No important clam industry would ever have been possible at New Bedford, under any circumstances, but the slight possibilities which once existed have been swept away and can never return under the present conditions, though shellfish grown in this region could, if suitable legislation were enacted, be transplanted to a sanitary environment, where in a month all danger of spreading typhoid germs would be avoided.

SUMMARY OF INDUSTRY.

Licenses for bait,	320
Capital invested,	–
Production, 1907: —	
Bushels (for bait),	300
Value,	$225
Total area (acres): —	
Sand,	5
Mud,	5
Gravel,	15
Mussels and eel grass,	–
Total,	25
Productive area (acres): —	
Good clamming,	–
Scattering clams,	15
Barren area possibly productive (acres),	–
Waste barren area (acres),	10
Possible normal production,	$3,000

Dartmouth.

The town of Dartmouth possesses a wide expanse of territory, but the actual amount of available clam ground is not as large as it would appear at first sight. Clams are found in more or less abundance at the following places: (1) Rickerson's Point ($\frac{2}{3}$ acre); (2) Apponagansett River (6 acres); (3) Apponagansett harbor (1 acre); (4) Nonquit ($\frac{1}{10}$ acre); (5) Round Hill Point ($\frac{1}{5}$ acre); (6) Salter's Point ($\frac{3}{4}$ acre); (7) Smith's Neck ($\frac{3}{5}$ acre); (8) Little River ($7\frac{1}{2}$ acres); (9) Slocum's River (6 acres); comprising a total of 23 acres. The best clamming is obtained on the flats of Little and Slocum's rivers. In Apponagansett River clams are dug in the summer for the Padanaram clam bakes.

A town by-law placing a closed season on Slocum's River was in force during the years 1904 and 1905. In 1906 Dartmouth, by a State law, required permits for clamming. These permits are issued by the selectmen free of charge.

SUMMARY OF INDUSTRY.

Number of men,	4
Capital invested,	$50
Production, 1907: —	
Bushels,	200
Value,	$160

Total area (acres): —	
Sand,	15
Mud,	10
Gravel,	5
Mussels and eel grass,	–
Total,	30
Productive area (acres): —	
Good clamming,	5
Scattering clams,	15
Barren area possibly productive (acres),	–
Waste barren area (acres),	10
Possible normal production,	$5,000

The Fall River District (Narragansett Bay).

The section of country bordering on Narragansett Bay and the Rhode Island line comprises a territory remote from the other clam-producing districts of the State, and possessing many characteristics not found in any other locality. Six towns of this region enjoy the privileges of a clam industry, situated as they are on the shores of Mt. Hope Bay and its tributary streams, the Cole, Lee and Taunton rivers. Beginning with the most westerly and taking them in order, these towns comprise Swansea, Somerset, Dighton, Berkley, Freetown and Fall River. These towns differ only in extent of resources or development of the industry, while the general nature of the clam flats and the methods employed in carrying on the business are essentially alike for all. The area in this region suitable for clam culture possesses some of the distinguishing features of the typical north shore flats, some of the Buzzards Bay variety and some peculiar to itself. There are scarcely any sand flats, and the prevailing type of soil is mud, as at Newburyport, or gravel, as in Buzzards Bay; while the greater part of the clam supply comes from a large and rather indefinite area, which is not properly tide flat at all, but lies continuously submerged.

The methods employed in carrying on this industry include both wet and dry digging. On the tide flats the clams are dug as elsewhere on the south shore, with hoes or the common digger. Where, however, clams are dug in 2 or 3 feet of water, as is most frequently the case, an ordinary long-handled shovel and wire basket are employed. The soil containing the clams is shoveled into the baskets, and then the clams are sifted out under water. Several years ago an attempt was made to dig clams by machinery. An enterprising oysterman spent several hundred dollars in constructing a machine which was designed to farm the under-water districts more quickly and successfully than could be done by hand. The device had some of the principles of a suction pump, and theoretically the clams on the submerged flats could be washed out from the soil and collected in a receptacle. The machine worked well enough in extracting the clams from the mud, but failed completely when it came to collecting them. In short, after a thorough trial it was pronounced a failure and had to be abandoned.

The main peculiarity of this region, and a far more important one than the type of soil or the methods of digging, is the nature of the clams which are produced. The inadequate territory and the constantly increasing demands of the Fall River markets have led to abuses which have had a most disastrous effect on the clam industry, and unless checked, and soon, these abuses will certainly cause its complete annihilation. The abuses in question are the universal custom of digging small seed clams for food. So importunate have the markets of Fall River and the vicinity become, that when the supply of suitable clams proves inadequate they demand and will gladly take "anything with a shell on," as the dealers say, so that it is no uncommon sight to see exposed for sale in the city markets clams of only 1 inch in length. This deplorable condition is fostered by the custom of digging under water, for the fine mesh of the woven-wire baskets retains even the smallest clams, which are saved for market.

No quicker or surer way of destroying the industry completely could have been devised than this method of digging seed clams for food. One barrel of these clams would produce 10 to 15 barrels of marketable clams if left for one year under favorable circumstances. Thus, when a clammer digs 1 barrel of these clams he is in reality destroying 10 or more barrels. This is truly reaping the "seed" before it has had any time to mature the proper harvest. Also, these "seed" clams are so immature that in many cases they have not spawned, and thus the clammer by destroying the clams in this manner damages irrevocably all chances of restocking the flats.

From the inherent difficulties of the problem, however, local regulation seems powerless to cope with the evil. The short-sighted clammers, while they know that these methods, if pursued very far, will ultimately destroy the industry, seem willing, nevertheless, to sacrifice the future for the present. The other clammers are inevitably brought into line on this mistaken policy, as they cannot but argue that if a few will persist in exploiting a natural resource it is the right of every man to have an equal chance, and take his share of the proceeds as long as they last. Another potent factor in this wastefulness is the irresponsible foreign element of the mill districts, who dig clams for their own use, large or small, with entire indifference. It might perhaps prove unjust and difficult to enforce laws preventing individuals digging "seed" clams for their own use; but legislation could possibly be enacted preventing the sale of such seed in the public market. This would strike a blow at the abuse sufficient to rob it of its worst features. The most casual glance at the facts in the case prove that there is a pressing need for some legislative action. The history of the clam industry in this region is one of steady and rapid decline. Any clammer of the vicinity is willing to acknowledge that conditions at present are in a very unsatisfactory state. The output of clams has greatly diminished, both in the consensus of opinion of those interested in the business, and also according to statistical figures. Furthermore, the end of the industry, as far as any economic importance is concerned, is plainly in sight, and at the present rate of destruction cannot long be delayed. It would seem that here was a striking example of the need of prompt and wise legislation for the protection and development of an industry which has made large profits for the community, and might yield still greater returns if properly regulated.

The towns of this region can never compete with the towns of the Newburyport district in the production of clams, for the reason that they have by no means an equal acreage of suitable flats. The Taunton River is also a considerable factor, as its contaminated waters impair the quality of clams grown along its shores. There remains, however, a considerable extent of suitable territory which might yield a large product if rightly controlled, and this territory, with its inherent possibilities depleted to the verge of exhaustion by unwise and wasteful methods, it is for the interest of the Commonwealth to protect and improve.

Swansea.

Swansea, the most western town of this district, is by far the most favorably located, and has the greatest possibilities of clam production. Situated on the northern shore of Mt. Hope Bay, and containing the majority of the flats in the Cole and Lee rivers, it possesses a greater available territory free from the contaminating influences of the Taunton River than any other town in this region.

Altogether, 200 acres comprise the possibly available clam area of this town. The best of this area is located in Cole's River, and includes Long Beach flat, the best flat of the district. Situated on the east shore of the river just below the railroad bridge, this flat stretches south in a broad triangle comprising some 20 acres of smooth, semihard mud. Over the main flat is sprinkled a very thick set of ½ inch to 1 inch clams, interspersed with some of larger growth. While this is the best flat, other flats extend along both shores far up the river until the clams become too "fresh" to be very good. Flats also occur in the Lee River, and there is a large and rather indeterminate amount of under-water territory. The total area suitable for culture is not far from 150 acres; of this, about 20 acres are gravel and the rest practically all mud.

No permits are necessary to dig clams on tidal flats, but permits are required to "churn" clams under water. Twenty of these permits were issued last year. Usually in digging under water two men work together, one shovelling the mud into the wire baskets and the other sifting out the clams. About 75 per cent. of the clams produced come from these under-water areas, as the tide flats are for the most part nearly exhausted.

The season lasts all the year round, though most of the clams are dug in the summer time. Of late years it has become increasingly hard for a man to earn a living by clamming, as only 1 to 1½ bushels now comprise an average day's work under the most favorable circumstances. Many of the clammers are leaving the business and seeking a livelihood in other employments.

The history of the industry is one of marked decline. The most conservative clammer estimates that at the present rate the passing of five years will witness the complete annihilation of the industry.

SUMMARY OF INDUSTRY.

Number of men,	25
Capital invested,	$250
Production, 1907: —	
Bushels,	5,000
Value,	$5,000
Total area (acres): —	
Sand,	100
Mud,	100
Gravel,	–
Mussels and eel grass,	–
Total,	200
Productive area (acres): —	
Good clamming,	20
Scattering clams,	30
Barren area possibly productive (acres),	100
Waste barren area (acres),	50
Possible normal production,	$24,000

Somerset.

Somerset, the next town in order, joins Swansea on the east and extends several miles up the left bank of the Taunton River. Its flats on the south and west, particularly in the Lee River, produce some clams, though the industry is practically run out. The total clam area comprises about 75 acres. This is mostly mud, though gravel stretches along the shore aggregate perhaps 10 acres. The development of latent possibilities in this territory is largely curtailed by the disastrous effects of the Taunton River upon the clams. This water, contaminated by the manufacturing plants of Taunton, makes the clams grown in the northern part of the town of inferior taste and quality.

Six licenses, costing $1 apiece, were issued last year for "churning" clams. No permits other than these are required.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	50
Value,	$50

Total area (acres): —	
Sand,	–
Mud,	25
Gravel,	25
Mussels and eel grass,	–
Total,	50
Productive area (acres): —	
Good clamming,	–
Scattering clams,	10
Barren area possibly productive (acres),	20
Waste barren area (acres),	20
Possible normal production,	$4,000

Dighton.

Dighton has a very limited area of clam flat, comprising only about 10 acres. Clams extend but little beyond the southern boundary of the town on the Taunton River and about 3/4 mile up the Segregansett River on the west. Practically no business is made of clamming by the citizens of the town except for local consumption. About 40 bushels were "churned" last year by outsiders. No permits are issued.

Summary of Industry.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	40
Value,	$40
Total area (acres): —	
Sand,	–
Mud,	5
Gravel,	5
Mussels and eel grass,	–
Total,	10
Productive area (acres): —	
Good clamming,	–
Scattering clams,	2
Barren area possibly productive (acres),	8
Waste barren area (acres),	–
Possible normal production,	$1,200

Berkley.

Berkley, on the right bank of the Taunton River, opposite Dighton, has a very similar clam territory both in extent and characteristics. But little use is made of the clam except for bait, as the river water renders them very unsatisfactory as food.

There is practically no industry, and there never could be any of importance, owing to the very limited area and the contamination of the waters.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	25
Value,	$25
Total area (acres): —	
Sand,	–
Mud,	5
Gravel,	5
Mussels and eel grass,	–
Total,	10
Productive area (acres): —	
Good clamming,	–
Scattering clams,	4
Barren area possibly productive (acres),	6
Waste barren area (acres),	–
Possible normal production,	$1,400

Freetown.

Freetown, joining Berkley on the south near the Fall River line, possesses a number of clam flats, aggregating 25 acres. Very little business is carried on, although conditions are better than in Berkley or Dighton. The clams, too, are of better quality, being freer from the disagreeable flavor of clams grown farther up the river. The possibilities for clam culture in this town are not attractive, but the present conditions can be vastly improved.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	100
Value,	$100
Total area (acres): —	
Sand,	–
Mud,	10
Gravel,	15
Mussels and eel grass,	–
Total,	25
Productive area (acres): —	
Good clamming,	–
Scattering clams,	15
Barren area possibly productive (acres),	–
Waste barren area (acres),	10
Possible normal production,	$3,000

Fall River.

Fall River has no clam territory on the south, owing to the wharves and other obstructions. On the more open waters of the north towards Freetown there is an extent of clam ground occupying about 25 acres. The foreign element in the city dig here for food, and some clams are likewise dug for bait, but the industry on the whole is of little consequence.

SUMMARY OF INDUSTRY.

Number of men,	–
Capital invested,	–
Production, 1907: —	
Bushels,	100
Value,	$75
Total area (acres): —	
Sand,	–
Mud,	20
Gravel,	5
Mussels and eel grass,	–
Total,	25
Productive area (acres): —	
Good clamming,	–
Scattering clams,	10
Barren area possibly productive (acres),	15
Waste barren area (acres),	–
Possible normal production,	$3,500

Nantucket.

At present Nantucket does not possess a clam industry of any importance. Years ago it is claimed that clams were abundant, and that quantities were dug for food or for bait. Now the reverse is true, and the fisherman often finds it difficult to procure clams even for bait. Indeed, Nantucket furnishes an excellent illustration of the decline of the clam industry.

Practically all the flats of Nantucket are shore flats *i.e.,* narrow flats along the shores of the harbor and on the sides of the creeks. Thus the area, though extending for many miles, is not great, and the clam industry of the island, though capable of development, nevertheless can never assume the importance of the quahaug and the scallop fisheries. In Nantucket harbor clams are found in the creeks, and particularly in Polpis harbor, although scattering clams are found all along the south shore of the harbor. A few clams are found on the north side in Coatou Creek and in First and Second Bend. The flats in Nantucket harbor are all coarse sand or a fine gravel, except in the creeks, where they become muddy. On the eastern and southern sides clams are found in scattering quantities in Maddequet harbor, on the north side of Tuckernuck and in the cove on the south side of Muskeget.

Comparison of 1907 with 1879.

Production.	1879.	1907.
Bushels,	2,253	400
Value,	$872	$350

Summary of Industry.

Number of men,	4
Capital invested,	$40
Production, 1907: —	
Bushels,	400
Value,	$350
Total area (acres): —	
Sand,	150
Mud,	25
Gravel,	25
Mussels and eel grass,	–
Total,	200
Productive area (acres): —	
Good clamming,	5
Scattering clams,	15
Barren area possibly productive (acres),	130
Waste barren area (acres),	50
Possible normal production,	$18,000

Edgartown.

Although Edgartown possesses 200 acres of clam flats, it is not in a true sense a clam-producing town. The reason for this small production is due to the nature of the flats, which are mostly under water at low tide, making clamming difficult. Naturally Edgartown devotes its energies to the more profitable quahaug and scallop fisheries.

The clam flats of the town are situated along the shores of Cape Poge Pond and in the lower part of Katama Bay, where many acres of flats are continually submerged. The shore flats are of small area, owing to the light rise and fall of the tide, less than 3 feet at this part of the coast.

(1) *Cape Poge Pond.* — Scattering clams are found all along the shore flats, except for a ¾-mile strip on the west side. The soil is of a coarse sand or gravel.

(2) *Katama Bay.* — The best clam flats of the town are situated in Katama Bay, and extend over a considerable territory. These flats, consisting of a coarse, sandy soil, lie continually submerged. Here the clams are dug by means of a "sea horse." This "animal" is nothing more than an elongated clam hoe with a belt attachment, whereby the clammer can "churn" out the clams at a depth of 2 to 3 feet.

The clam industry of Edgartown has fallen off considerably since 1879. However, the clammers say that it has improved during the last fifteen years. The following comparison is made between the production of 1879 and 1907: —

COMPARISON OF 1907 WITH 1879.

YEAR.	Production for Food (Bushels).	Production for Bait (Bushels).	Total Production (Bushels).	Value of Production.
1879,	1,000	3,000	4,000	$1,570
1907,	625	575	1,200	1,000

The general shellfish regulations which govern the other shellfisheries of the town apply to the clam fishery; but the industry has never been considered important enough to need special legislation, and but slight attention has been given to it.

SUMMARY OF INDUSTRY.

Number of men,	7
Capital invested,	$50
Production, 1907: —	
Bushels,	1,200
Value,	$1,000
Total area (acres): —	
Sand,	150
Mud,	–
Gravel,	50
Mussels and eel grass,	–
Total,	200
Productive area (acres): —	
Good clamming,	20
Scattering clams,	100
Barren area possibly productive (acres),	50
Waste barren area (acres),	30
Possible normal production,	$33,000

In the opinion of many, doubtless, this report may appear unduly lengthy, and to include many seemingly trivial facts and unnecessary repetitions. To the trained observer, however, it seems of the greatest importance in dealing with such a practical and important problem to place on record all facts and opinions which may become of value, and to emphasize by frequent repetitions certain fundamental facts.

Respectfully submitted,

D. L. BELDING.

The preceding report is intended to be a reliable statement of facts, and suggestions for consideration. On such a basis of facts the future policy of developing the shellfisheries must be based. It is the purpose of the Commissioners on Fisheries and Game to hold a series of public hearings in the different sections of the State for the purpose of giving personal expositions of the shellfish conditions and possibilities, and of giving a better opportunity for exchanging, discussing and weighing opinions. Meantime, in considering the conditions of the shellfisheries of Massachusetts, and the laws necessary to improve these conditions, the following points are of importance.

The present shellfish laws are based upon the principle of "public" fisheries, and were made at times and at places where there was such a superabundance that the natural increase was sufficient to meet the market demands. Artificial cultivation was unnecessary. The fundamental laws were made in the colonial days. Since then the demand for shellfish as food has enormously increased, and for many years the annual natural increase has been entirely inadequate to meet these demands. We have outgrown the conditions which the original conception of that law covered. Under parallel conditions it has been found necessary to sell or lease the public lands, in order that the yield of food may be increased by cultivation under the immediate direction and responsibility of individual citizens, and under protection of State and national laws. When it was learned that the yield of a cultivated oyster bed far exceeded the natural product both in quantity and quality, the oyster laws were so modified that an important industry was built up, until to-day practically the entire oyster yield of Massachusetts, Rhode Island and Connecticut is from cultivated beds, and the total product is many times the total catch from the natural beds in their palmiest days. To-day not only is it necessary to so modify the oyster laws as to increase the opportunities for better utilizing our bays and estuaries for oyster growing on a more extensive scale than is done at present, but also for developing similar methods of growing clams and quahaugs, and perhaps also scallops. The tidal flats must, as well as the deeper waters, be made to produce food and money by securing a larger yield per acre, and by the utilization of thousands of acres which are now practically idle, but which either are now adapted for growing shellfish or can readily be made so.

Our present shellfish laws are a heterogeneous, conflicting patchwork, devised to meet temporary and local conditions, utterly inadequate to-day to permit the fishermen to secure a just return for their labor, and completely sacrificing the public interests. In many cases the responsible tax-paying citizen cannot find a place to dig a family supply of clams or quahaugs, neither can the industrious native fisherman get a fair day's pay for his labor.

An entirely new code of shellfish laws is necessary, based upon the general principles (1) that in selling the shores the State reserved the right of fishing as " far as the tide doth ebb and flow," and (2) that the State may now lease these fishing rights under such conditions and restrictions as to secure to every citizen so desiring and so deserving an opportunity to cultivate such a definite area as may meet his needs and powers. Experience has proved conclusively that it is a correct economic principle for the State to give a secure title to certain carefully defined lands to a capable man, and to say: " This land is yours. You may raise potatoes, corn, hay or anything you choose. Every plant, fruit or tree growing on this property is yours. You have become responsible for its right and proper use. You have full and complete rights in this property, and can develop it by investing your labor and your money according to your own judgment, and the State will protect you in these rights as long as you do not interfere with the rights of other persons." Equally so it is an indubitable economic fact that the landowner finds it more profitable to plant or transplant corn, potatoes, grass, strawberries, etc., rather than to depend upon the natural methods and yield. Similarly, it is equally logical for the State to give to the fisherman equal opportunities with the farmer. The State should guarantee the tenure of the fisherman in his definitely bounded shellfish garden, and should protect his interests and the property on that garden as securely as if it were potatoes or corn, and should, so far as possible, guard him from local jealousy or the effects of petty politics so long as he continues wisely to improve his grant in conformity to the spirit and letter of laws which are found by experience to give the greatest good to the greatest number.

Further, the State should protect the fishermen and the consumers of shellfish by defining the areas which from a sanitary point of view are (1) totally unsuitable for shellfish cultivation; (2) those where shellfish may be grown but not eaten; and, finally, (3) definite areas from which alone shellfish may be sold for food. Provide suitable penalties for sale of shellfish which have not been kept for the required time (at least thirty days) in sanitary surroundings before going to market. The entire question of pollution of streams and estuaries must be carefully considered in view of the public rights and of the commercial interests of the fishermen. Further, the laws must be so carefully drawn that the respective rights and interests of individual fishermen, shore owners, summer cottagers and the transient public at the seashore are completely safeguarded against the dangers of predatory wealth monopolizing the opportunities for cultivating shellfish in the waters and the tidal flats.

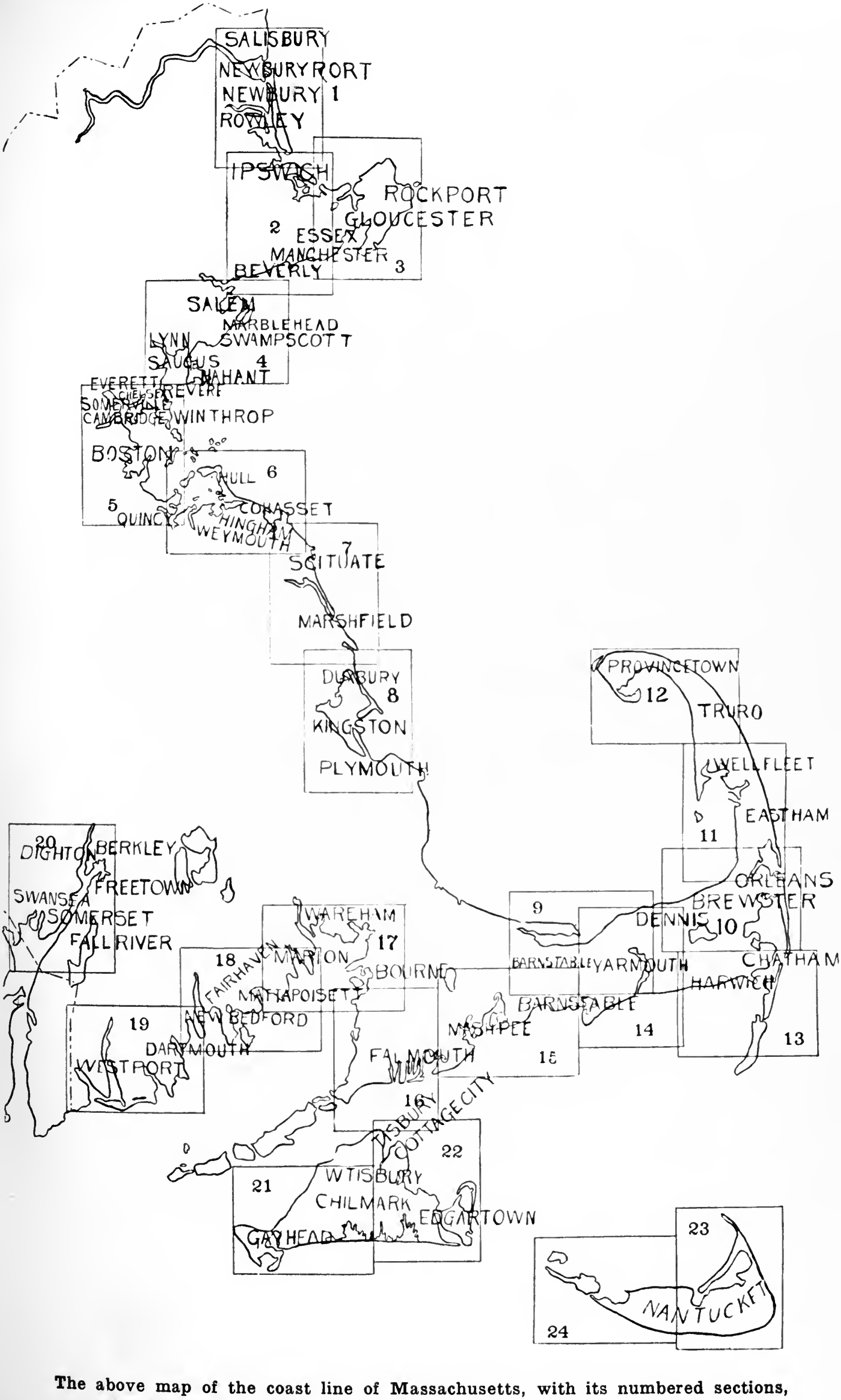
The situation is extremely complicated on account of the diverse conditions and the numerous conflicting interests, oystermen, quahaugers, clammers and scallopers, native and alien fishermen, owners of shore property, town and State rights, local interests and petty politics, and careful judicial consideration is necessary not alone as to the substance of the necessary laws, but upon the methods of administering these laws.

Respectfully submitted,

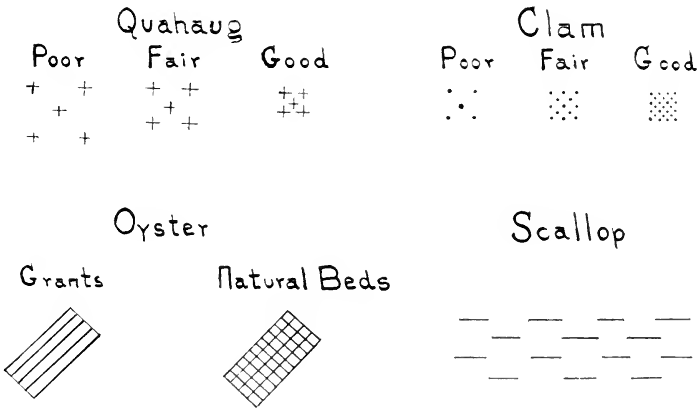
G. W. FIELD.
J. W. DELANO.
G. H. GARFIELD.

INDEX.

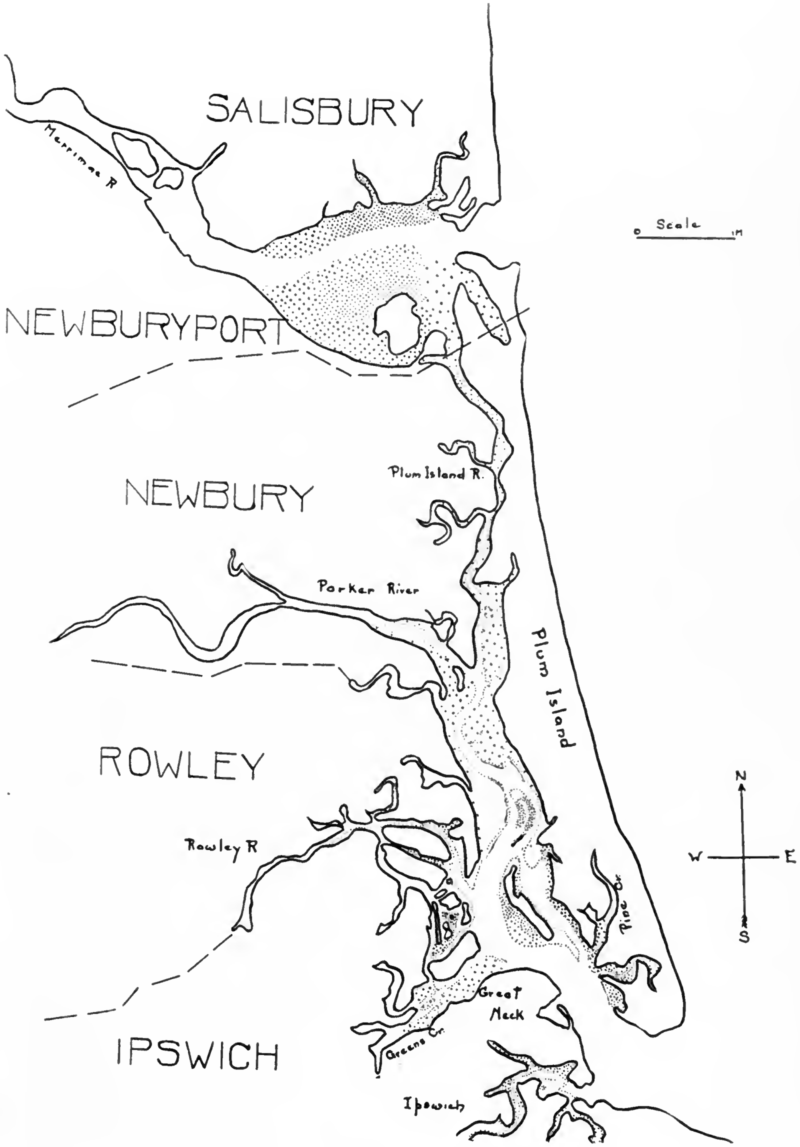
INDEX.



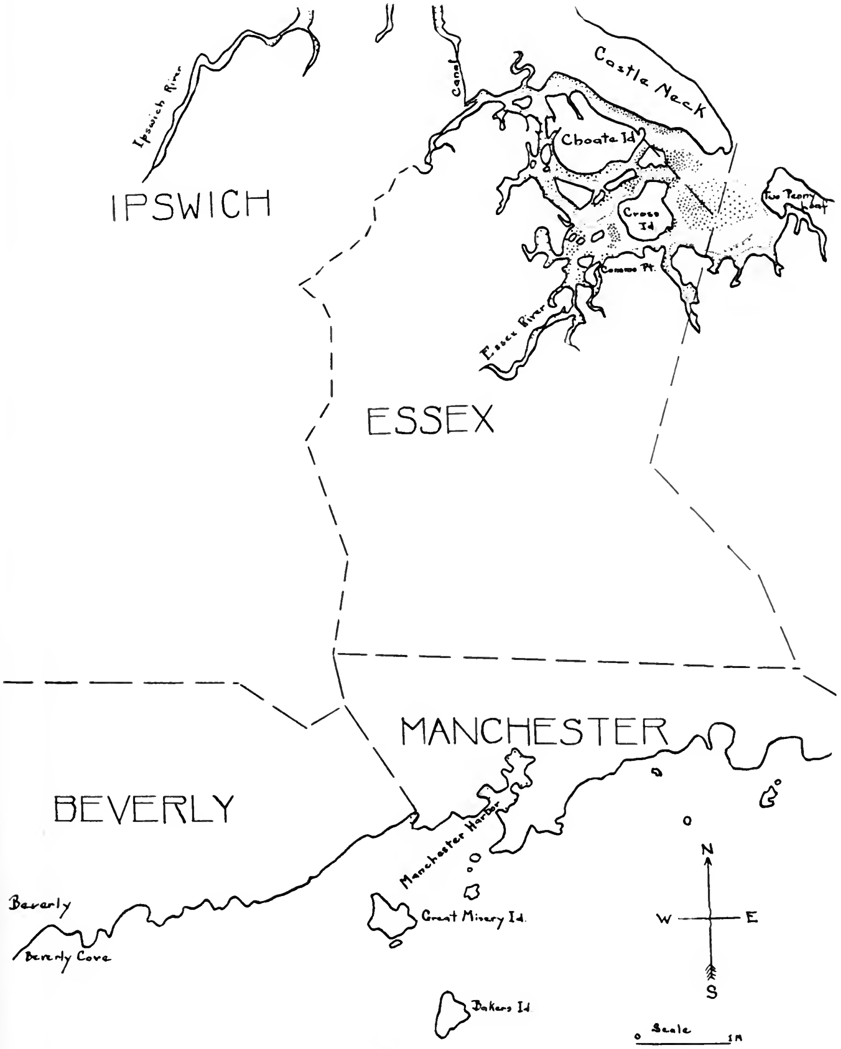
The above map of the coast line of Massachusetts, with its numbered sections, furnishes an index to the following series of shellfish areas.



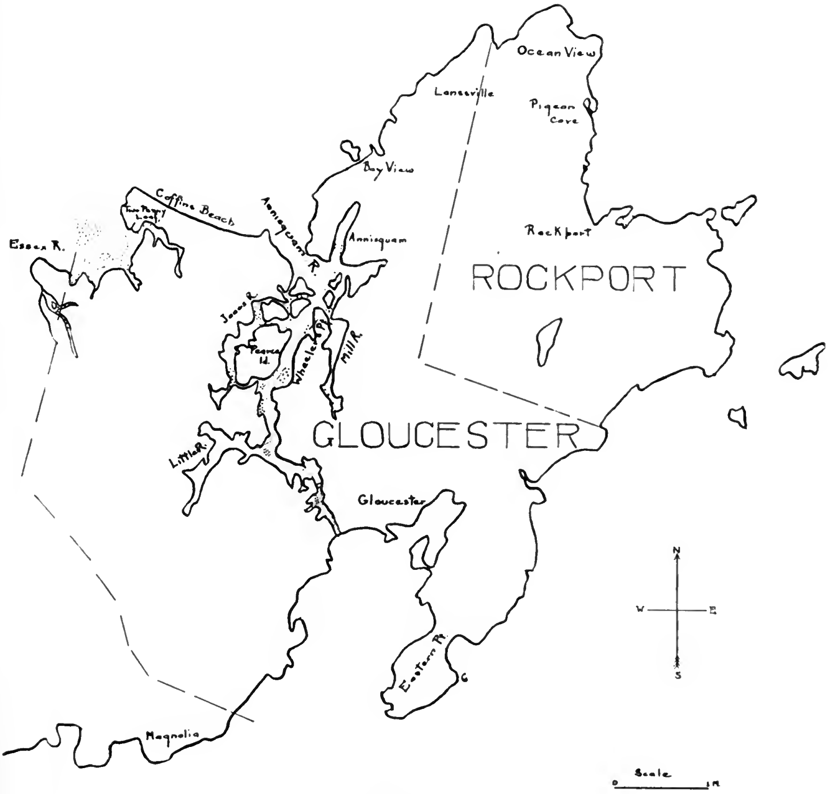
The above characters, as used on the following maps, indicate the position and relative quantities of the various shellfish in their respective localities. No attempt is made to give the relative abundance of scallops and oysters, while the present productive value of the different clam and quahaug areas is indicated by different standards of marking.


SALISBURY
Merrimac R
Scale
NEWBURYPORT
NEWBURY
Plum Island R.
Parker River
Plum Island
ROWLEY
N
W
E
S
Rowley R
Rice Cr.
Great Neck
Greens Cr.
IPSWICH
Ipswich

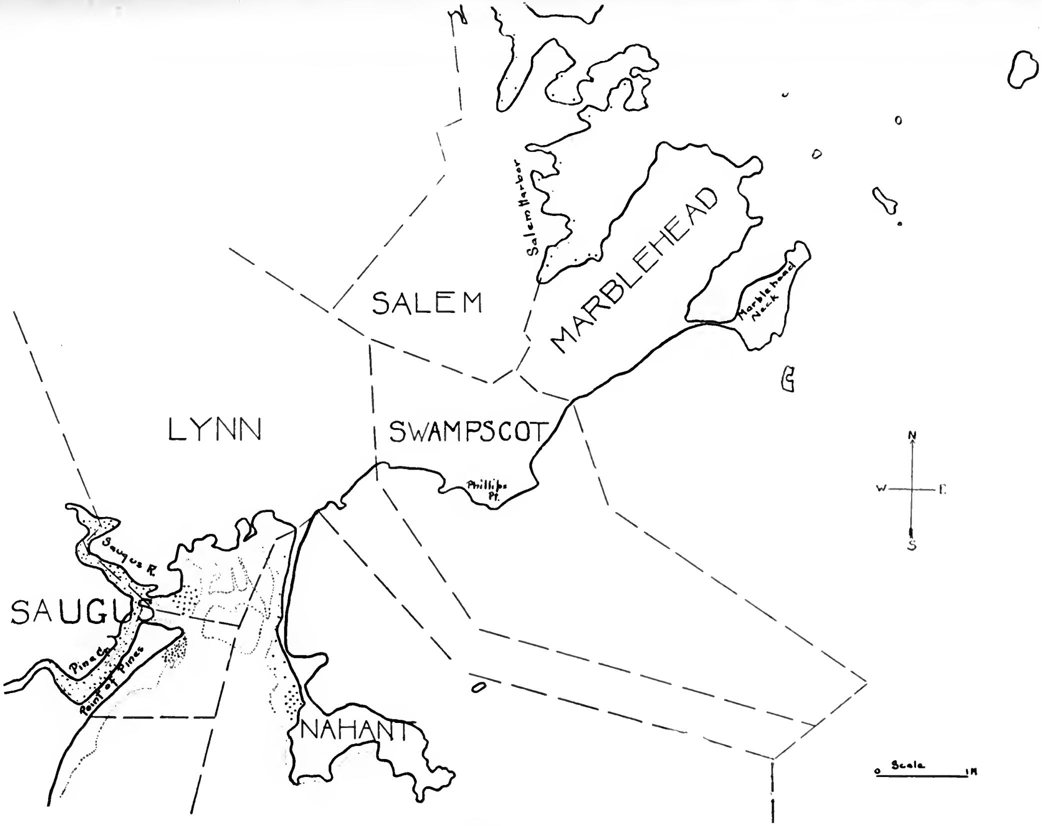
Map 1.


Ipswich River
Canal
Castle Neck
Choate Id
Cross Id
Two Penny Loaf
Essex River
IPSWICH
ESSEX
MANCHESTER
BEVERLY
Manchester Harbor
Great Misery Id.
Bakers Id
Beverly
Beverly Cove
N
W
E
S
Scale

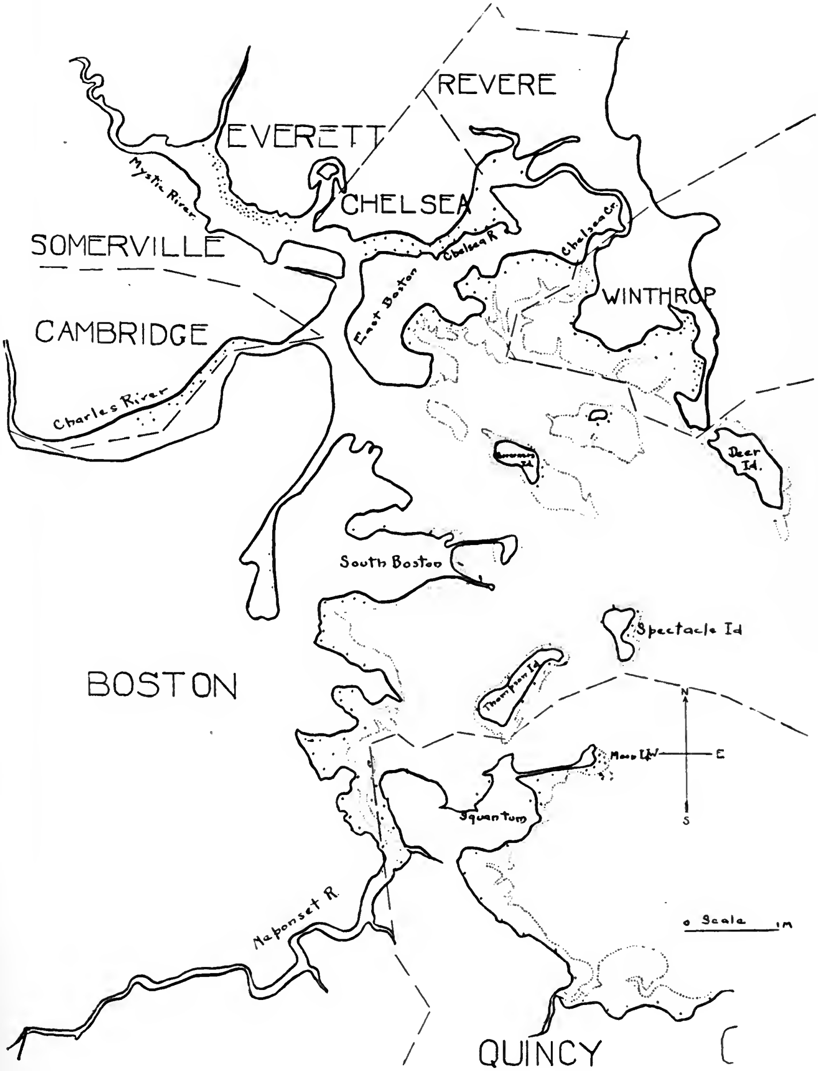
Map 2.


Ocean View
Lanesville
Pigeon Cove
Bay View
Rockport
ROCKPORT
Annisquam
Annisquam R.
Coffins Beach
Essex R.
Jones R.
Mill R.
GLOUCESTER
Little R.
Gloucester
Eastern Pt.
Magnolia
N
W
E
S
Scale

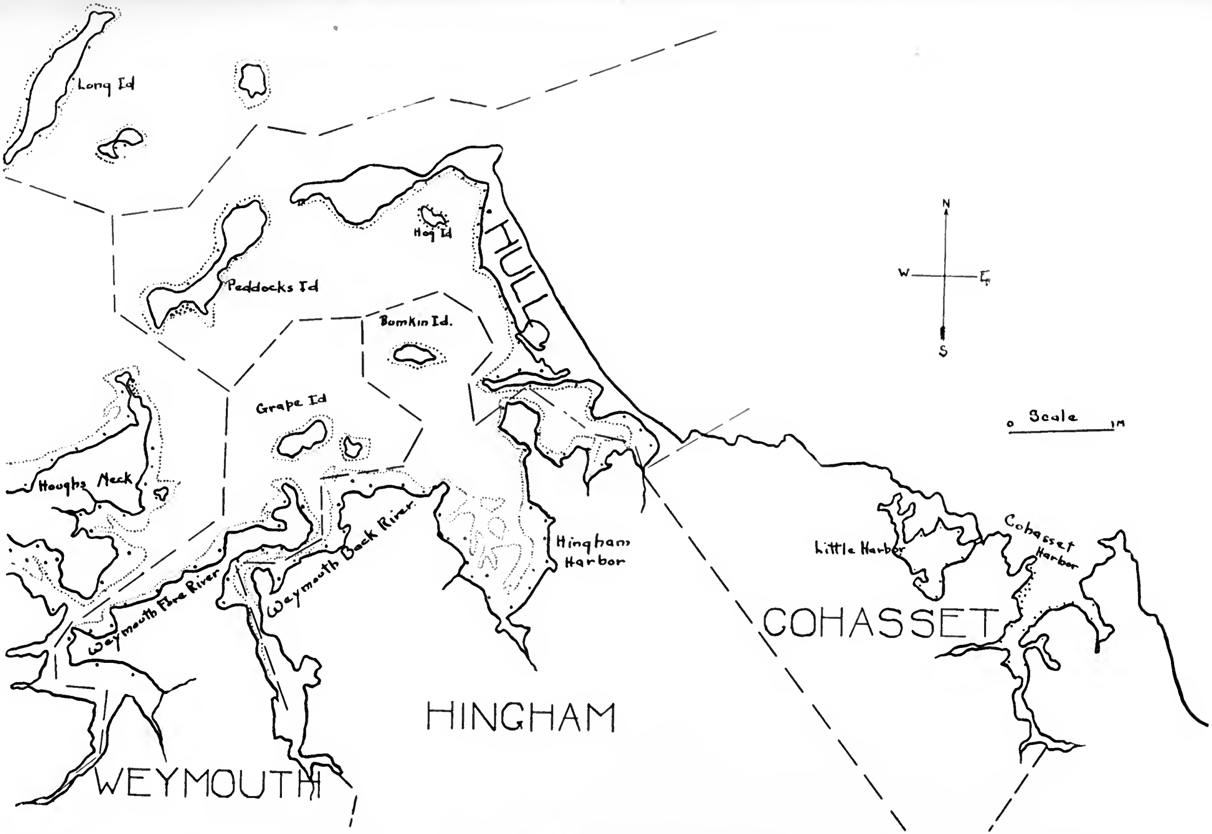
Map 3.


SALEM
Salem Harbor
MARBLEHEAD
Marblehead Neck
LYNN
SWAMPSCOT
Phillips Pt.
Saugus R.
SAUGUS
Pine Co.
Point of Pines
NAHANT
N
W
E
S
0 Scale 1M

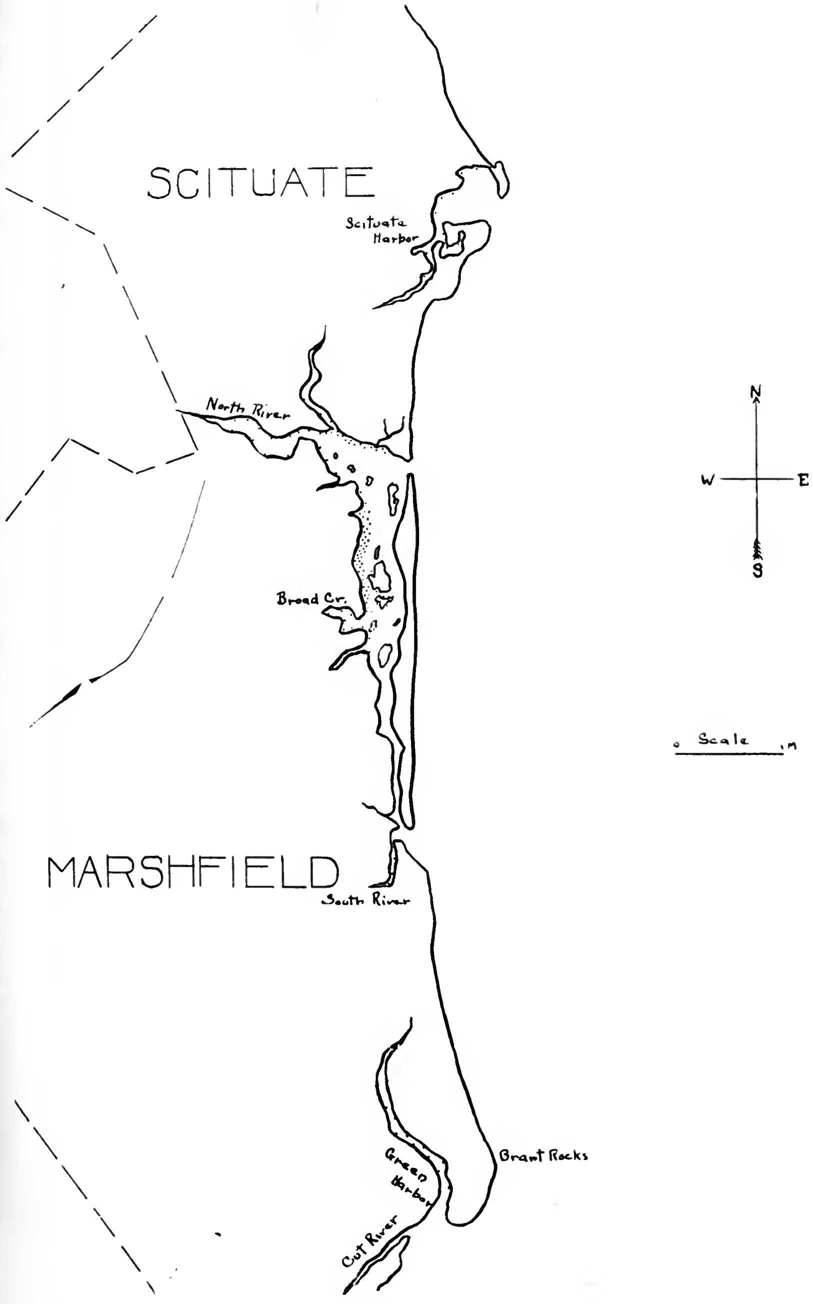
Map 4.


REVERE
EVERETT
Mystic River
CHELSEA
Chelsea R.
Chelsea Cr.
SOMERVILLE
CAMBRIDGE
East Boston
WINTHROP
Charles River
Deer Id.
South Boston
Spectacle Id
BOSTON
Thompson Id
N
E
S
Squantum
Neponset R.
Scale
QUINCY

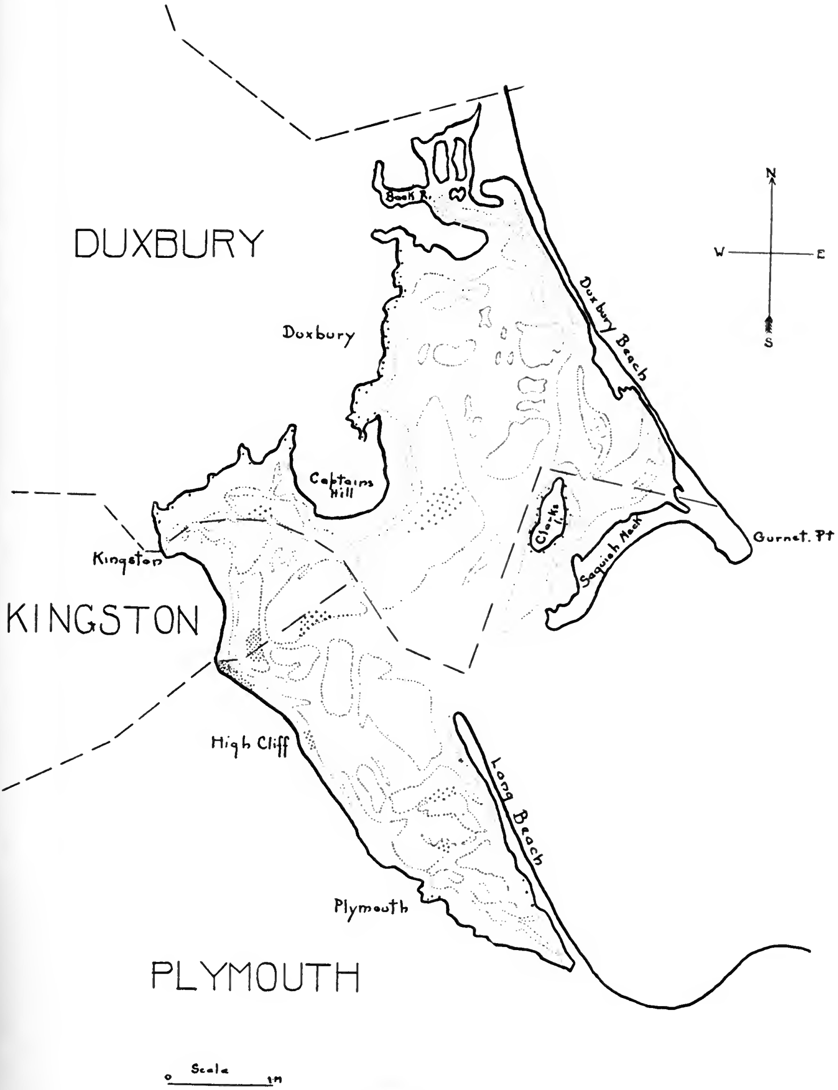
Map 5.


Long Id
Peddocks Id
Hog Id
HULL
Bumkin Id.
Grape Id
Houghs Neck
Weymouth Fore River
Weymouth Back River
Hingham Harbor
Little Harbor
Cohasset Harbor
N
W
E
S
0 Scale 1M
COHASSET
HINGHAM
WEYMOUTH

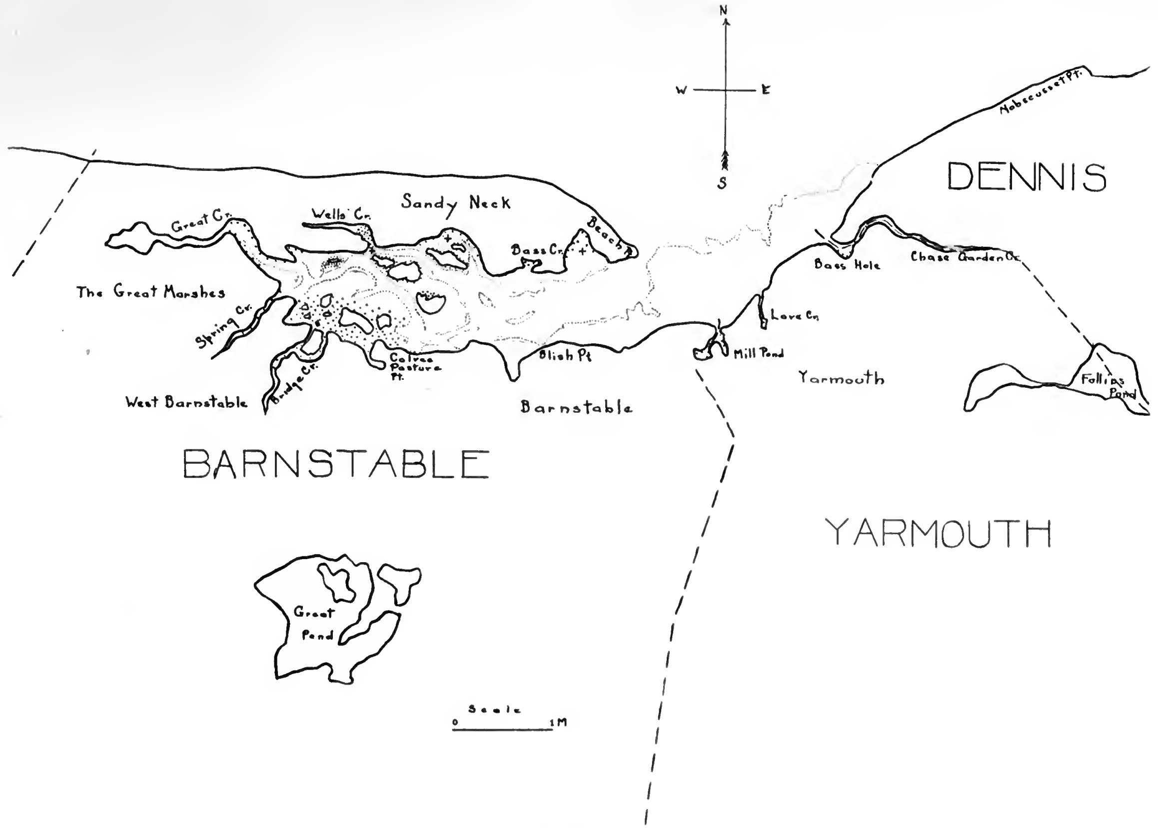
Map 6.


SCITUATE
Scituate Harbor
North River
Broad Cr.
MARSHFIELD
South River
Brant Rocks
Green Harbor
Cut River
N
W
E
S
0 Scale 1M

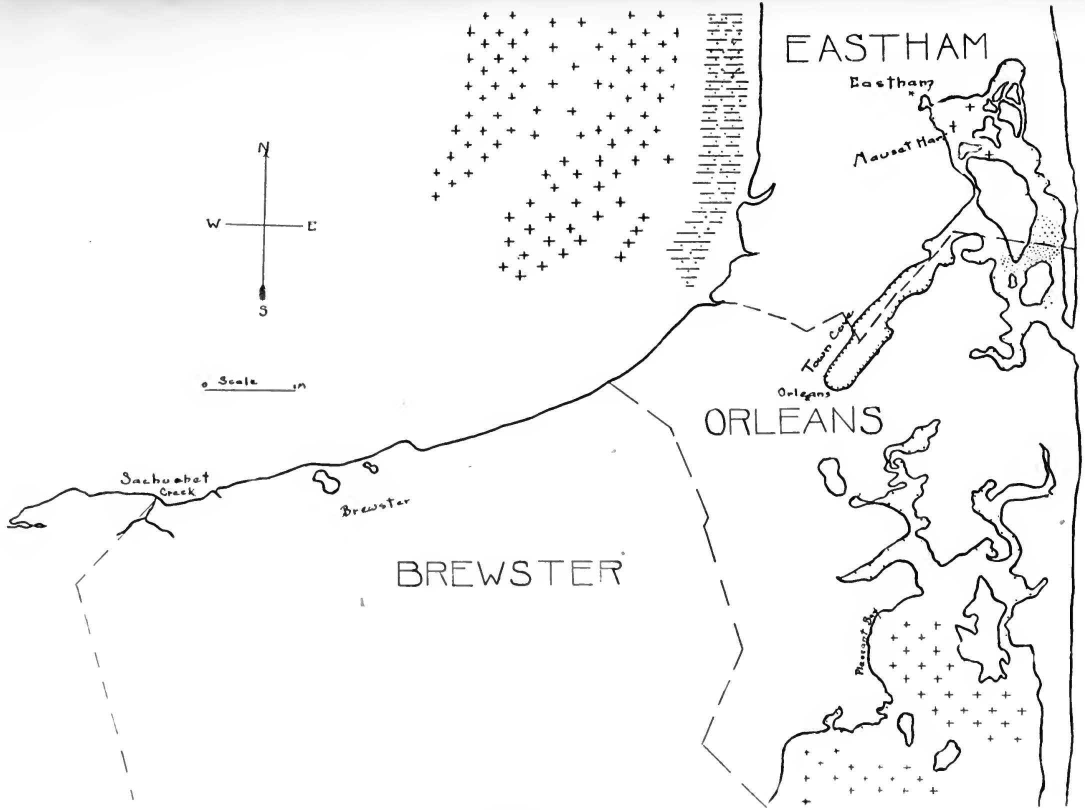
Map 7.


DUXBURY
Duxbury
Captains Hill
Duxbury Beach
Gurnet Pt
Saquish Neck
Clarks I.
Kingston
KINGSTON
High Cliff
Long Beach
Plymouth
PLYMOUTH
N
W
E
S
Scale
0
1 M

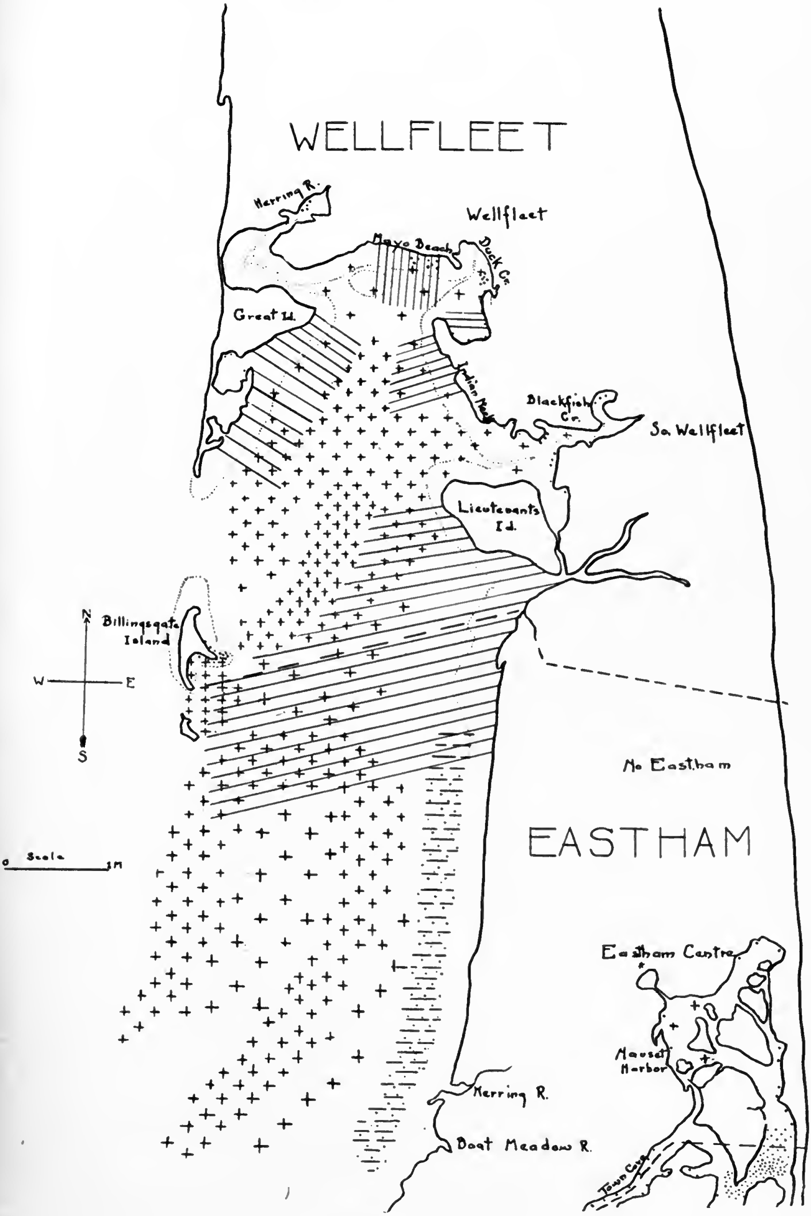
Map 8.


N
W
E
S
DENNIS
Nobscusset Pt.
Sandy Neck
Wells Cr.
Great Cr.
Bass Cr.
Beach Pt.
The Great Marshes
Spring Cr.
Bridge Cr.
West Barnstable
Calves Pasture Pt.
Blish Pt
Barnstable
Mill Pond
Love Cr.
Bass Hole
Chase Garden Cr.
Yarmouth
Follins Pond
BARNSTABLE
YARMOUTH
Great Pond
Scale
0
1M

Map 9.

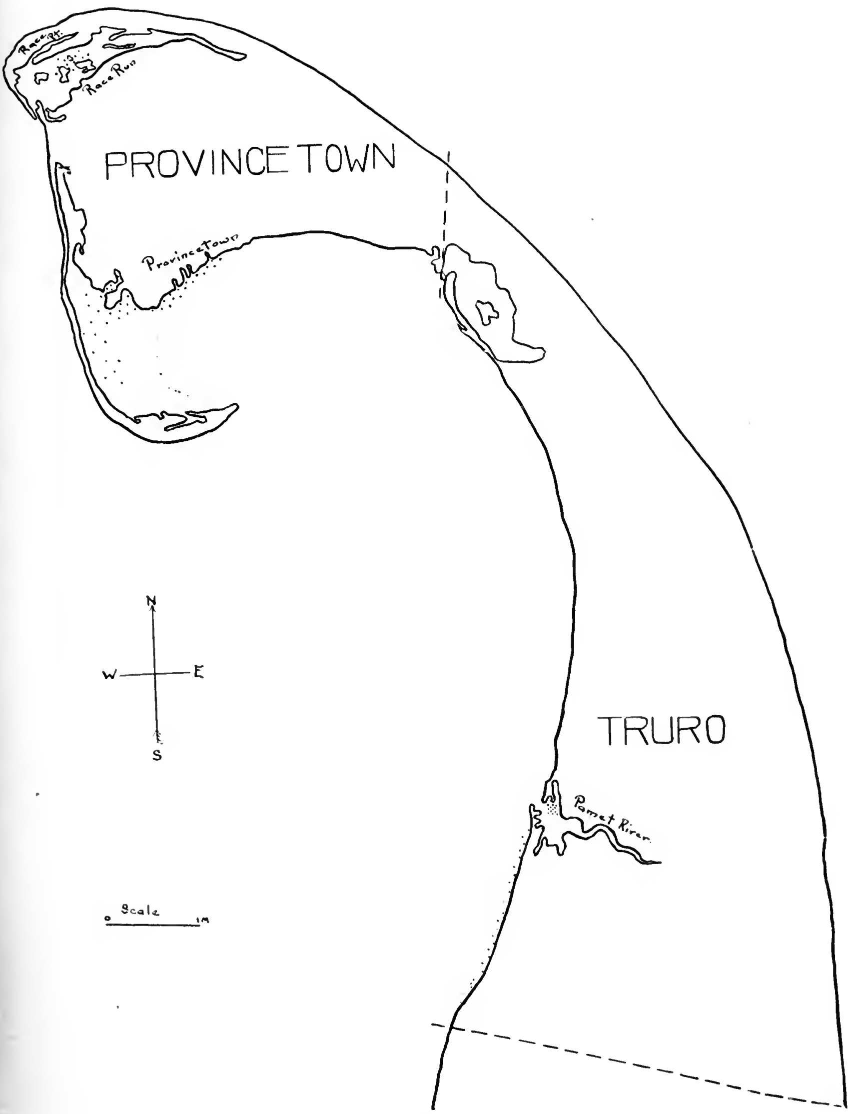

EASTHAM
Eastham
Nauset Har.
Town Cove
Orleans
ORLEANS
Pleasant Bay
BREWSTER
Brewster
Sachuebet Creek
N
W
E
S
0 Scale in

Map 10.



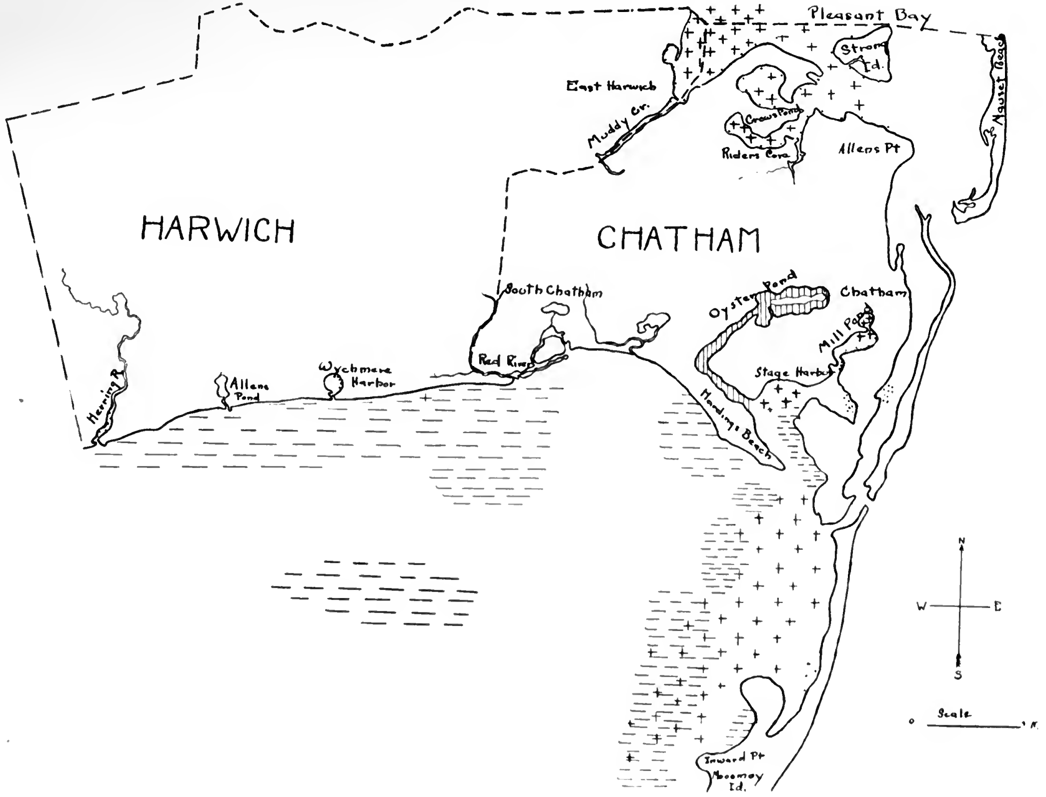
WELLFLEET
Herring R.
Wellfleet
Mayo Beach
Duck Cr.
Great Id.
Indian Neck
Blackfish Cr.
So. Wellfleet
Lieutenants Id.
Billingsgate Island
N
W
E
S
Scale
No Eastham
EASTHAM
Eastham Centre
Nauset Harbor
Herring R.
Boat Meadow R.
Town Cove

Map 11.



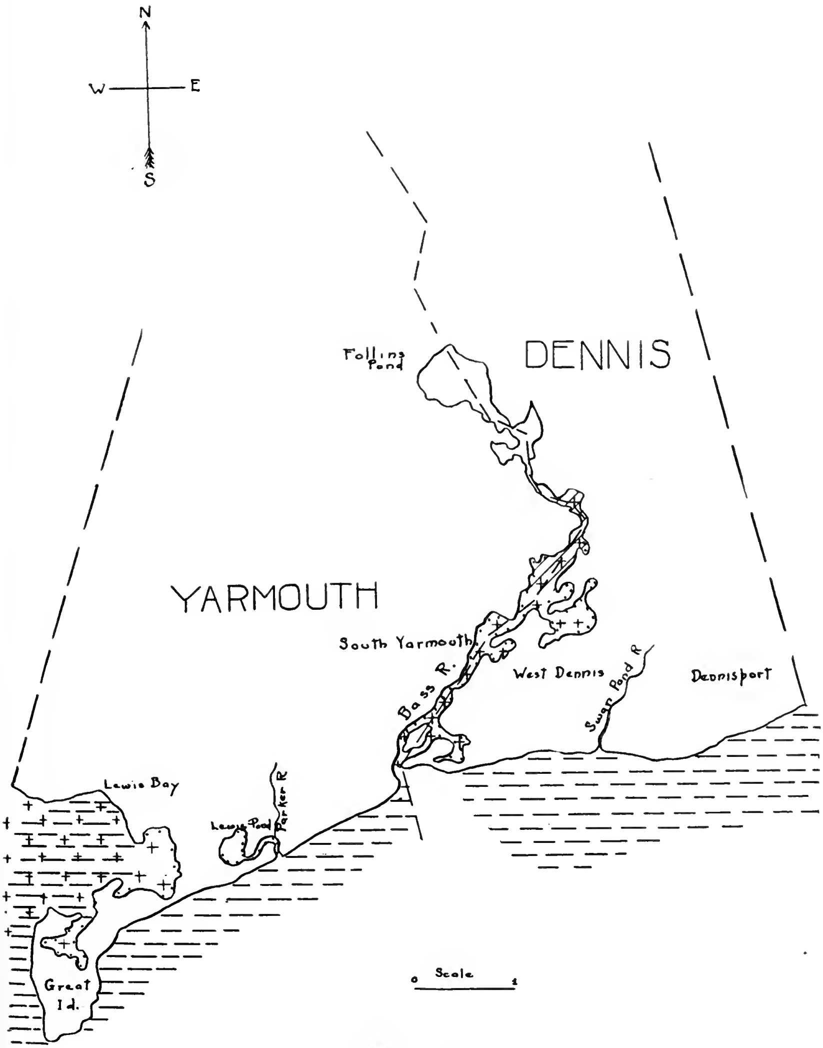
Race Pt.
Race Run
PROVINCE TOWN
Provincetown
TRURO
Pamet River
N
W
E
S
Scale
0
1 M

Map 12.

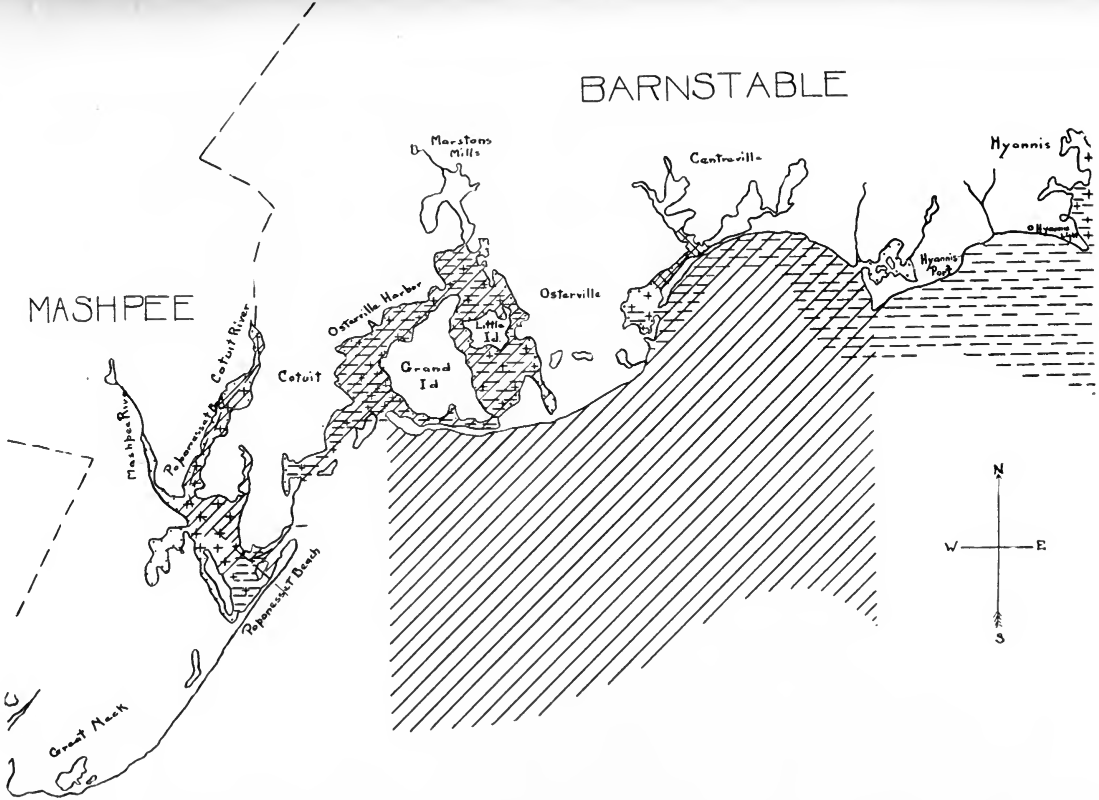


Pleasant Bay
Strong Id.
Nauset Beach
East Harwich
Muddy Cr.
Crows Pond
Riders Cove
Allens Pt
HARWICH
CHATHAM
South Chatham
Oyster Pond
Chatham
Mill Pond
Stage Harbor
Red River
Wychmere Harbor
Allens Pond
Herring R.
Hardings Beach
Inward Pt
Monomoy Id.
N
W
E
S
Scale

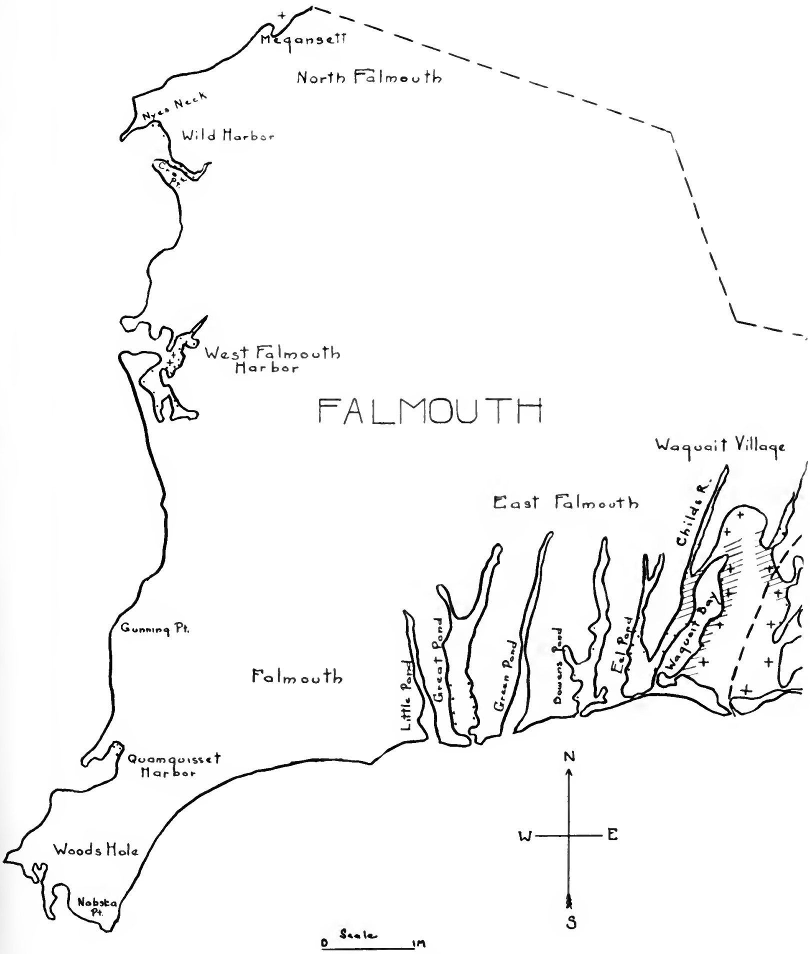
Map 13.


N
W
E
S
DENNIS
Follins Pond
YARMOUTH
South Yarmouth
Bass R.
West Dennis
Swan Pond R.
Dennisport
Lewis Bay
Lewis Pond
Parker R.
Great Id.
Scale
0
1

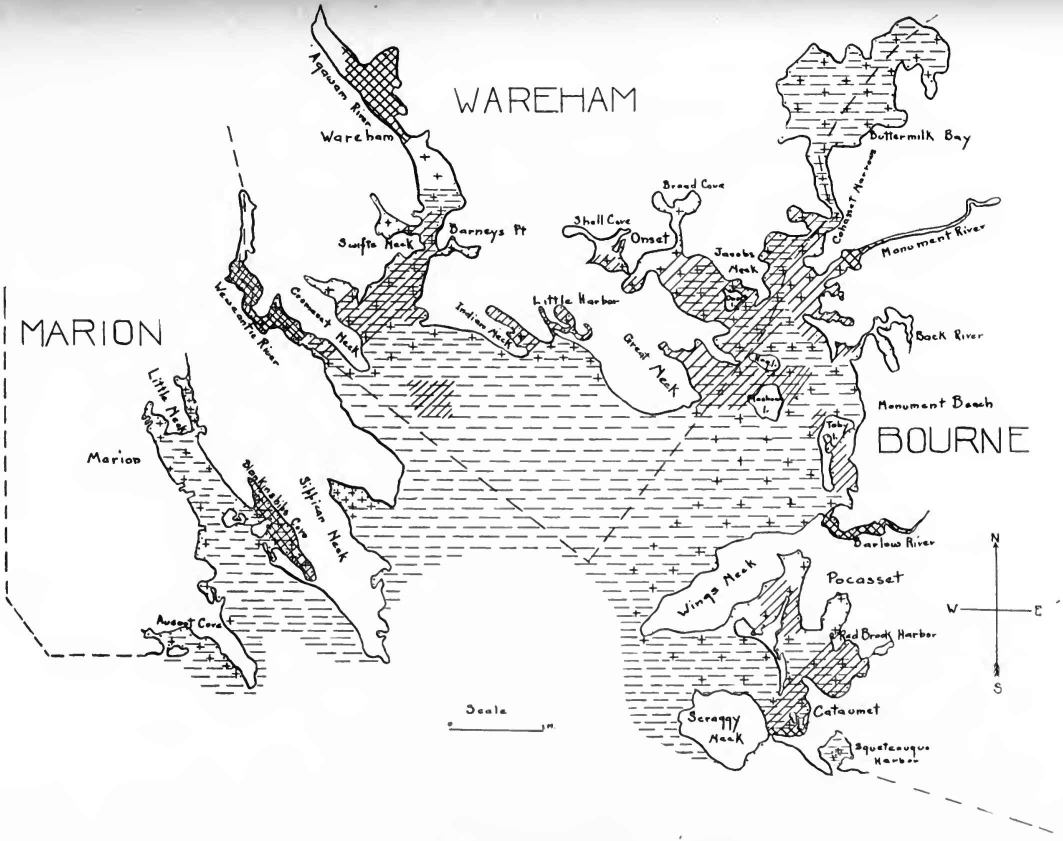
Map 14.


BARNSTABLE
MASHPEE
Marstons Mills
Centreville
Hyannis
Hyannis Port
Osterville
Osterville Harbor
Little Id
Grand Id
Cotuit
Cotuit River
Mashpee River
Poponesset Beach
Great Neck
N
W
E
S

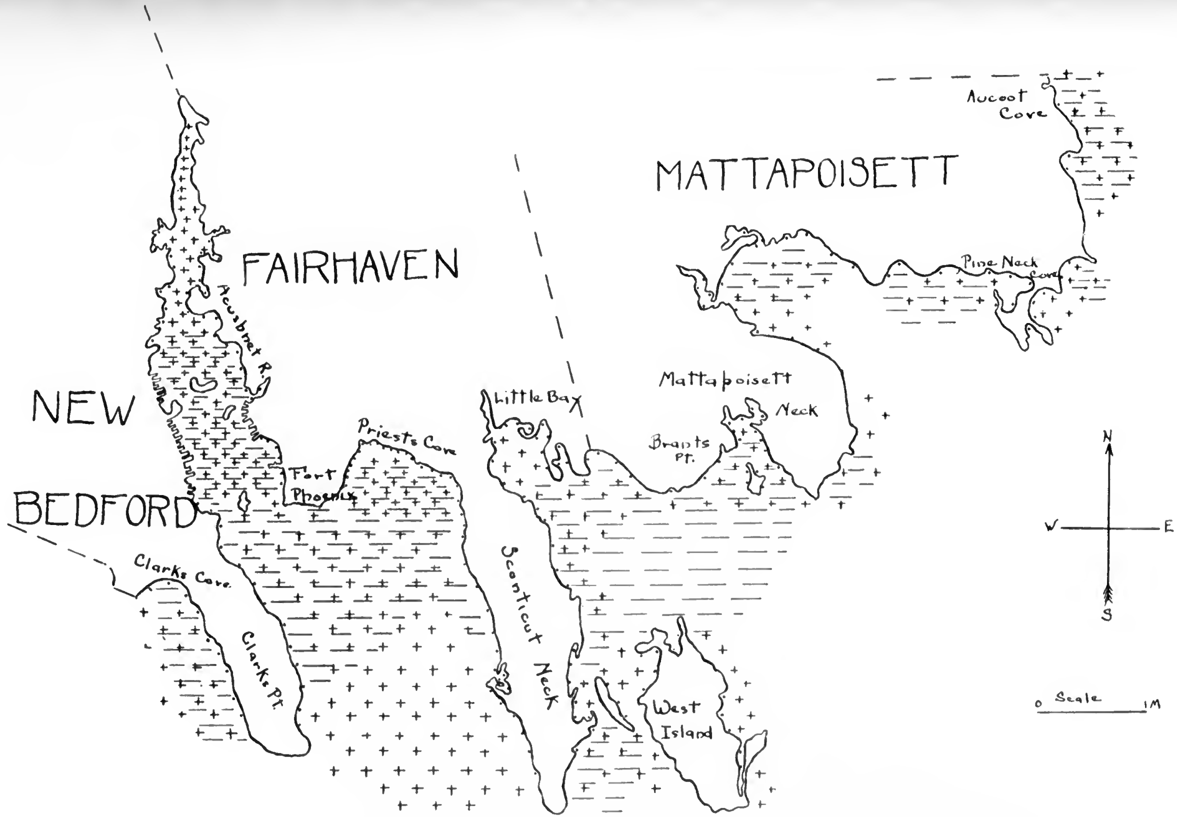
Map 15.


Megansett
North Falmouth
Nyes Neck
Wild Harbor
West Falmouth
Harbor
FALMOUTH
Waquoit Village
East Falmouth
Childs R.
Waquoit Bay
Eel Pond
Bowens Pond
Green Pond
Great Pond
Little Pond
Gunning Pt.
Falmouth
Quamquisset
Harbor
Woods Hole
Nobska
Pt.
N
W
E
S
0 Scale 1M

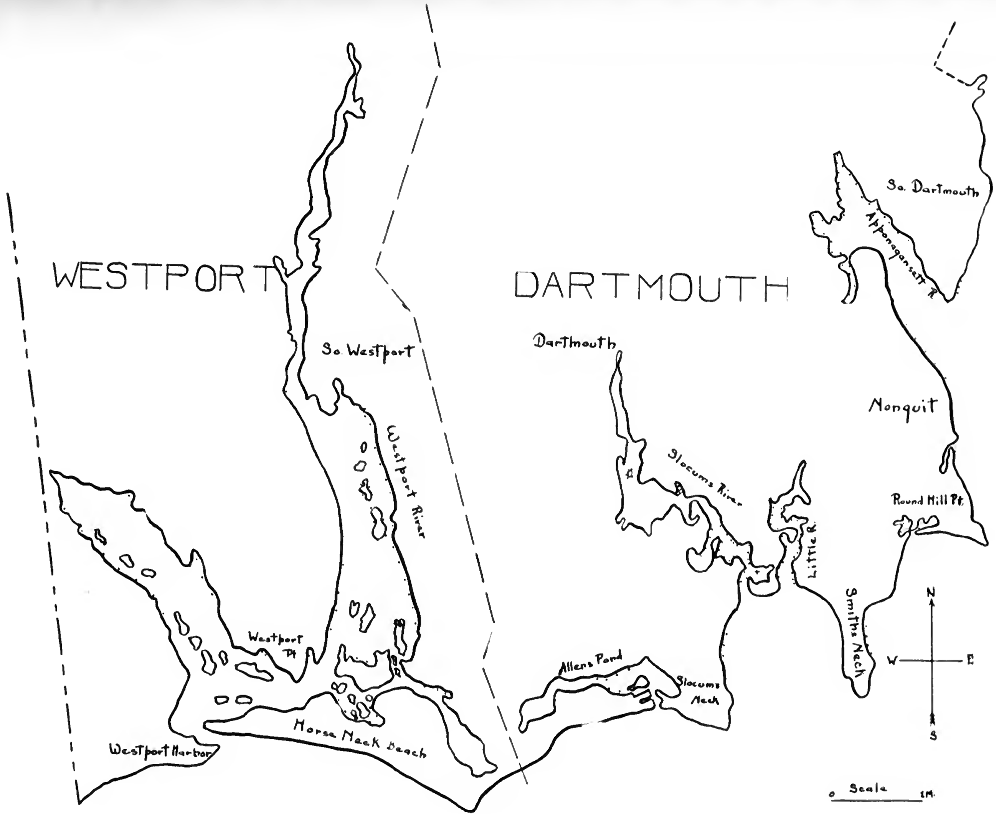
Map 16.


WAREHAM
MARION
BOURNE
Agawam River
Wareham
Swifts Neck
Barneys Pt
Shell Cove
Broad Cove
Onset
Jacobs Neck
Buttermilk Bay
Cohasset Narrows
Monument River
Wewewantic River
Cromeset Neck
Indian Neck
Little Harbor
Great Neck
Back River
Monument Beach
Toby I.
Little Neck
Marion
Blankinship Cove
Sippican Neck
Aucoot Cove
Barlow River
Pocasset
Wings Neck
Red Brook Harbor
Cataumet
Scraggy Neck
Squeteague Harbor
Scale
N
S
W
E

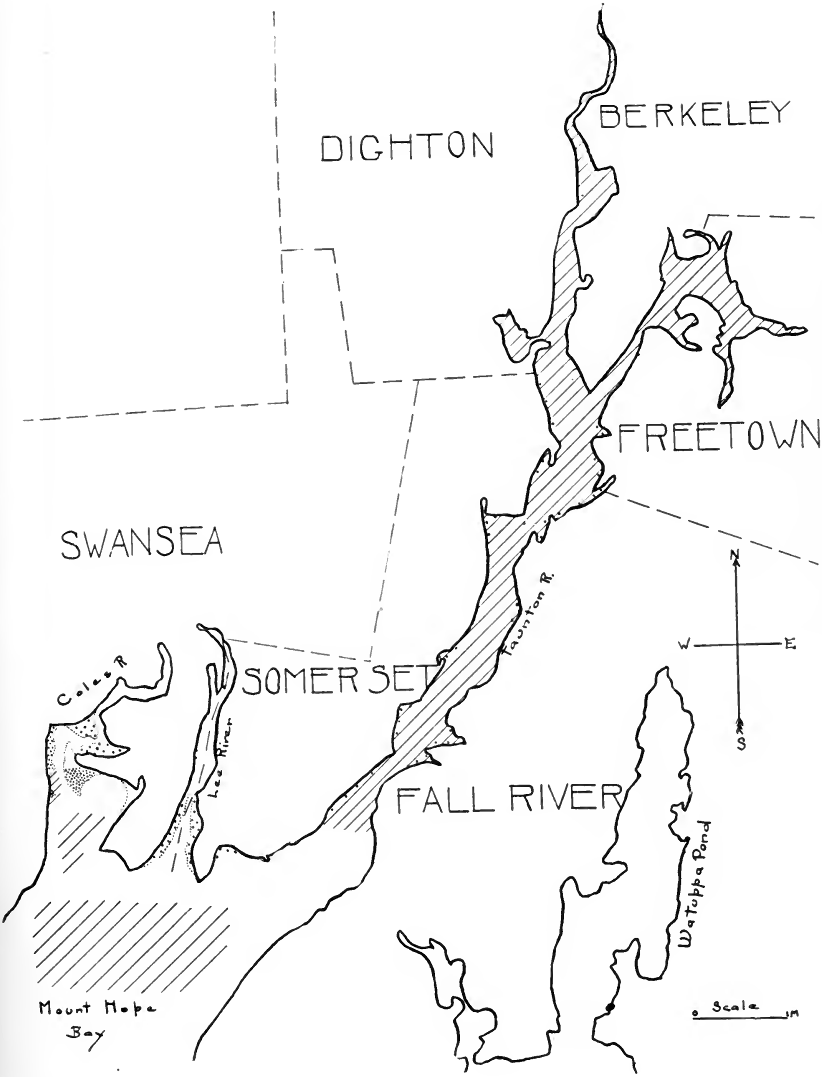
Map 17.


MATTAPOISETT
Aucoot Cove
Pine Neck Cove
FAIRHAVEN
Acusbnet R.
NEW BEDFORD
Fort Phoenix
Priests Cove
Little Bay
Mattapoisett Neck
Brants Pt.
Clarks Cove
Clarks Pt.
Sconticut Neck
West Island
N
W
E
S
0 Scale 1M

Map 18.

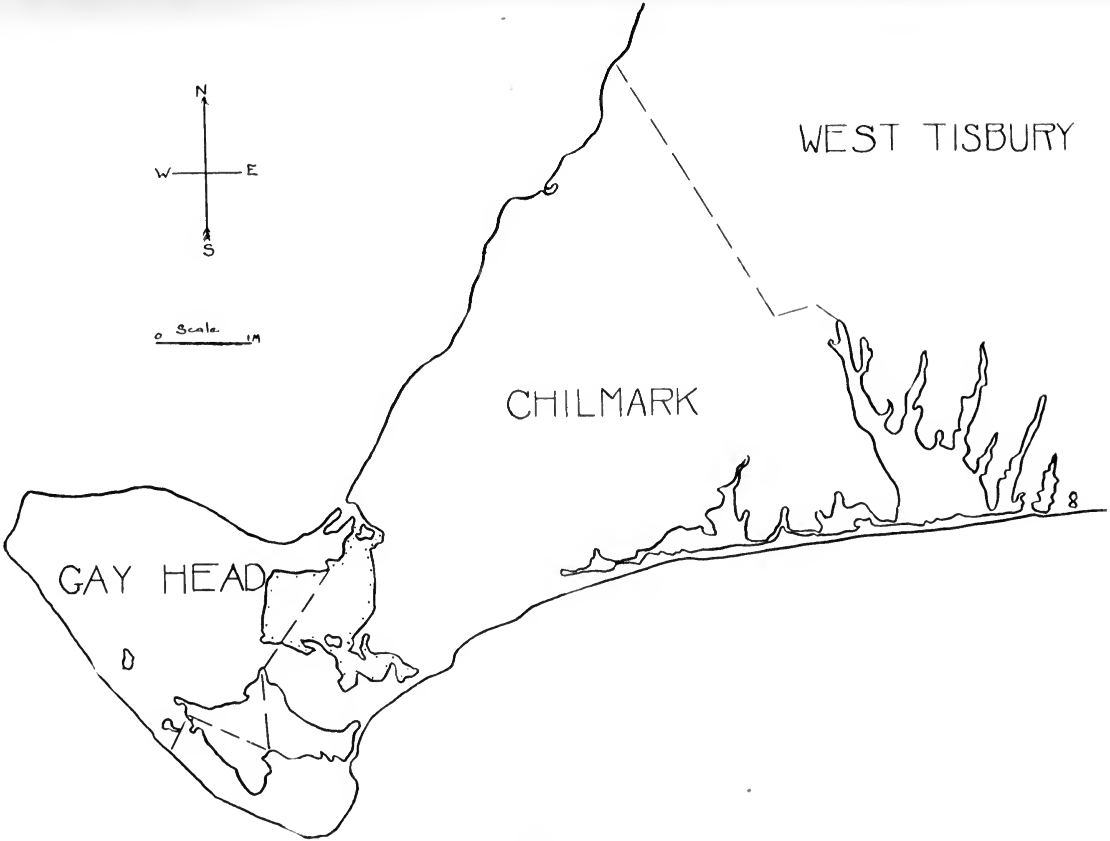

WESTPORT
DARTMOUTH
So. Dartmouth
Apponagansett R.
Nonquit
Round Hill Pt.
Smiths Neck
Little R.
Slocums River
Dartmouth
Allens Pond
Slocums Neck
So. Westport
Westport River
Westport Pt.
Horse Neck Beach
Westport Harbor
N
S
E
W
0 Scale 1M.

Map 19.

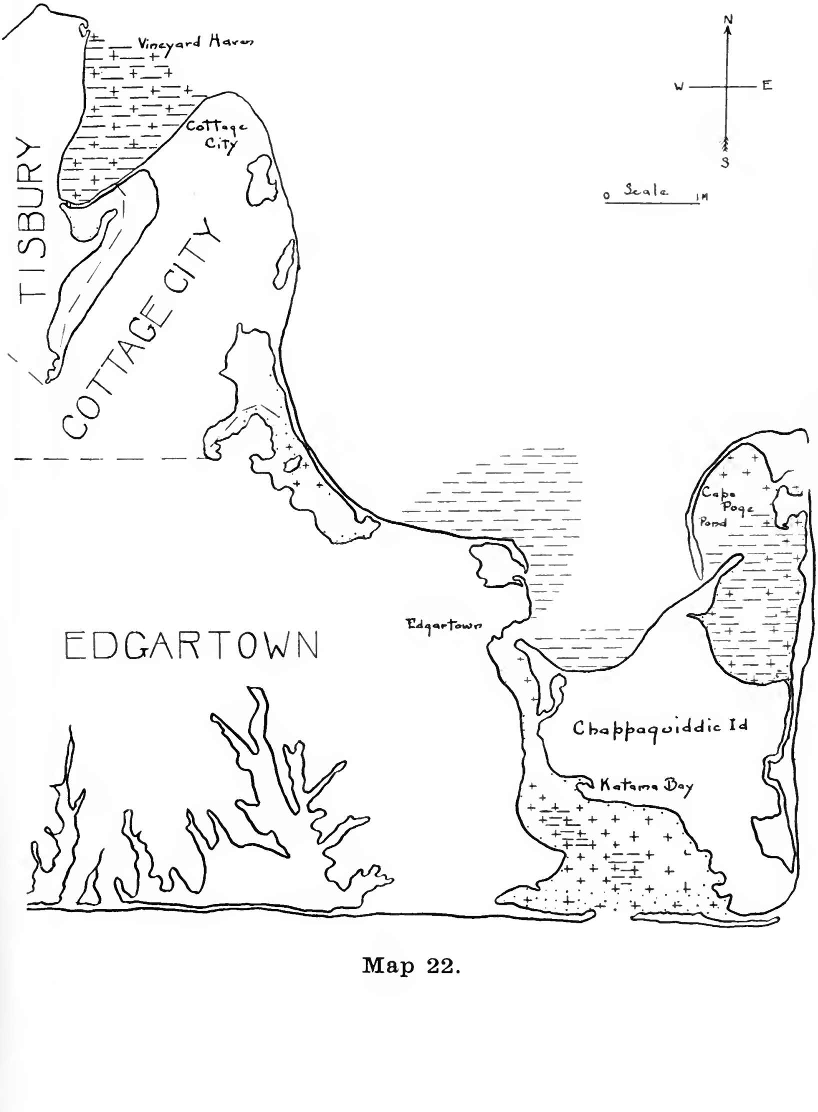


BERKELEY
DIGHTON
FREETOWN
SWANSEA
Taunton R.
SOMERSET
Coles R
Lee River
FALL RIVER
Watuppa Pond
N
W
E
S
Scale
Mount Hope
Bay

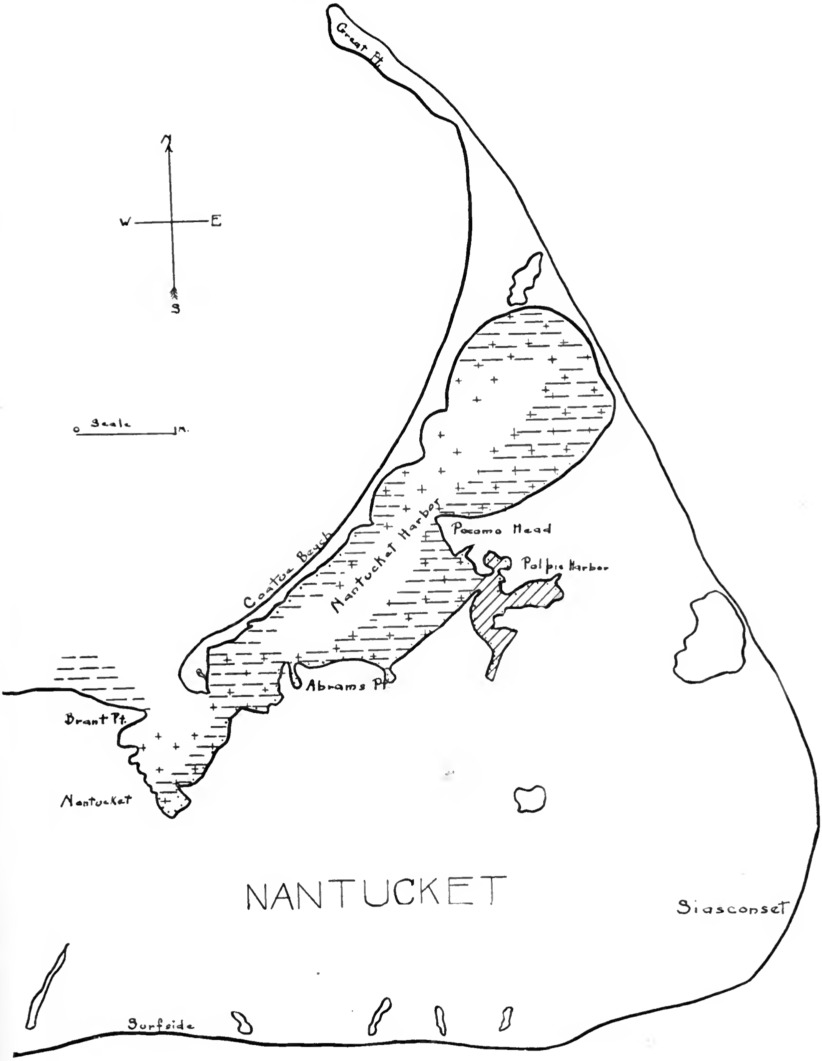
Map 20.



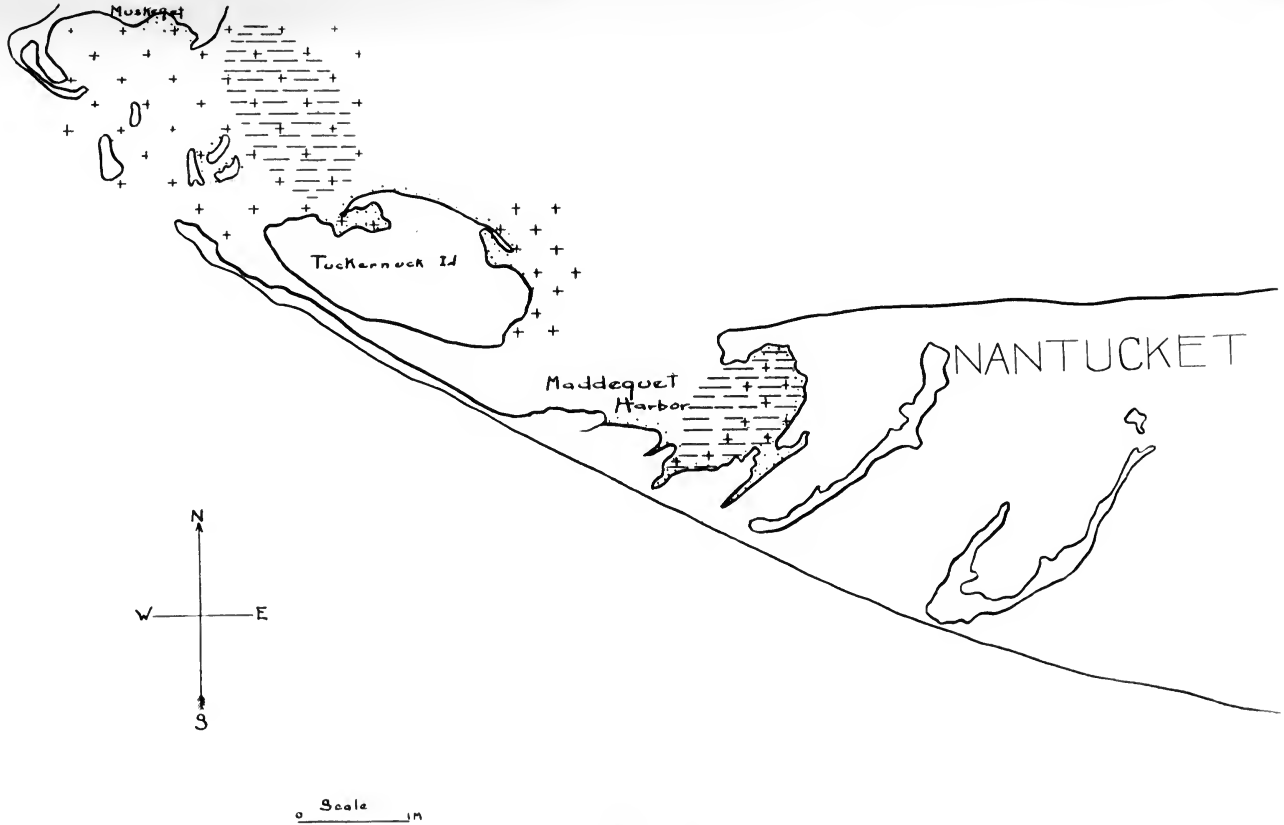
Map 21.


Vineyard Haven
Cottage City
TISBURY
COTTAGE CITY
N
W
E
S
Scale
0
1M
EDGARTOWN
Edgartown
Cape Poge Pond
Chappaquiddic Id
Katama Bay

Map 22.

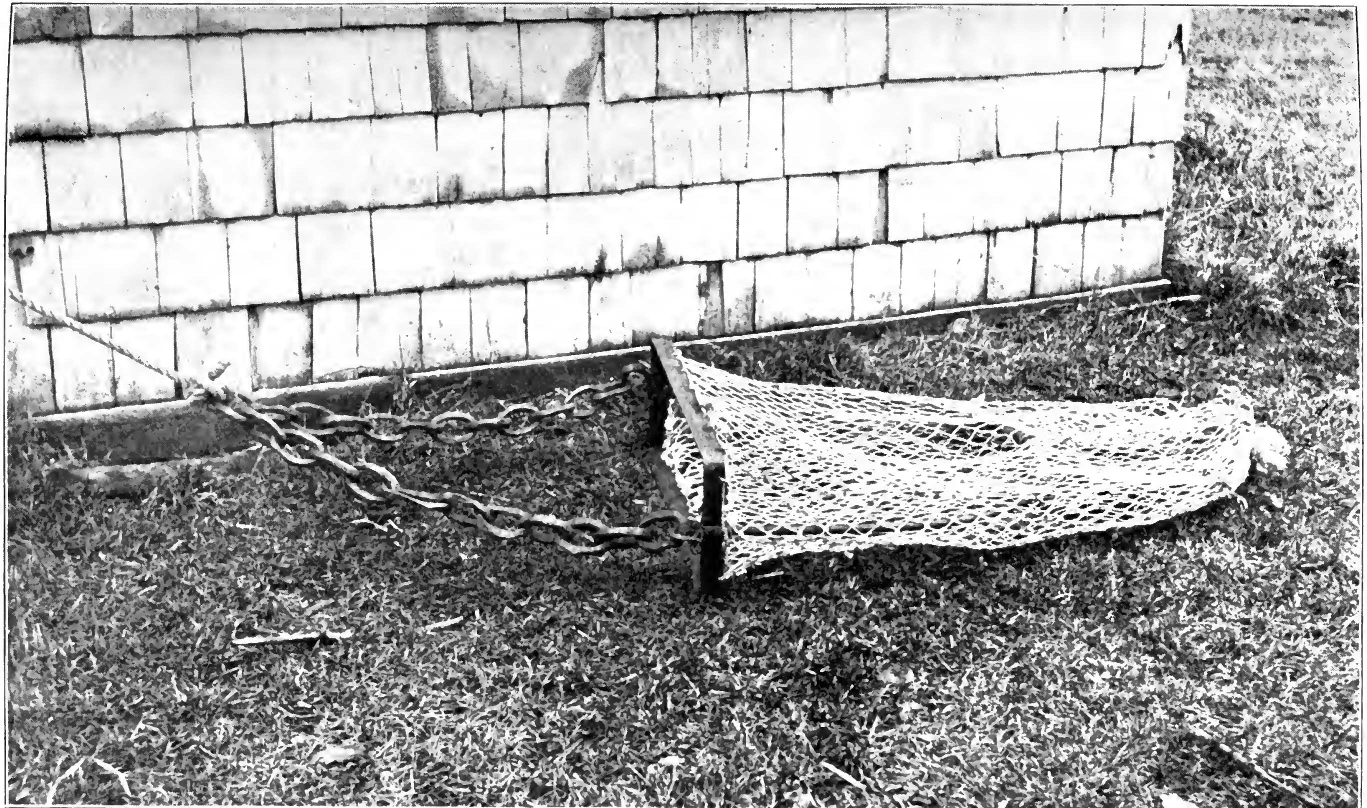

Great Pt.
W
E
S
Scale
Coatue Beach
Nantucket Harbor
Pocomo Head
Polpis Harbor
Abrams Pt.
Brant Pt.
Nantucket
NANTUCKET
Siasconset
Surfside

Map 23.


Muskeget
Tuckernuck Id
Maddequet
Harbor
NANTUCKET
N
W
E
S
0 Scale 1M

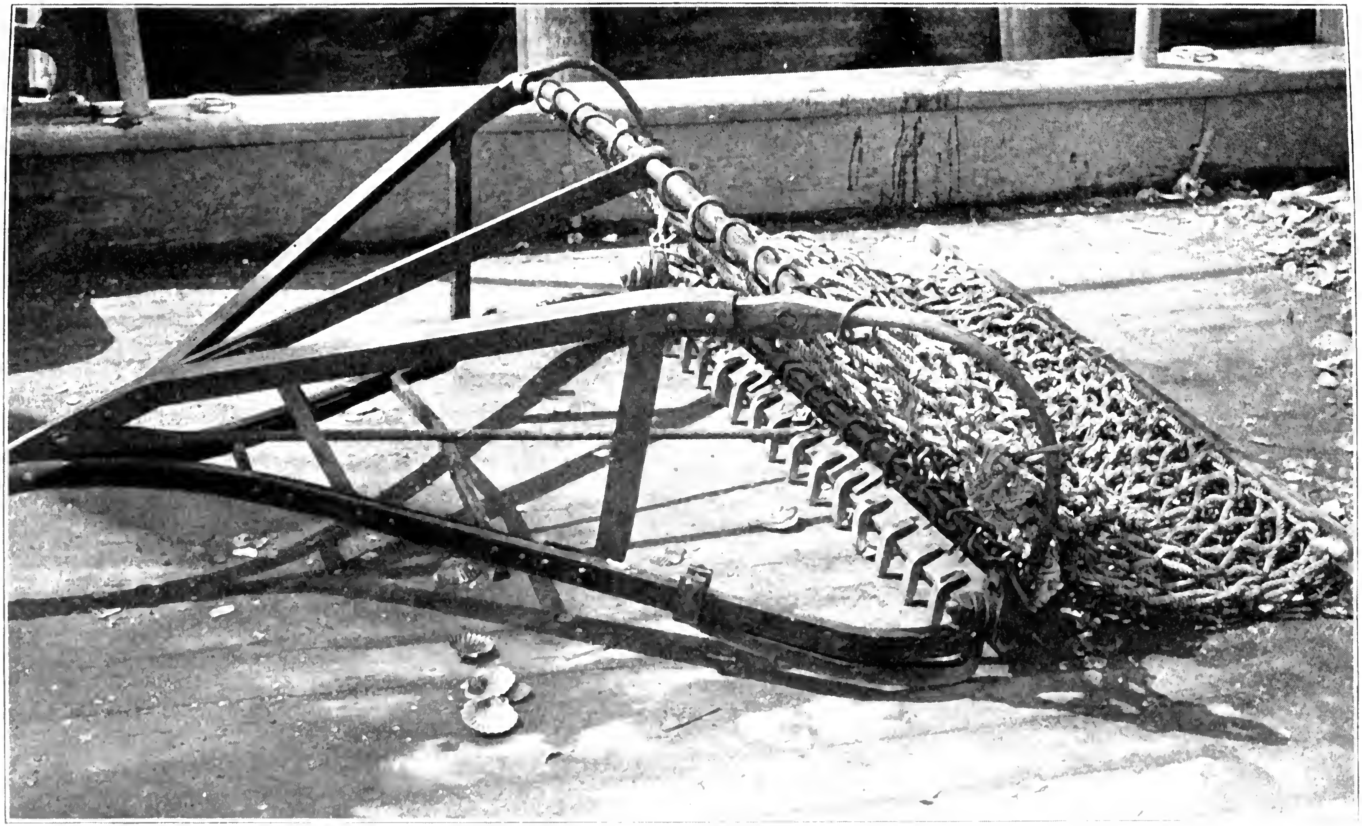
Map 24.

The Scallop Pusher. — This implement consists of a wooden pole, from 8 to 9 feet long, attached to a rectangular iron framework, 3 by 1½ feet, fitted with a netting bag, 3 feet in depth. The scalloper, wading in the shallow water, gathers the scallops from the flats by shoving the pusher among the eel grass. The photograph shows the correct position of the pusher in operation. Only a small part of the pole is shown.

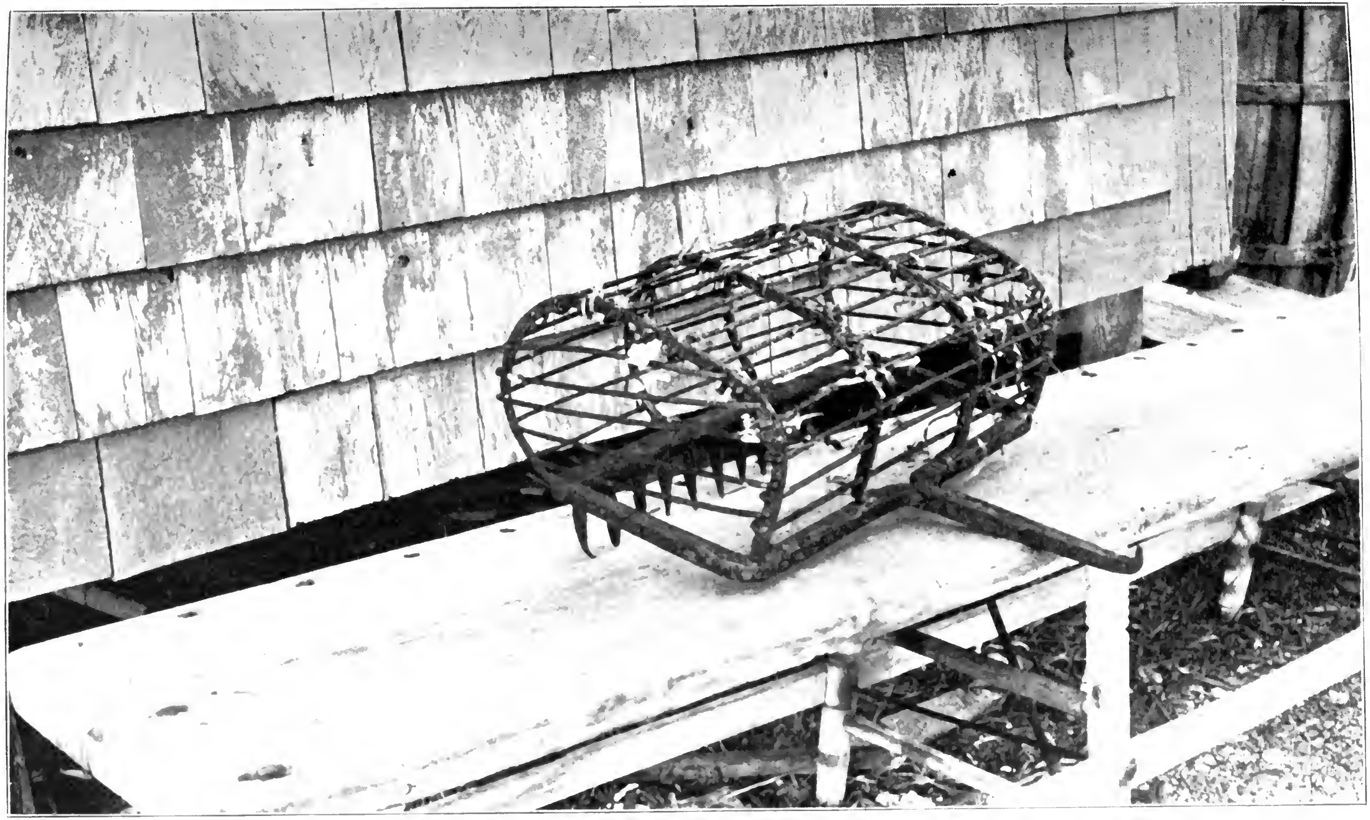


The Box Scallop Dredge. This dredge consists of a rectangular framework, 27 by 12 inches, with an oval-shaped iron bar extending backward as a support for the netting bag, which is attached to the rectangular frame. To the sides of this frame is joined a heavy iron chain about 4 feet long, to which the drag rope is fastened. This style of dredge is used only at Chatham and the neighboring towns of Cape Cod.

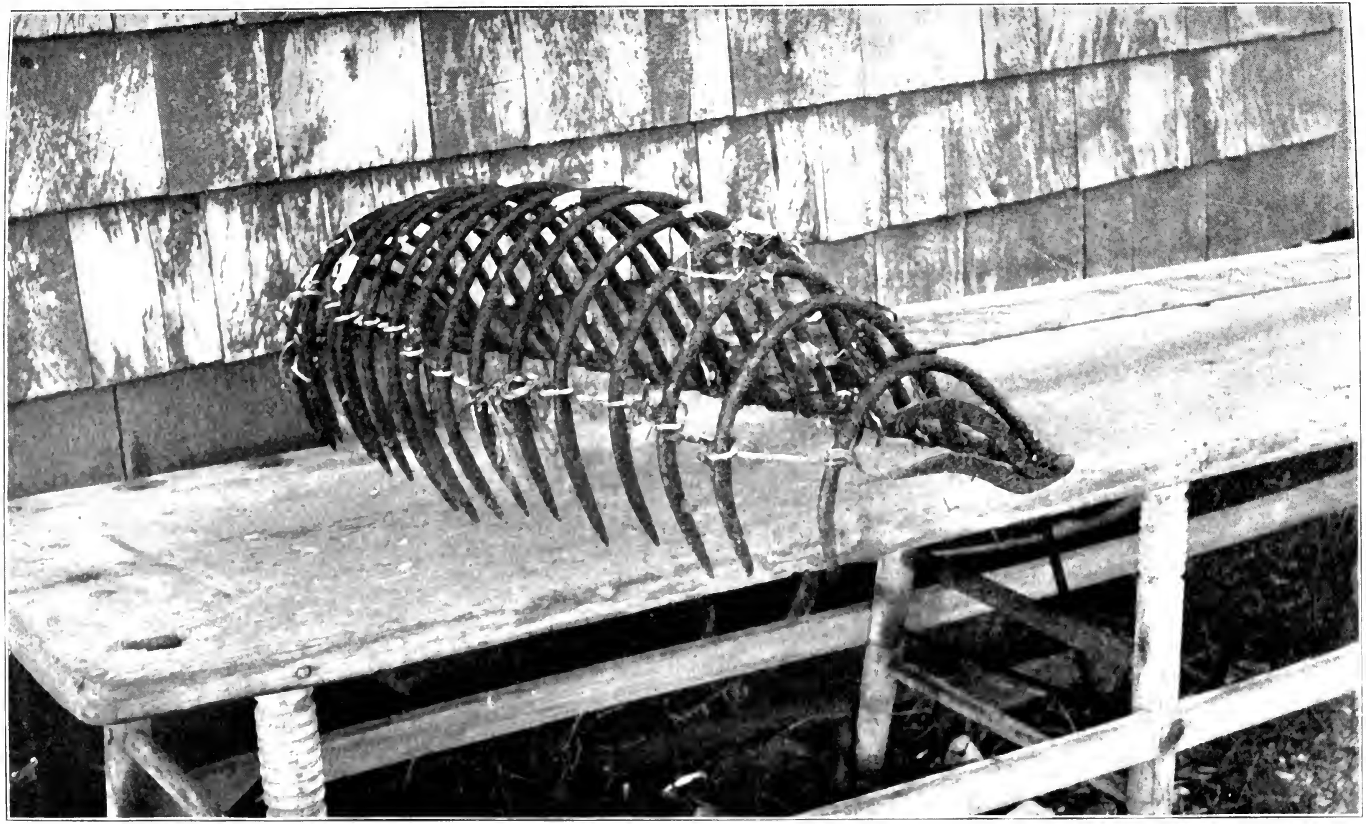
Scallop Dredge, "The Scraper." This implement has the form of a triangular iron framework, with a curve of nearly 90° at the base, to form the bowl of the dredge. On the upper side a raised cross bar connects the two arms, while at the bottom a strip of iron 2 inches wide extends across the dredge. This narrow strip acts as a scraping blade, and is set at an angle so as to dig into the soil. The top of the net is fastened to the cross bar and the lower part to the blade. The usual dimensions of the dredge are: arms, 2½ feet; upper cross bar, 2 feet; blade, 2½ feet. The net varies in size, usually running from 2 to 3 feet in length and holding between 1 and 2 bushels. Additional weights can be put on the cross bar when the scalloper desires the dredge to "scrape" deeper. A wooden bar 2 feet long buoys the net. The scraper used at Nantucket has the entire net made of twine, whereas in other localities the lower part consists of interwoven iron rings.



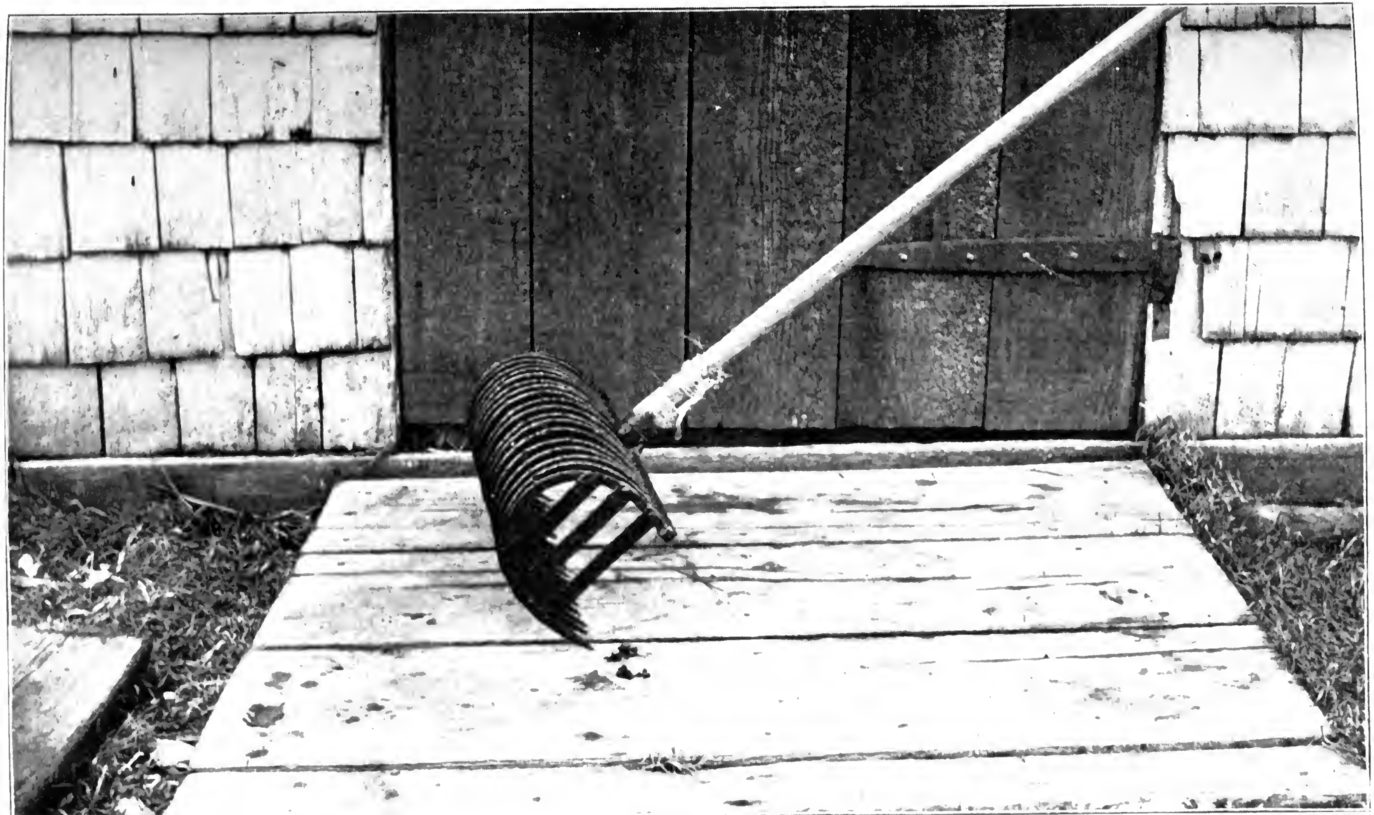
The Oyster Dredge. — This is the type of oyster dredge used on the large gasolene boats. The photograph was taken on board the oyster boat of Mr. James Monahan of Wareham. The dredge consists of a net of woven iron rings attached to an iron framework. From each corner of the framework rods extend, converging at a point some feet away, where the drag rope is attached. The blade, resting horizontally on the surface, is armed with large teeth which rake the oysters into the bag. When this bag, which holds from 8 to 15 bushels, is full, the dredge is raised by a gasolene hoist.



The Basket Quahaug Rake.—This style of basket rake is used at Edgartown and Nantucket. The whole rake is made of iron, no netting being required, as thin iron wires 1/3 of an inch apart encircle lengthwise the entire basket, preventing the escape of any marketable quahaugs, while at the same time allowing mud and sand to wash out. This rake has 16 steel teeth, 1½ inches long, fitted at intervals of 1 inch on the scraping bar. The depth of the basket is about 8 inches. Short poles not exceeding 30 feet in length are used, as the raking is carried on in water which does not exceed 25 feet in depth. Only the iron framework of the rake is shown.



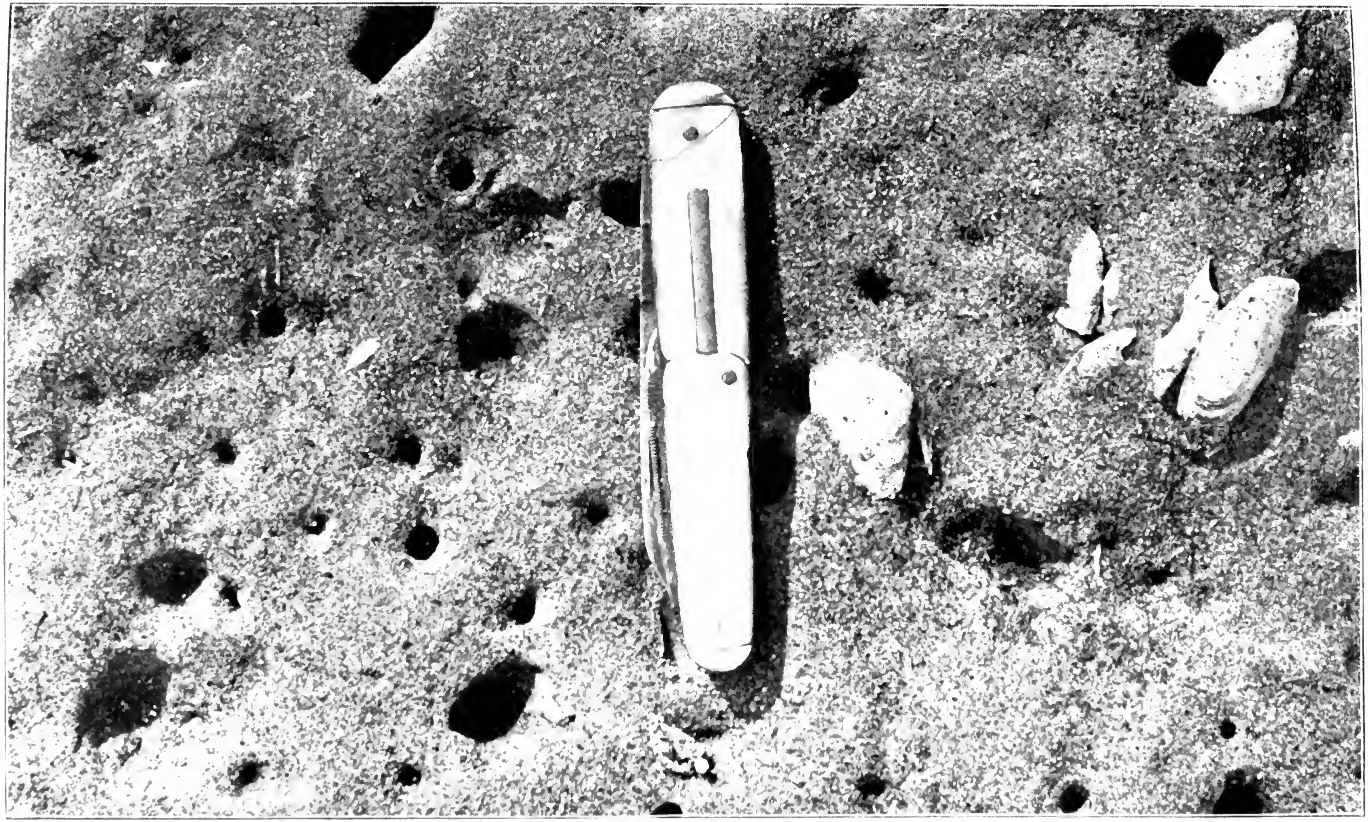
The Claw Quahaug Rake. — This rake varies greatly in size and length. Its use is chiefly confined to Nantucket. The general style has a handle 6 feet long, while the iron part, in the form of a claw or talon, with prongs 1 inch apart, is 10 inches wide. A heavier rake, as here shown, is sometimes used in the deeper water.



The Scallop Rake. — The use of this rake is confined almost exclusively to the town of Chatham. Both scallops and quahaugs can be taken with it. The bowl is formed by a curve of the prongs, which are held together by two long cross-bars at the top and bottom of the basket, while the ends are enclosed by short strips of iron. Handles from 15 to 20 feet long are generally used with this rake.

Rowley Reef Clam Set. — This photograph shows the surface of Rowley Reef, one of the flats of Plum Island Sound. In the summer of 1906 a heavy set of clams was found on this flat, averaging 1,500 to the square foot of surface. These rapidly diminished, and one year later, Aug. 27, 1907, when this photograph was taken, the clams numbered about 400 to the square foot. This area furnished an excellent illustration of the great destruction of natural clam set. Only 5 per cent. of these clams reached maturity, and the remaining 95 per cent., destroyed by natural agencies, could have been saved if proper measures had been taken. At least 100 acres of the barren flats of Rowley could have been planted with the "seed" from this flat, and after two years the crop would have been worth $30,000. The present shellfish laws of the Commonwealth are alone to blame for this waste. The clam hoe shown in the foreground is the typical digger or "hooker" of the North Shore clammer.

Rowley Reef.—This photograph, taken on the same date as the preceding, shows another section of the reef, where the clam set has been torn up and destroyed by horse-shoe crabs and cockles.

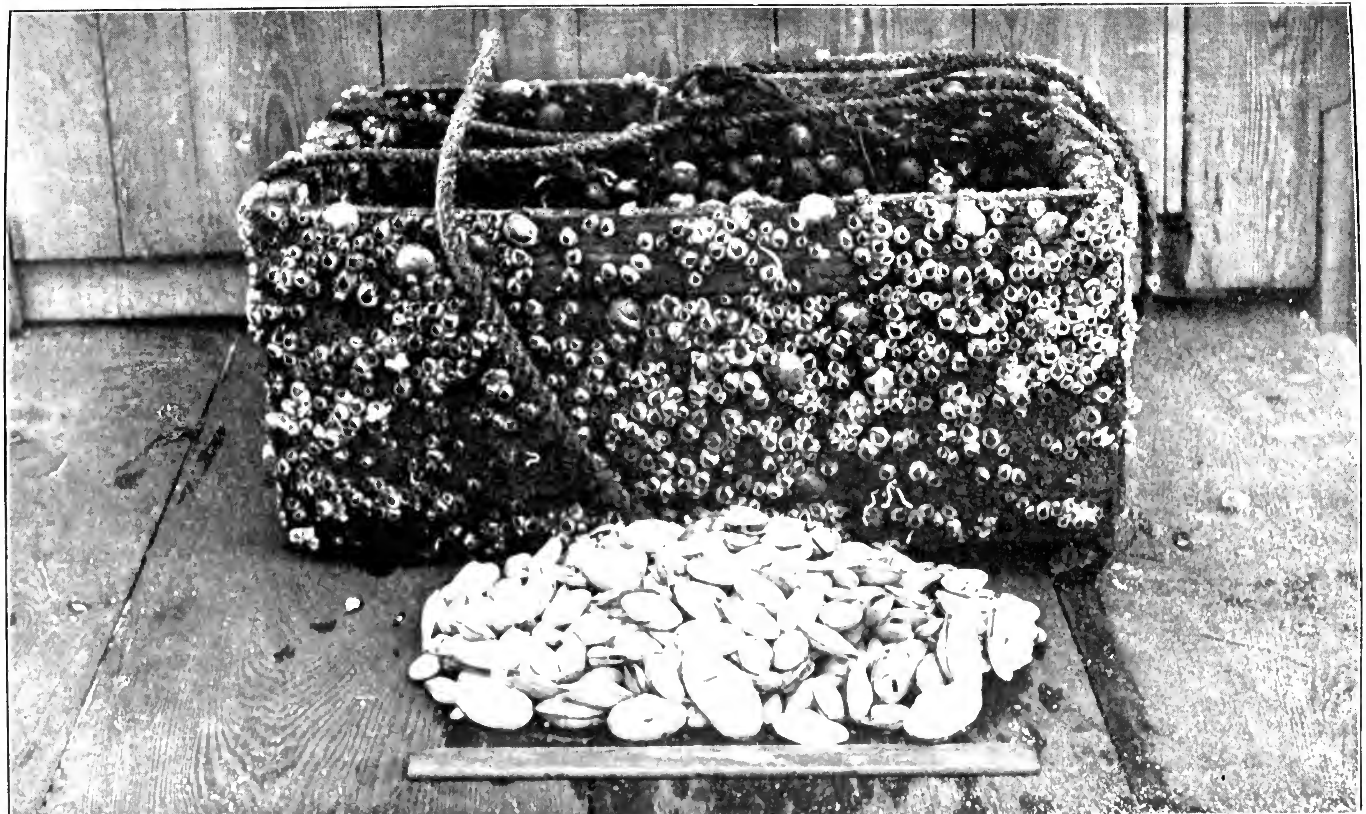


Rowley Reef. – A photograph, natural size, of a thickly set part of the same flat. The broken shells on top show clams which have been crowded out of the sand and destroyed. In this way nature regulates the number of clams in a given area.

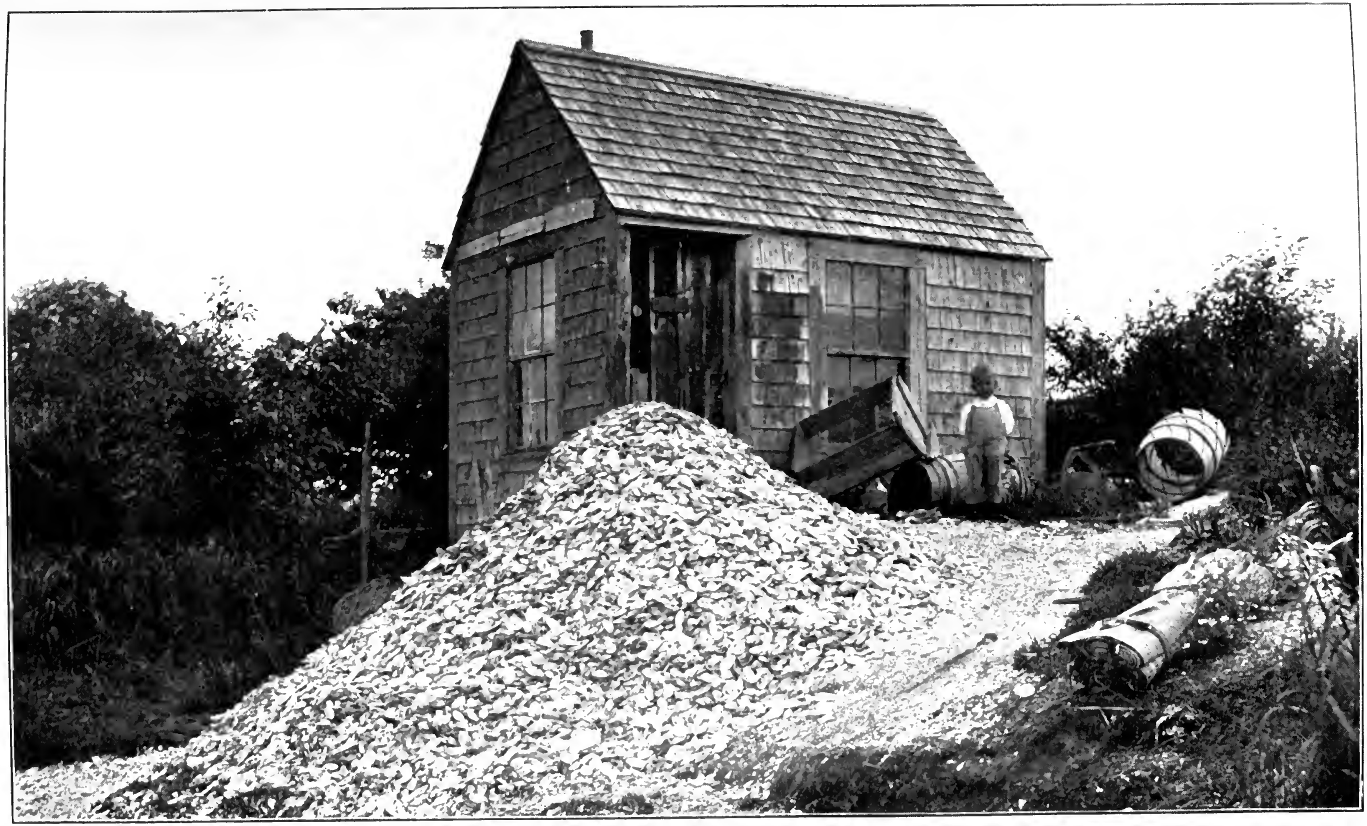
Castle Neck Flat (Essex River). — A scene at low tide, Aug. 28, 1907, showing the area turned over by two clammers in one hour. At this date there was a heavy set of small clams on this flat.

Plymouth Harbor.— This photograph was taken at low tide, from the boat house of Mr. Frank Cole. In the foreground are a few of the experimental clam beds of the Massachusetts department of fisheries and game. Note the large tracts of eel grass covering the flats.

Cole's Clam Grant. — This photograph shows a portion of the grant leased to Mr. Frank Cole by the town of Kingston for the propagation of clams. Several of the experimental beds of the Massachusetts department of fisheries and game were situated on this grant.



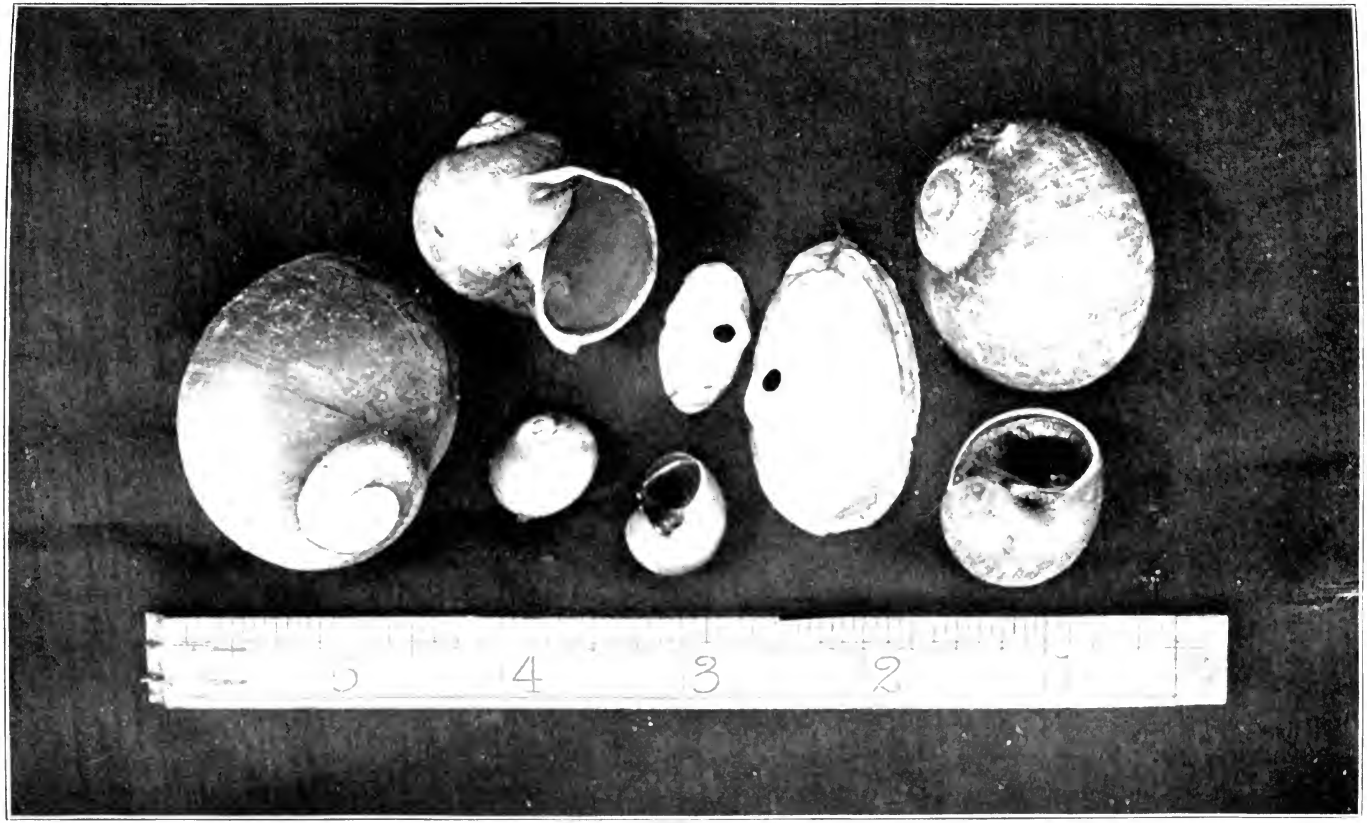
Clam Spat Box.—This box was suspended from a raft during the summer of 1907. The small clams which were caught in it are heaped before the box. These clams vary in size from $\frac{1}{2}$ to 2 inches in length, showing that the spawning season is at least of two months' duration. The spat box was put down May 15 and taken up October 15. Note the barnacles, silver shells (*Anomia*), etc., on the box and rope.



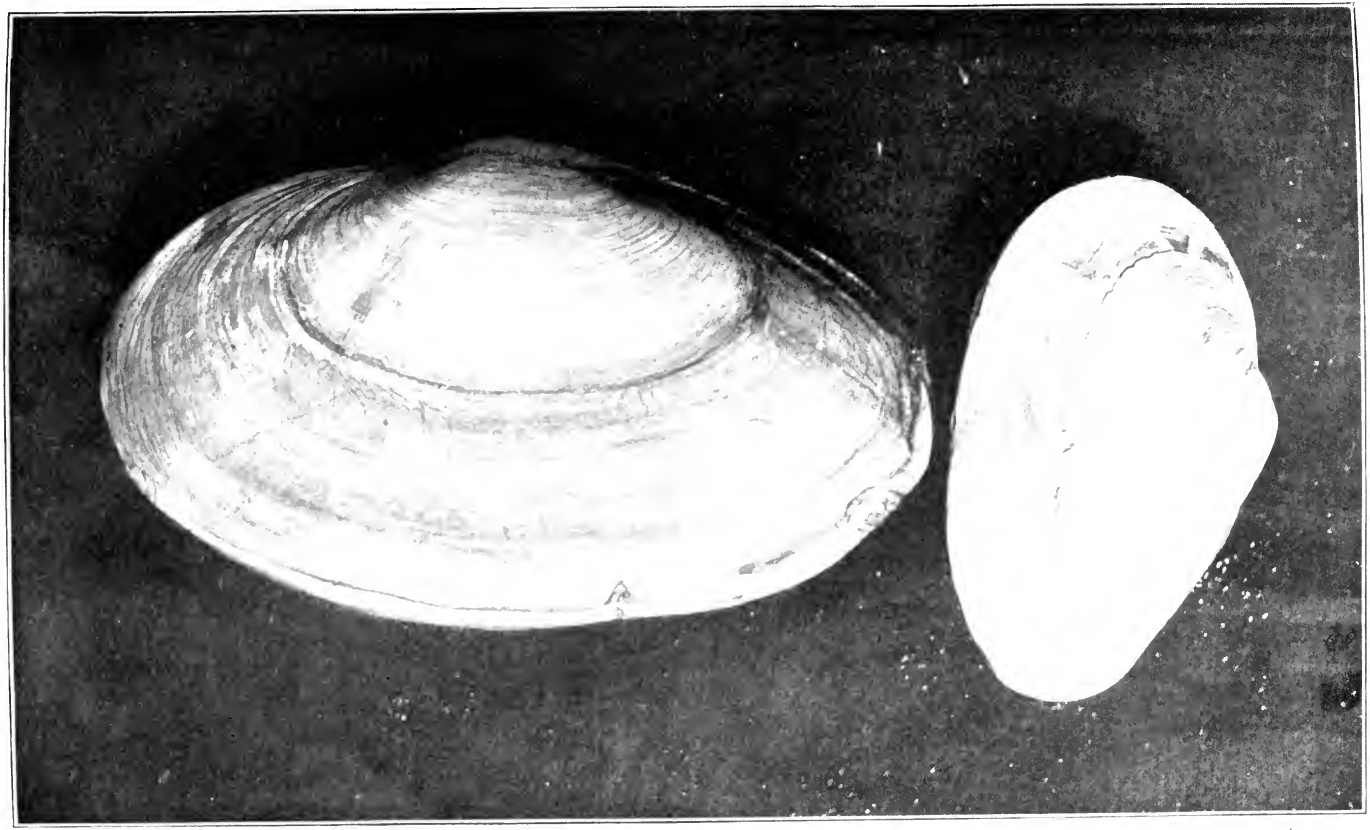
A Clam Shanty. — The shanty of Samuel Kilbourn, an experienced Ipswich clammer. The large heap of shells is the result of six weeks of steady digging. Numerous shanties of this sort are used for "shucking out" clams when marketed by the gallon. This photograph also shows the clam sifter which was used in obtaining the small "seed" clams from Rowley Reef for the experimental beds.

Taking up One of the Clam Gardens of the Massachusetts Department of Fisheries and Game. — The bed was planted Nov. 15, 1905, in Essex River, on a sand flat locally known as "Newfoundland." When the bed was planted the flat was considered barren, as it produced practically no clams. The photograph was obtained Nov. 15, 1907, when the bed was taken up, and shows the clammers at work. Note the heaps of marketable clams which were taken from the bed.

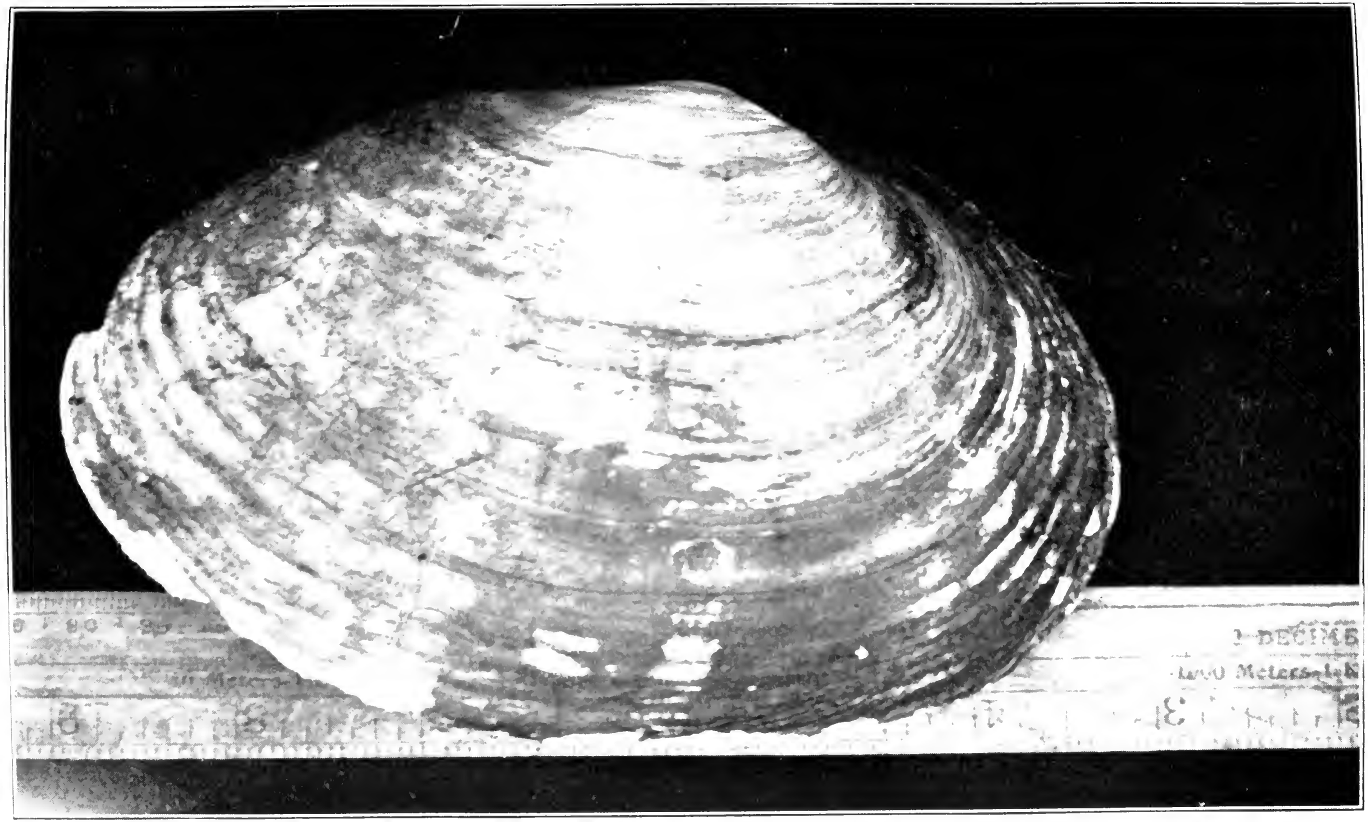
Yield in Two Years of the Garden shown in the Preceding Photograph. — Note the amount of clams planted, compared with the marketable clams taken out. The size of the bed was 1/100 of an acre. The clams had increased in size so that 8 quarts were obtained for every quart planted. This shows what could be done with many barren flats if individuals had the privilege of cultivating clam farms.



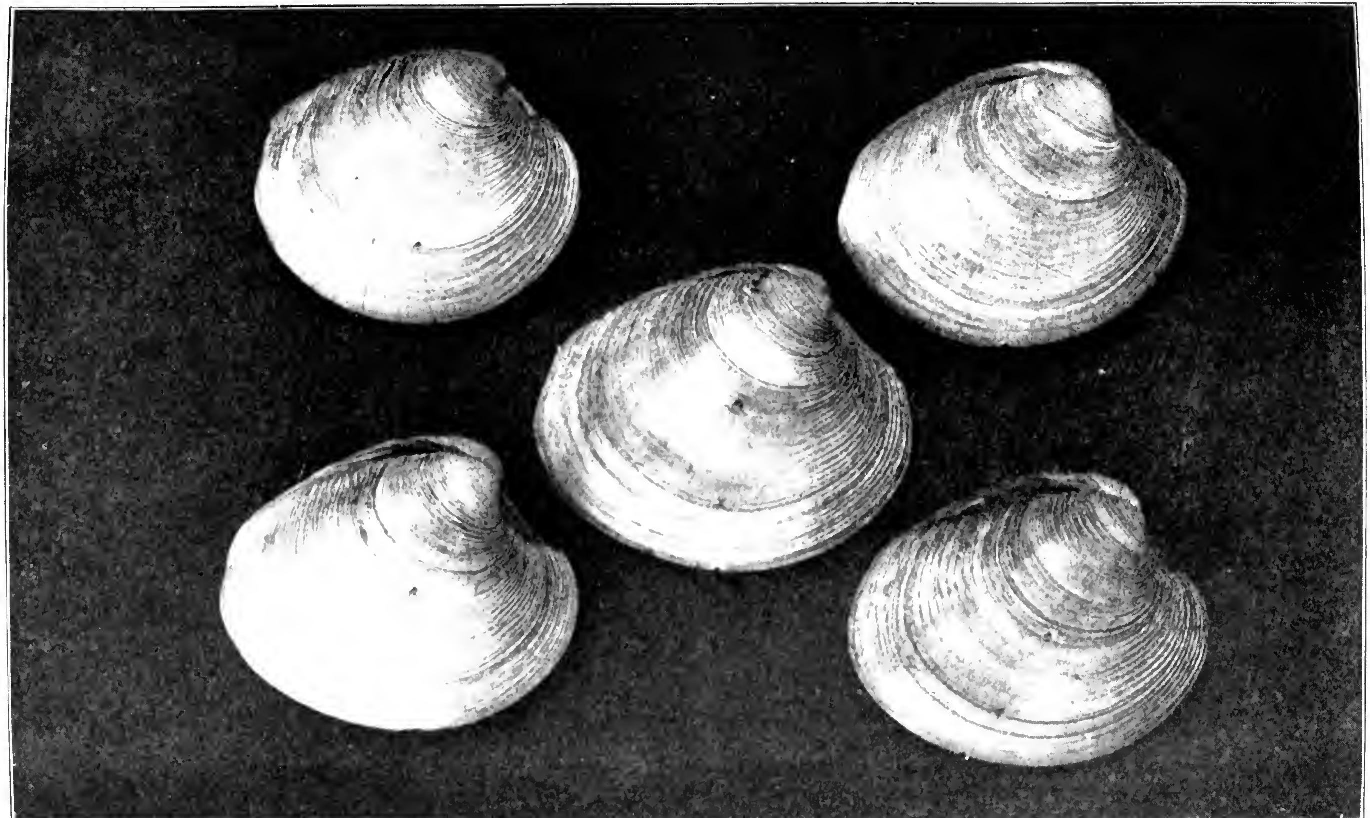
The Winkle or Cockle (**Lunatia heros and duplicata**). — An enemy of the clam, which it destroys by boring a hole through the shell and sucking out the contents.



Clam Growth. — This photograph gives a comparison between the growth of small and large clams from a single bed under the same natural conditions. The large clam shows a much slower growth than the small. Both clams were notched when planted on the "spit" in Essex River, April 18, 1907. They were dug Aug. 28, 1907.



Soft-shelled Clam (Mya arenaria).—This large clam shell, measuring $5\frac{3}{4}$ inches in length, was found on Grey's Flat, Kingston. Where the flat has been worn away by erosion the ground is white with thousands of these shells in an upright position in the soil, showing that sudden destruction had overtaken them at some time in the past.



Quahaugs from an Experimental Bed at Monomoy Point, showing Two Years' Growth. — The two notches or file marks on the shells indicate the growth per year. The photograph is two thirds life size. These quahaugs have shown rapid growth, having gained nearly 1 inch a year in length, which is the best growth thus far found in any of the experimental beds.

Gathering "Seed" Oysters in the Weweantit River, Wareham, May 6, 1908.—The natural beds of the town of Wareham had been closed for seven years, and on this date were opened for the period of one week for the inhabitants of the town to gather "seed" oysters. The photograph was taken on the opening day, and shows the oystermen at work tonging the "seed" oysters. In the foreground is a loaded skiff, ready to have its contents estimated by the inspector, who declares the number of bushels. The tongers pay the town 10 cents per bushel for the privilege of gathering the oysters, and sell them for 35 cents per bushel to the planters, thus realizing a profit of 25 cents.

Typical Steam Dredger. — The oyster boat of Mr. James Monahan of Wareham, showing oyster dredge and hoist. The large cans aboard the boat contain young flatfish from the Woods Hole Hatchery of the United States Fish Commission. Mr. Monahan is distributing these in Wareham River.

Typical Oyster Schooner. — Oyster schooner loaded with 1,935 bushels of Wareham "seed" for L. Dodge, Providence River. This "seed" was taken in May, 1908, from the natural oyster bed in the Agawam River, which had been closed for the past three years.

The Commonwealth of Massachusetts.

A REPORT

UPON

THE SCALLOP FISHERY

OF

MASSACHUSETTS,

INCLUDING THE HABITS, LIFE HISTORY OF *PECTEN IRRADIANS*, ITS RATE OF GROWTH, AND OTHER FACTS OF ECONOMIC VALUE.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
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Mass. Dept. of fish & game.

Approved by
The State Board of Publication.

The Commonwealth of Massachusetts.

COMMISSIONERS ON FISHERIES AND GAME,
STATE HOUSE, BOSTON, Sept. 15, 1910.

To the Honorable Senate and House of Representatives.

We herewith transmit a special report upon the scallop fishery of Massachusetts, as directed by chapter 74, Resolves of 1906. The complementary portion relating to the lobster fishery is embodied in a separate report.

Respectfully submitted,

GEORGE W. FIELD.
JOHN W. DELANO.
GEORGE H. GARFIELD.

A Report upon the Scallop Fishery of Massachusetts.

The bays, estuaries and tidal flats of New England are practically undeveloped as sources of food. The demands and conditions of an increased population, far surpassing the dreams of the framers of the colonial laws, have in a very great degree destroyed the delicately adjusted balance of animal life in these waters, and left us only a comparatively barren waste, governed by laws far out of tune with the changed conditions. The waters are capable of producing for man as much "sea food" as formerly, possibly more, but certainly an enormous increase over present supply if the laws could be so amended as to permit the cultivation of the bays and shores to the full capacity, after the scientific agricultural methods already adopted for increasing the yield of the land.

It is a well-established law of economics that increased population increases the demand for food, with consequent higher prices. These higher prices tend to spread to well nigh every branch of living expenses. The fundamental method of checking this undue increase is to increase the supply. We have learned to do this in the case of corn, potatoes, wheat and other agricultural staples, and (apart from uneconomic and often harmful manipulation of prices by speculators) the increased demand brings forth an increased supply. With the supply of game, lobsters, fish, clams, scallops, etc., however, we apply the absurd practice of limiting the demand by restrictive legislation, *e.g.,* close season, size limit, limits upon time of catching or upon quantities to be taken each day, etc., rather than seeking to augment the supply. If the demand for corn or potatoes tends to higher prices, the logical remedy is the production of more corn and potatoes. We do not call vociferously for a close season on corn or potatoes, or for any other law which tends to restrict the demand. Measures are taken as quickly as possible to augment the supply.

The necessary increased development of our shellfish supply is notoriously prevented by antiquated and inadequate laws. Agriculture cannot flourish where the community must depend either upon natural yields ("volunteer" crops), or upon fields tilled in common by persons whose chief aim is to selfishly appropriate the results "before the other fellow" can.

The capital required for cultivation of the water, aquiculture, is far less than that required for successful cultivation of the land, while the returns per acre are far greater, both in money and in food value of the product. Our shores, therefore, offer remarkable opportunities for the development of shellfish gardens. Here employment could be furnished for many thousands of unskilled laborers, in a healthy and remunerative occupation.

To secure such desirable results the public mind must be disabused of the false idea, almost universally and tenaciously held, that the "public rights" of getting shellfish wherever they may be found is a valuable and inalienable right. It is equally illogical to apply the same reasoning to forest and fruit trees, to strawberries, raspberries and cranberries, making these the property of the person who discovers and markets them, while at the same time making laws which prevent increasing the natural yield through cultivation by individual owners or lessees. The intelligent public cannot fail, however, to see, upon careful and thoughtful consideration, that what has been represented to be a boasted blessing is now in fact a veritable incubus, impeding further progress, and to this are to be traced many of the unfavorable conditions which check the development of our fishing industries and the prosperity of our shore dwellers.

An abundance of "sea food" is a strong attraction to our summer visitors. But the supply must be certain, regular, definite, readily accessible for quick consumption; available in sufficient quantities to meet special seasons of largely increased demand; and produced under unquestionable sanitary conditions.

Further, the supply of bait for our shore fisheries is an exceedingly important item, and should furnish directly large opportunities for employment, in addition to increasing the quantity of sea fish landed upon our shores.

For these reasons it has seemed wise to the Legislature to devote some attention to the questions involved in the very obvious decline in the shellfish production along our coasts, since this decline affects not alone the shore communities, but, to some degree, every citizen of the State. The problem must be viewed in its broad aspect. The source and the supply of sea food is not solely and exclusively the peculiar asset of the seashore town, to be kept forever closed to development. It should be truly public, in the sense which our forefathers intended, *i.e.,* "free to every citizen of the Commonwealth," free, not for plunder and destruction, but for intelligent development for the increased production of food and wealth.

Inasmuch as the scallop (*Pecten irradians*) and the lobster (*Homarus vulgaris*), though formerly exceedingly numerous and cheap, have now become merely a delicacy, practically beyond the reach of the average citizen, it seemed desirable to investigate for the purpose of suggesting some feasible methods for increasing the market supply, before the source is commercially exhausted.

To say that the fault lies in the increased use of these foods is but idly begging the question. The fault rather lies in the failure to assist Nature, which is ever ready to respond to intelligent and well-directed efforts to increase her bounty.

The report covers in very considerable detail the facts connected with the scallop industry. The notable peculiar fact in the life history, the weak link in the chain of supply, and, therefore, of greatest importance, is that the abundance and even the continuance of the scallop depend chiefly upon the generation immediately preceding. Thus, successful fishing depends upon the number of eggs laid by the previous generation of scallops. The number of eggs laid depends upon how many adults lived through the vicissitudes of the previous winter, after escaping the dredges of the scallopers. As a general rule, the scallop lays but a single litter of eggs, inconceivably vast in numbers, but yet only a single litter. It seems surprising that nature should, so to speak, rest all on a single throw. So narrow, indeed, is the margin of safety that the excessive destruction of scallops less than one year old, *i.e.,* "seed scallops," may result in complete annihilation of the future supply, — a condition which has occurred in some localities.

The present report is largely the work of the biologist to the commission, D. L. Belding, A.B., and has been carried on upon a broad outline laid out by the chairman, under whose general supervision the work has progressed, in accordance with the provisions of the following resolve: —

Acts of 1906, Chapter 74.

Resolve to provide for an Investigation and Report by the Commissioners on Fisheries and Game as to Scallops and Lobsters.

Resolved, That the commissioners on fisheries and game be authorized and directed to investigate and report upon the life history, feeding and breeding habits of scallops and lobsters, and to make any investigations which may assist in devising methods of commercial propagation of these animals, or of increasing the market supply. The said commissioners are authorized to establish and adequately protect structures and areas of land or water wherein such animals may be kept under observation, and to protect animals or material contained therein, and to erect or lease such areas of land or water, buildings, boats or other structures, as in their opinion may be necessary for the proper pursuit of the above objects. Said commissioners may expend for the purposes of this resolve a sum not exceeding fifteen hundred dollars a year for a period of three years.

CHAPTER I. — INTRODUCTION.

Dr. George W. Field, *Chairman, Massachusetts Commission on Fisheries and Game, State House, Boston, Mass.*

Sir: — I herewith submit the following report upon the life history and habits of the scallop (*Pecten irradians*). All investigations herein were made in accordance with the provisions of chapter 74, Resolves of 1906. The work was conducted by D. L. Belding, assisted by W. G. Vinal in 1907, 1908 and 1909, and by W. H. Gates and C. L. Savery in 1906.

Respectfully submitted,

David L. Belding, *Biologist.*

The following report embodies the results of the experiments and investigations conducted on the Massachusetts coast during the years 1905 to 1909. The facts discussed in this paper are intended for the inspection of three classes of readers: the fisherman, the consumer, and the scientific student, each accustomed to the daily use of terms with which neither of the others is familiar. This circumstance, added to the fact that the subject-matter of the report is largely technical in character, renders it doubly hard to present the material in clear and comprehensive form. As the investigations were primarily designed for the benefit of the fisherman, the terms as far as possible will be those used by the practical seacoast inhabitants, while the report is arranged so that sections which are purely scientific may be omitted without impairing the value of the whole paper. Whenever a scientific or colloquial name is used in the text the common name is either given with it or a more complete definition is appended in the glossary.

The circumstances which led to the legislative act authorizing the investigation were briefly as follows: In the years previous to 1905 the scallop industry, while still an important source of winter revenue for the southern coast towns of Massachusetts, manifested signs of serious decline, especially in the Buzzard's Bay region. A natural resource of sufficient importance to bring into the Commonwealth a yearly revenue of nearly $150,000 could not be neglected, and the result was that the Legislature directed the Department of Fisheries and Game to study methods of improving the scallop fishery. The laws which were at that time in force were based on very defective knowledge of the life history and habits of the scallop, and it early became apparent that a knowledge of these important points was essential for proper legislation for the conservation of the industry. It is earnestly hoped that an immediate result of this investigation will be the passage of suitable legislation for the preservation of the scallop fishery.

Object. — The aim of this report is to publish all known facts about the life and habits of the scallop, and to show their proper bearing upon the present fishery. At the beginning of the investigation certain important questions of a practical nature presented themselves.

(1) Is the scallop supply of Massachusetts in danger of extermination? If so, how can this be avoided?

(2) Is the present protective legislation based on accurate knowledge of the life and habits of the scallop?

(3) Can the scallop be propagated artificially?

(4) How can the present industry be increased?

In order to obtain satisfactory answers to these questions it was found necessary to obtain information upon: —

(1) The distribution and range of the scallop.

(2) The anatomy and its relation to the habits of the animal.

(3) The spawning, reproduction, early life history and propagation.

(4) The habits of the young and of the adult.

(5) The rate of growth and length of life.

(6) The scallop fishery, — its present extent and possibilities.

Presentation. — Information on the above points, as completely as possible, is presented in the following pages, each topic in the form of a chapter; and the practical bearing on the four questions is considered whenever feasible under each subject, and is summarized in the general conclusion at the end of chapter VI. It is realized that there are various facts which still require further study, and that it will take years of investigation to complete the history of the animal. The anatomical description in chapter II. is by no means complete. The object is merely to give the reader a general idea of the structure of the animal, and to make clear the more intricate development of the various organs as they appear in chapter III. No claim is made for marked originality or for detailed work in the chapter on anatomy; the general scheme given by Drew (1) is closely followed, and only a simplified description is given. Likewise, the embryology of all the lamellibranch mollusks have such a close similarity, not alone in the general course of development, but even extending in some cases to very minute details, that the description of any species might be applied equally well during its early stages to any other closely related species. Thus, although our work upon *Pecten irradians* was begun four years ago, and carried on entirely independently, and is, we believe, the only work upon this species which even professes to approximate completeness, its general features closely parallel the admirable work of Drew (1) upon *Pecten tenuicostatus* (the deep-sea scallop). Many of our results, therefore, are entirely new for *Pecten irradians,* and, since they confirm the earlier published observations on this and other species by Drew (1), Jackson (4) and others, to whom due credit is given, are of use not alone as confirmatory evidence; but since they contribute new observations and original applications of these facts to the practical solution of how best to develop and maintain our scallop fishery we trust that they are not without value. The life history is given in narrative form and is not explained in detail, as could be done by sectioning the developing eggs and embryos. As it is the purpose of this paper to present not only new material but also a rather complete account of the life and habits of the scallop, it has been frequently necessary to reprint or refer to previous works on the subject. In most cases these observations have been verified by our experiments, and are printed with the consent of the authors.

Courtesies. — At the start of the investigation in 1906 there was found a general lack of knowledge among the fishermen upon such important points as the spawning season, rate of growth and length of life of the scallops (*Pecten irradians*). Indeed, little literature on the subject was available, Kellogg (5), Jackson (4), Ingersoll (8) and Risser (2) comprising all publications on *Pecten irradians.* Of these, Risser alone dealt with the spawning, growth and length of life in his report upon the life history and habits of the scallops in Narragansett Bay, Jackson with the young scallop, and Kellogg and Ingersoll with the industries. While the paper by Risser was of great assistance at the start of the work, the diverse natural conditions in Massachusetts waters often rendered our results at variance, and unfortunately made this excellent report only valuable for comparative purposes. In addition to these publications the following papers proved of special value in the work: Drew (1) was of great assistance in studying the embryology and in preparing the chapter on anatomy; Jackson (4) furnished considerable help and useful methods in tracing the post-embryonic development; and Kellogg (6) was found a most comprehensive and valuable paper for general reference work.

The writer is deeply indebted to Dr. George W. Field for his general supervision and helpful advice in the investigations and in the preparation of the report; to Prof. James L. Kellogg of Williams College, and Prof. Gilman A. Drew of Maine University for their kindly criticism; and to the scallop fishermen of Massachusetts for their friendly assistance. More especially is acknowledgment due to the assistants in the investigation. In the summer of 1906 W. H. Gates and C. L. Savery ably assisted in the post-embryological investigations and general growth experiments. During the summers of 1907, 1908 and 1909 W. G. Vinal, together with D. L. Belding, brought the embryological and post-embryological work to a completion. The work of all three assistants, particularly the continued investigations by W. G. Vinal, is worthy of special commendation.

Methods of Investigation. — The greater part of the work on the scallop was conducted at Monomoy Point in the town of Chatham. Near the end of this point an enclosed body of water, some 6 acres in area, connected with the ocean by a shifting channel through which the tide passed every twelve hours, was acquired by the State for experimental purposes. This body of water, called the Powder Hole, is a natural breeding ground for shellfish, and proved an excellent place to study their life history and habits. A few scallops were found in the Powder Hole at the beginning of the investigations; more adults were brought there for breeding purposes and the basin was transformed into a natural aquarium. In this way it was possible to keep close observation on several successive generations of scallops in regard to their growth and length of life under completely natural conditions. A small laboratory was erected on the shore, and a raft 20 feet long by 10 feet wide was securely moored in the deepest part of the cove. The raft proved an invaluable aid in catching and rearing the young, some of the most important experiments being conducted on it.

While Monomoy was the central station for the scallop work, observations were made in other parts of the State under as diverse conditions as possible. Records of the spawning, growth, migration and habits were kept at Edgartown, Nantucket, Chatham, North Falmouth, Marion and Monument Beach. In this manner the entire scalloping territory of the Commonwealth was under surveillance. Under chapter VII. the specific methods of work will be given in greater detail.

The Scallop Family. — The scallop belongs to the class of mollusks called the *Lamellibranchia,* or, to use an older nomenclature, the *Pelecypoda.* The family of the *Pectenidæ* includes a great many species, totalling about forty, of which the most important commercially is the shallow-water variety, *Pecten irradians.* Of the four species found on the Atlantic coast only two are of commercial importance in New England, *Pecten irradians* and *Pecten tenuicostatus,* the giant or deep-sea scallop of Maine. These are rivals in the Boston market, but the smaller scallop is usually preferred by reason of its more delicate flavor. Several different species of the *Pectenidæ* are used as food in other countries. Fossil *Pectens* have been found as far back as the Carboniferous age.

Names. — *Pecten irradians* is more commonly given as the scientific name for the shallow-water scallop of the Massachusetts coast, but the later and more exact title of *Pecten gibbus,* var. *borealis* Say., is now used. In New England the animal is ordinarily called by the name "scallop," sometimes written "escallop." This word, according to Ingersoll (8), is derived from either the French "escallope" or the Dutch "schelp," meaning a shell. In Italy the scallop is called "cape saute," in Holland "mantels," in England "fan shells," "frills," "queens," and "squims."

Distribution. — *Pecten irradians* has a wide geographical range, extending from Massachusetts Bay to the Gulf of Mexico, where it has been reported in the vicinity of the Chandeleur Islands in Louisiana by Professor Kellogg (7). It is occasionally found along the Atlantic seacoast wherever the coast is sufficiently broken to afford sheltered bays and inlets. In 1880 Ingersoll (8) reports its presence in North Carolina, where it was used for local trade at Moorehead City. The scallop inhabits quiet waters, where it is protected from heavy winds and storms, which would wash it high on the sandy beaches. Long Island Sound is very productive of scallops, and many thousands of gallons are shipped from its waters in a successful season.

In Massachusetts this species occurs commercially only in the waters south of Boston (Fig. 78). It is usually found in abundance along the southern shore of Cape Cod, in Buzzard's Bay and about the islands of Nantucket and Martha's Vineyard. According to a map in the Boston Museum of Natural History a small bed formerly existed in the waters off Nahant. Shells are often picked up on the North Shore beaches, but at present no live scallops are found in this State north of Boston. It is reported that a few are to be found in some of the warm bays of the Maine coast. Thus the scallop fishery in Massachusetts is only a partial industry, as it concerns only the Vineyard Sound and Buzzard's Bay shore.

The bathymetrical range of the scallop is extensive, as many thousand acres of eel-grass flats, extending even to a depth of 60 feet of water, are covered at times with this bivalve. Usually the scallop is found in water from 5 to 30 feet deep. Scallops are often abundant on the high flats where there remains but a foot or two of water at low tide, as on the Common Flats at Chatham. These exposed places with the thick eel grass seem to receive the heaviest sets, but the young often perish in the cold winters. Scallops can arbitrarily be separated into two classes: (1) the channel or deep-water scallops, found in water 15 to 60 feet deep, and (2) the shallow-water or eel-grass variety, from low-water mark to 15 feet.

While the extent of the scalloping area is large, owing to the wide range of the animal, only portions are ever productive at any one time. A set may be in one place this year and the next year's spawn may "catch" in a different locality. Thus, while all the ground is suitable for scallops, only a small part is in productive operation each year. The natural barrier to the distribution of the scallop is the exposed nature of the coast, as this mollusk cannot live in rough waters.

CHAPTER II. — ANATOMY.

The loss of the anterior adductor muscle in Pecten, as shown by Drew (1) and Jackson (4), has been accompanied by a shifting of the soft parts, so that the antero-posterior axis, instead of running parallel to the hinge line, forms with it an angle of at least 60°. While this fact is recognized, for simplicity the relation of the hard and soft parts in the following description is considered as in a typical lamellibranch. The animal is oriented: (1) dorso-ventral axis or height, from the hinge to the opposite edge of the shell; (2) antero-posterior axis or width, the distance across the shell; (3) lateral axis or thickness, the distance between the two valves (Fig. 65).

The Shell. — The scallop shell consists of two lateral valves joined together on the dorsal edge, the hinge line (HH), by means of a thin ligament. The two valves, which open on the ventral or lower edge, are nearly round and of equal curvature. The right or lower valve, on which the animal rests, is of a lighter and cleaner color and differs from the upper in having a byssal notch (B) or foot groove. In the scallop less than a year old this notch is lined with several projecting teeth, which are absent in the old animal. If the shell of an adult is broken along the notch a row of thirty-five or more of these teeth can be seen extending back to the umbo. The adult scallop is somewhat wider than high, the average dimensions being: height, 2⅖ inches; width, 2⅗ inches; thickness, 1⅒ inches.

On the outer surface of the shell are prominent ridges and furrows (R, F) which radiate from the beak to the free margin, giving the animal a beautiful fan-like appearance. The number of ridges does not vary in the individual scallop, the adult having the same number as the very young animal. In different scallops the number of ridges varies from 14 to 19, the average being 16. Crossing the radiating ribs are concentric growth lines, which almost show the daily accretion of the shell. Age and wear cause these to be less conspicuous toward the beak and on the lower valve. During the winter months growth ceases and when again resumed in the spring, a heavy line has formed by the thickening of the edge of the shell, comparable to the annual ring of a tree. This is the so-called growth line, which defines a "seed" or immature scallop. Such marks may not always represent the end of the season's growth, but may indicate that unfavorable conditions for a certain length of time checked the building processes of the animal. When scallops were transplanted from Inward Point to Monomoy Point, being confined several days, the change caused a mark similar to the annual growth line.

In old age these growth lines may pile up and form a very slight re-entrant in the shell, due to retrogressive development. The re-entrant is not so conspicuous in Pecten as in other lamellibranchs which have a thicker shell. If the edge of one valve is broken, the opposite valve grows down abnormally to protect the soft parts. Both valves are needed in place to get a normal growth in the same manner as rodents require both sets of incisors to wear on each other.

Besides these markings the outer surface of the shell may be engraved by various enemies. The oyster drill often punctures a small hole in the shell and through it sucks out the soft parts. The boring sponge does not attack the scallop as frequently as it does the oyster and other mollusks which lead a sedentary life, but occasionally parts of the shell are dissolved by the secretions of the sponge. In the older scallop of fifteen months the upper valve is usually covered with various forms of life, such as Serpula (worm tubes), barnacles, young oysters, Anomia (silver shells), Crepidula (quarter deckers), Acmæa and such sea weeds as Enteromorpha, Ulva and Champi parvia. Many old scallops are doubtless killed by the accumulation of foreign growth, which at times fastens the valves together.

The inner surface of the shell is very smooth and somewhat vitreous, due to the nacreous or pearly material secreted by the mantle. The ridges and furrows exist but are not conspicuous. The scar, which marks the attachment of the adductor muscle, can be seen indistinctly outlined slightly to one side of the center of the shell.

The hinge line (HH) is curved in most lamellibranchs, but in Pecten it is straight, and extends to the end of the well-developed "ears." A V-shaped spring in the central part of the hinge tends to keep the valves apart after the same manner of doubling a large piece of rubber in the hinge of a door. When the animal is at rest the large adductor muscle is relaxed and the valves remain open.

The calcareous shell is formed by the secretions of the mantle. Although it is added to slightly by the surface of the mantle, the main increase is in height and width at the edge of the mantle. These two secretions differ in structure; the inner pearly or nacreous portion being formed of thin layers, the outer of prisms. The valves increase in size as the direct consequence of the increase in size of the soft parts.

The shell is well adapted to the life of the scallop. Being light in weight it is suitable for movement through the water, while the rounded outline is the form which offers the least resistance for swimming. The opposite ridges and furrows fit tightly together when the valves close. Thus, when the animal moves, streams of water are forced by the aid of the mantle through the small openings below the "ears," or from the ventral edge of the shell.

The Mantle. — The shell of the scallop is lined with a thin ciliated organ called the mantle (Fig. 73, m). The thickened margins of the two mantle lobes are free ventrally but are united dorsally and to a slight extent on the anterior and posterior ends in the region of the "ears." In a scallop of 52 millimeters the mantle lobes are united posteriorly for 13 millimeters and anteriorly for 6 millimeters. This corresponds roughly to the width of the "ears" of the shell, 12 millimeters and 6 millimeters respectively. The shorter union anteriorly permits the extrusion of the foot. The free edge of the mantle, often brightly pigmented, possesses tentacles (t) or tactile organs, and bead-like eyes of a bright blue color. These sensory organs are not so numerous or so large near the byssal notch and the corresponding posterior edge. Each lobe of the mantle is attached to the inner surface of the valve about one-half inch from the free edge. The broad face of each lobe rests on the inner surface of the shell except when the animal is disturbed and the mantle withdrawn by the retractor muscles. While resting, the mantle lobes are held slightly apart, the guard tentacles forming a lattice work between the perpendicular flaps of the mantle through which the water passes. As previously stated, the mantle also functions in the formation of the shell.

Tentacles. — The sense organs of the mantle are of two kinds, tentacles and eyes. There are numerous tentacles near the free edge of the mantle, which vary greatly in size and formation. These tentacles can be divided into two classes, (1) the mantle tentacles, which are situated on the external edge of the lobe in several rows, and (2) the guard tentacles, situated on the edge of the perpendicular flap of the mantle, 5 to 6 millimeters from the edge. Each class differs in form and function; the mantle tentacles are larger, capable of greater extension and contraction, and armed with papillary projections, while the guard tentacles are smaller, less extensible and of a bright color. The tentacles have a sensory or tactile function, and when the scallop lies undisturbed, the mantle tentacles, lengthening out, wave slowly in the currents of water. They can be withdrawn immediately at the passing of a shadow or at any slight disturbance in the water. When contracted each forms a slight conical projection.

Eyes. — Situated between the band of tentacles and the outer edge of the mantle are many well-developed eyes, brilliantly hued with blue and brown pigment, which help to make the scallop attractive to summer colonists. When sectioned, these eyes are found to be specialized organs comparable to the eyes in the higher animals. They vary in size and number, the larger ones usually occupying the grooves of the shell, although in the adult definite arrangement appears to be lacking. To what degree the eyes react to light and to external stimuli is problematic, and offers a field for research. They appear to be keenly sensitive to any change in light and shade, possibly observing the approach of an enemy by its shadow or movement in the water.

Muscles. — Unlike the soft clam (Mya) and the quahaug (Venus), which have two adductor muscles for closing the shell, the scallop has only a single adductor muscle (the so-called eye in the fisherman's vernacular), which is situated posterior to the center of the shell, forming a conspicuous part of the internal anatomy. The muscle is made up of two parts, a large anterior section and a small posterior division. As is shown in the development of the young scallop, this muscle is the posterior, the anterior adductor disappearing during the early shell stage. The muscle is the edible part of the scallop, and its shape is maintained when served on the table as "fried scallops." When the muscle is cut the valves immediately gape open, being forced apart by the V-shaped cartilaginous elastic pad in the middle of the hinge. The other important muscles are the retractor muscles of the foot, the gills and the mantle.

Gills. — There are four gills (Fig. 74, g) in the scallop, a pair on each side of the generative mass and ventral to the adductor muscle. Each pair has a free end posteriorly and extends in a curved line nearly around the posterior adductor muscle. The gills are attached dorsally near the adductor, the inner and outer gills having a common membrane. Each gill is made up of two lamellæ of radiating filaments. Fine markings cross the filaments at right angles, thus giving each lamella a delicate lace-like appearance.

When a few grains of carmine powder are sprinkled on the gills the small grains pass to the base of the gills and then move toward the anterior end in a definite channel. This movement is due to the cilia between the filaments, which cause the grains to pass toward the mouth. The work of the gills is not only to strain out the food but to aid in respiration. The impure blood flows into the capillary spaces of the gills, where the delicate membranes are bathed by the inflowing water, and, having acquired a new supply of oxygen, passes back to the heart. The area is increased by the folding of the lamella. If stimulated, the gills contract immediately, showing that they possess a nervous mechanism.

Palps. — Just dorsal to the gills on the borders of the mouth are two pairs of delicate filaments similar in structure to the gills. These organs are the labial palps (lp), which correspond to the lips of higher animals and function in conducting the food to the mouth. The central portion of these lips, which extend laterally for a distance equal to the thickness of the animal near the umbo, has arbor-vitæ-like processes, concealing the mouth. The flaps which extend on each side of the branching area are united to the body dorsally and posteriorly, leaving the other edges free. The exterior surface is smooth, while the internal surface is covered with ciliated ridges and furrows which aid in conducting the food from the gills to the mouth.

Digestive System. — The digestive system of the scallop is comparatively simple. The mouth opens into a short œsophagus or gullet, which leads into a gourd-shaped stomach (s). On the posterior end of the stomach is a curious hard socket into which fits the tip of a translucent gelatinous rod, the crystalline style. This rod extends along the intestine in a sort of pocket or groove as far as the lower part of the visceral mass (Fig. 75, vm). The stomach is enveloped by a dark-brown mass, connected with it by two short canals, one on each side. This large conspicuous organ is the digestive gland or "liver" (l), and "is only bounded in the region of the stomach by the sexual gland on its ventral surface." Kellogg (6). The liver (l) sends secretions into the stomach to aid digestion. The food is caught up as soon as it leaves the stomach by the cilia of the intestine (i), which forms a double loop in the visceral mass (Fig. 76, vm). It then passes in a dorsal direction through the liver, curving posteriorly to pass through the heart, and finally ends posterior to the ventral portion of the adductor muscle.

Circulatory System. — The scallop has a blood system passing over the whole body and through the gill filaments, where the blood is aerated. The heart (ht), a three-chambered organ, is situated in a pericardial cavity dorsal to the adductor muscle. The intestine passes through the pericardium and is surrounded by the ventricle of the heart. The auricles are two filmy bodies connected with the ventricle. From the heart arise the different arteries which conduct the blood to all parts of the body, whence it is returned through the venous system to the sinus venosus, from there to the gills, and finally back to the heart.

Nervous System. — The nervous system of the scallop is complicated, and the animal is highly sensitive in all parts, especially in the region of the mantle, through the circumference of which passes a large nerve connecting with the tentacles and eyes. Several ganglia lie in the region of the mouth, foot and visceral mass. From these, numerous nerves pass to the various parts of the body.

Excretory System. — The kidneys are a pair of yellow-colored organs in the form of sacs, encircling the anterior part of the adductor muscle. These glandular organs open into the mantle chamber above the gills, where they are joined by the openings of the reproductive organs.

Foot. — The foot (f) of the adult scallop is a small muscular organ extending from the upper part of the visceral mass dorsally for about a quarter of an inch. It is nearly cylindrical, with a deep groove on one side and a hollow, sucker-like disc on its distal end (Fig. 42). It has a slight twist which places the cleft portion in juxtaposition to the right valve, instead of on the ventral border. This is of use to the young in crawling, as the sucker can be put down evenly on the surface without a twist of the foot to hinder the retraction. Jackson (4). The function of crawling is only for the young, and the adult has either lost the power of locomotion through degeneration or at least does not make use of it. A byssal gland (bg) is on the proximal end of the foot, and secretes the bundle of threads by which the mollusk anchors itself to various objects, as described under "Attachment" in chapter IV.

The Reproductive Organs. — The generative organs comprise a large share of the soft parts of the scallop, and lie, surrounding the folds of the intestine, in the lower portion of the visceral mass. The surface of this mass, which terminates bluntly some distance below the large adductor muscle, is usually covered with a black glossy pigment, which is especially noticeable previous to and during the spawning season, when it completely hides the bright color of the egg sac. Both the male and the female organs are found in the same scallop, whereas in *P. tenuicostatus,* the giant scallop of the Maine coast, the sexes are separate. Drew (1).

The testis (Fig. 75, ts) or male gland is a cream-colored organ lying just ventral to the liver and foot and extending down the side of an orange-colored sac. This sac is the ovary (ov) or female gland, which during the spawning season takes on a bright orange color, presumably due to the number and ripeness of the eggs. In size it is somewhat larger than the testis, and lies ventral and slightly posterior to that organ. During the early part of the spawning season, when full of eggs and spermatozoa, these glands are well rounded and brilliantly hued; but after the completion of spawning they become small and lighter colored. In the ovary of the scallop previous to spawning are many millions of little eggs in various stages of maturity. These eggs, held in large follicles, are packed firmly in place, giving to the generative mass a smooth, plump appearance. Dr. James L. Kellogg has kindly permitted the use of an illustration from his work on the "Morphology of Lamellibranchiate Mollusks, 1890," which shows a section of the generative organs of *Pecten irradians,* and supplements it with the following excellent description: —

Fig. 67 represents a section passing vertically through the outer wall of the visceral mass, where the testis and ovary are closely apposed. The body wall is represented at ep and consists of a single layer of columnar, ciliated, epithelial cells, whose nuclei are about equally distant from their outer ends and the thick basement membrane (bm). In this epithelium are many conspicuous gland cells (glc). Between it and the follicles of the generative gland is a thick layer of connective tissue, extending in between the follicles. The follicles of the ovary (ov) are not so regular in outline when seen in section as those of the testis (t). The walls of the latter bear a follicular epithelium (fep). In the ovary, the cells of this layer are in all stages of development into eggs. The eggs themselves, crowding the follicles, possess a very thick membrane and their protoplasm is finely granular. A duct from the follicles is seen at d.

The mother cells of the spermatozoa (fep) are circular and of constant size in the follicles of the testis (t). As we follow the mass of cells inward from these mother cells they become very gradually smaller and smaller, until their final divisions result in the spermatozoa. They are so arranged that their "tails," in forming, project in extended masses toward the lumen of the follicle and give it a radiating appearance. I have not been able to determine how many times a mother cell divides in forming spermatozoa, for the cells are all rounded and give no evidence of their divisions, as they do in the testes of many animals. A duct of the testis containing spermatozoa is shown at d. The ducts of both testis and ovary are composed of slightly columnar, ciliated cells. In the wall of the duct of the testis is shown a single deeply stained cell, which is evidently a gland cell.

CHAPTER III. — EARLY LIFE HISTORY.

The Ripening of the Reproductive Organs. — In the early spring the sex products of the scallop begin to ripen, as the eggs and spermatozoa mature preparatory to the summer spawning. The final ripening takes place during the month of May, when the water has reached a temperature ranging from 45° to 50° F., and the scallop is prepared "to shoot its spawn" in the first part of June. During the month of May the generative organs take on a plump appearance; the eggs grow larger; the spermatozoa become active; and the ovary passes from an indiscernible pink to a deep orange color. This change in color furnishes a general index for recording, by the aid of color charts, the spawning period of the scallop.

The Egg. — The egg or female cell (Fig. 1) is a small spherical body surrounded by a thin membrane inclosing a protoplasmic fluid. Lying in the protoplasm are numerous yolk granules which give to the egg an opaque appearance. These granules form the nutritive part of the egg. The shape of the mature egg when extruded appears spherical, but, when measured, one axis will be found slightly longer than the other. If the eggs are cut from the ovary they have a variety of shapes, due to the manner in which they were compressed within that organ (Fig. 3). The scallop egg resembles that of the clam and oyster in size, the average diameter being about 1/400 of an inch. In the ovary the eggs, when mature, have an orange color, and when discharged "en masse" still retain that color; but when separated appear to the naked eye as minute white specks. The color intensity of the mass seems to be due to the arrangement of the yolk granules within the egg. A light color appears to be caused by large vacuoles or clear spaces among the yolk granules, as are often found in distorted and immature eggs. Evidently the number, size and arrangement of these vacuoles in respect to the granules determine the color of the mass, and thus indicate the maturity or immaturity of the eggs. Orange-colored ovaries when placed in 75 per cent. alcohol in a short time become white, the orange color being extracted by the fluid.

The Spermatozöon. — The spermatozöon or male cell (Fig. 2) is extremely minute, being only an exceedingly small fraction of the size of the egg. It consists fundamentally of two parts, an elliptical head and a slender whip-like tail, which is used as an organ of locomotion in seeking the egg. The size of the head is $\frac{1}{260}$ by $\frac{1}{500}$ of a millimeter ($\frac{1}{6500}$ by $\frac{1}{12500}$ of an inch), with a tail about $\frac{1}{20}$ of a millimeter ($\frac{1}{500}$ of an inch) in length. The minute anatomy was not studied.

Spawning. — The term "spawning" refers to the discharge of the eggs from the female or the spermatozoa from the male. With most of the lamellibranchiate mollusks, the class to which the scallop belongs, it is the act of throwing off the sex products, which meet in the water for the purpose of fertilization. *Pecten irradians,* as is often the case with highly specialized mollusks, is hermaphroditic, *i.e.,* both sex elements are found in the same individual. Spawning in this instance is the discharge of either eggs or spermatozoa from the same animal, usually at different times.

In the Pectinidæ the opening from both ovary and testis lead into a common duct with a single orifice, which opens into the kidney comparatively near its external aperture. Pelseneer (9). The sexual products, as they are extruded, pass through a part of the kidneys just dorsal to the large adductor muscle into the mantle chamber, where they are discharged into the water. The discharge takes place through the pseudo-siphon, formed by the mantle when closed, at the right or posterior edge of the shell, as the animal lies in a natural position. The spawn is usually cast forth as a fine spray by a quick snap of the valves and is rapidly diffused through the water, though sometimes the valves remain quiet, the spawn then passing out in a steady stream. As the mantle fringe is slightly opened to allow the spawn to roll gently out, this latter method can be compared to the exhaling of tobacco smoke from the human lips. If eggs are given off they either appear in pink masses or are just visible to the naked eye as fine white specks, making it possible for the observer to readily distinguish them from the spermatozoa, which give to the water a quivering, milky appearance. The amount of eggs extruded at one time varies considerably, but generally numbers high in the thousands and even millions.

The following observations upon the spawning of individual scallops were made at Monomoy Point. The scallops were confined, as described in chapter VII., in small aquaria during the period of observation, and were replaced in their native element between times. Possible error arises from the unnatural conditions, which may render the spawning abnormal. Unfortunately no satisfactory method of eliminating this error could be devised. These observations, however, have been partially confirmed in other ways.

(1) *When the scallop spawns, which sex cell is liberated first?*

Observations on 38 scallops showed that 19 produced spermatozoa, 17 eggs, and 2 a mixture of both at the first discharge. In general, the scallop continues shooting for a number of discharges the kind of sex cell with which it starts, and although scallops are hermaphroditic, only a single kind is usually given off at any one time, the length of the period varying from a few minutes to five or six hours. It can be safely concluded that it is purely a matter of chance which sex cell is given off, and that the tendency toward one kind may be a precaution against self-fertilization.

(2) *How long are the intervals between discharges?*

The intervals between discharges vary from one-half a minute to forty-five minutes, or even days. After a series of rapid discharges the resting period appears to be longer. One scallop was observed to give as many as five successive discharges, while two are of frequent occurrence. Other specimens have been observed to shoot spawn at intervals of two or three minutes for over five hours. The scallop possibly can adapt itself to existing conditions and spawn only at favorable times. If the germ cells are set free at intervening periods over a long space of time there is a greater chance of surviving.

(3) *Do scallops throw all their spawn in one day?*

Numbered scallops were placed in separate aquaria for periods of two hours for several days, a record being kept of the spawning of each individual. After each test the animals were suspended in wire baskets from a raft at a depth of 10 feet in water, which was considerably cooler than the sun-warmed water in the aquaria, probably preventing further shooting of spawn. Although only 25 per cent. threw spawn we can infer that scallops shoot their sex products little by little, as the same individuals were found to give forth spawn after an interval of several days. This fact indicates that the spawning season for one scallop probably extends over a period of days and even weeks. Records with color charts, upon scallops of another set, likewise show that spawning is gradual.

(4) *Do scallops spawn at any particular time of day?*

Scallops have been observed to spawn as early as 8.15 A.M. (July 13, 1907) and as late as 4.30 P.M. (July 12, 1909), and at various times between these hours. Although sunlight is more favorable, the scallop will spawn on cloudy days and probably at night, as the time of spawning is largely determined by the temperature.

(5) *What temperature is most favorable for spawning?*

In confinement scallops have been observed to throw spawn at all temperatures from 68° to 84° F., although above 76° F. was most favorable. Great variation is found, as every scallop is a distinct individual and the eggs vary in degree of maturity. One scallop gave off its sex elements at a temperature of 68° F. in fifteen minutes after being placed in the aquarium, while at 78° F. one spawned in three minutes and others took hours. Under natural conditions the spawning season begins when the water reaches 61½°F. As a rule high temperatures are most conducive for spawning.

(6) *At what age does a scallop first spawn?*

The extreme rapidity of growth makes it possible for the scallop to spawn when exactly one year old. With the clam, spawning occasionally occurs at the age of one year, with the quahaug only in very exceptional cases, but with the scallop the most important reproductive period, and the only one of practical value, comes at this early age. This fact is explained by the short life of the scallop, from twenty to twenty-six months, as compared with the many years of the clam and quahaug.

(7) *Is there a second spawning season?*

For the majority of scallops there is only one spawning season. Nature has so regulated that less than 25 per cent. attain a length of life of two years. In the few scallops which pass the two-year mark, eggs and spermatozoa apparently develop normally, and if the animal lives through the season it produces offspring for the second time in its life. These two-year-old scallops are larger, and the ovaries and testes are of correspondingly greater size. Two-year-old scallops are occasionally found in small beds, but large numbers are by no means of common occurrence. In the protected waters of the Powder Hole two-year-old specimens were frequently found. During the summer of 1909 a comparatively large number of the set of 1907 were found. This set was peculiar for its slow growth and small size, the two-year-old animals being about the size of normal one-year-old scallops. The spawning of this set was perfectly normal during the second season, and the sex products could in no way be distinguished from those of yearlings. Although it is possible for scallops to spawn a second time, provided they pass the two-year limit, their economic importance is slight, owing to the small per cent. which survive so long. The first spawning season must, therefore, be considered the only practical one in legislation for the welfare of the scallop fishery.

This fact proves that all scallops under *one year* old *must be protected,* as these furnish practically all the spawn for the following year. Only scallops under this age *need* protection. If the scallop under this age is amply protected, the law has done all in its power to insure the future of this profitable industry. It does no harm to capture scallops *over* one year old; in fact, it would result in economic loss if they were not taken, as nearly all die from natural causes before a second season.

The Spawning Season. — In Massachusetts waters, owing to the diversity of conditions as regards locality, environment and seasonal changes, it is difficult to define the spawning season exactly and only general limits can be given when the entire territory is considered. As a rule, temperature seems to be the controlling factor, as is demonstrated by the variation of the season according to locality and years. The entire period roughly covers two months, averaging from the middle of June to the middle of August (Fig. 83). The height of the spawning occurs during the first weeks in July, and although the season drags on for a month longer, the greater part of the mature eggs have been liberated. Different localities, with the same general limits, often vary in having the height of the spawning at different times. While the spawning of the scallop as a class extends for two months, the duration of the season for the individual runs anywhere from one day to several weeks.

(*a*) *Spawning Season at Monomoy Point.* — During the summers of 1906 and 1907 the spawning season of the scallop was followed in the waters of the Powder Hole at Monomoy Point, and supplementary observations were made during 1908 and 1909. During the first two years conditions in this locality were practically the same, thus eliminating nearly all variation factors except seasonal change. It is, therefore, fair to assume that the following variations are mostly due to the difference in the temperature of the two years.

In comparing the two years 1906 and 1907 the following points will be considered: (1) date of first spawning; (2) length of time spawn could be obtained for successful artificial fertilization; (3) date of appearance of the set on raft spat collectors.

(1) Careful observations were made in regard to the beginning of the spawning season, and the start was accurately determined for this locality. In 1906 scallops first extruded eggs and spermatozoa on June 12, and in 1907 on June 21, a variation of nine days. The average temperature of the water on June 12, 1906, was 61.5° F., on June 21, 1907, 61.5° F. June 4, 1906, was equivalent to June 18, 1907, in regard to the temperature, which reached 60° for the first time on these dates, showing that the seasonal variation in temperature was about two weeks. In both cases there had been a previous rise in temperature. By June 20 this difference had vanished and the daily temperatures for the two years were approximately the same (Fig. 81).

(2) For successful artificial fertilization spawn could be obtained for both years as late as July 20. Mature eggs and active spermatozoa were found in the reproductive organs later, but the scallops did not give forth spawn readily after this date. The records made with the color chart show that the spawning season is not complete before the middle of August.

(3) Very little variation was found in the sets of 1906 and 1907 on the raft spat collectors, but the 1908 and 1909 sets were slightly earlier, though fewer in number. The temperature of the water at the time of set was about 70° F. In 1906 the set began July 26 and reached its height August 4; in 1907, July 24 and August 2; in 1908, July 18 and July 26; in 1909, July 22 and July 29, respectively.

In the above cases, more especially the first, temperature seems to be the controlling factor. The warmth of the water determines an early or late spawning season, as is shown by the difference in the start of the seasons of 1906 and 1907, the latter being nine days behind the former. In each case spawning did not start until the water had assumed a temperature of 61.5° and had been over 60° for a few days. Spawning does not take place until the temperature of the water is sufficiently high to enable the young larvæ to live. Thus, in comparing the two years we find that the variation in the spawning compares in every detail with the variations in temperature, and, when other factors are eliminated, depends directly upon it. The average summer temperature controls the length and completeness of the spawning season, as is directly manifested by the time and amount of set.

(*b*) *Conditions influencing the Spawning Season.* — In any given area the spawning depends on the latitude and on the climate, temperature again being an important factor. In Rhode Island, in the warmer waters of Narragansett Bay, the season lasts from June 1 to July 1, reaching its height about June 15, Risser (2), as compared with June 15 to August 15 in Massachusetts waters. Naturally the farther south the earlier the season, as the warmer waters hasten the spawning.

While the temperature is the main factor in determining the spawning, it is by no means the only one. The natural conditions of any locality, such as its suitability for growth, for food, depth of water, kind of bottom, enemies, exposure, and other factors which make up the environment of the scallop, play their part in determining the spawning season. Scallops in shallow water spawn slightly earlier than those in the deep, probably due to difference in temperature, while those under favorable growing conditions probably spawn in advance of scallops less favorably situated.

(*c*) *Length of Season in Massachusetts Waters.* — The different localities present considerable variation not only within their borders but with each other. The four sections of the scalloping territory given in chapter VI. are useful for a comparison of the spawning season, owing to their divergent conditions. The work of determining the spawning season, as described in chapter VII., was conducted during 1905 and 1906 by (*a*) general observations of the ovary; (*b*) color chart records; (*c*) appearance of set.

(1) On the north side of Cape Cod conditions are not favorable for scallops and there is but a small industry. In Cape Cod Bay the water

is colder than south of the Cape, and the spawning would naturally be somewhat later. In the harbors, such as Wellfleet Bay, the reverse is true, as the broad exposure of flats, heated by the sun, gives a greater warmth to the water. In these cases many scallops are left in little tide pools, where they bask in the sun and shoot spawn in these small natural aquaria. The eggs have thus a chance to develop in quietude until the incoming of the tide, when the little embryos join company with the young from the other pools and begin the keen competition of life. The spawning season lasts from June 25 to August 15.

(2) On the south side of Cape Cod is found a great variety of territory and conditions, which nearly approximate those of Monomoy Point. The limits of the season in this locality are from June 15 to August 15.

(3) The conditions at Nantucket and Edgartown closely approximate those on the south side of Cape Cod, and except for local variations the spawning season is the same.

(4) In the warmer waters of Buzzard's Bay spawning is somewhat earlier, the set usually being about two weeks in advance of Monomoy. The limits of the season scarcely differ from the south side of Cape Cod and the Islands, but the main part of the spawning takes place earlier. The season lasts from June 1 to August 1. The Buzzard's Bay scallop is larger in size than the scallop in the other localities, owing to earlier spawning and rapid growth.

Fecundation. — Fecundation is the union of the female cell (egg) with the male cell (spermatozoön), which results in the formation of a new individual that partakes of the nature of both parents. Since the eggs of the scallop are fertilized externally, in the water, it is comparatively easy to watch the act of fertilization and the subsequent development of the embryos. In the water a transparent substance envelops the egg, which holds the spermatozoa a short distance from the cell proper (Fig. 6). The only reason for believing that such a substance is present is the fact that preserved eggs still retain the circle of spermatozoa. The attraction of the male cell to the egg is believed by scientists to be of chemical origin. Although the egg is thickly surrounded with spermatozoa, only one is needed for fertilization, and after its entrance the rest are held outside by the formation of a membrane through which they cannot penetrate. Occasionally more than one spermatozoön enters the egg, but in this case the egg possibly fails to attain complete development.

(*a*) *Natural Fecundation.* — Judging from the enormous number of eggs and spermatozoa annually liberated by a single adult scallop, nature seems prodigal with her bounties; but on second thought it appears that an equilibrium has been established and that an abundance of spawn is needed to compensate for the destructive agencies which beset the scallop. It seems strange, perhaps, that the spermatozoa should outnumber the eggs 1,600 to 1, as it only requires one spermatozoön to fertilize one egg. But as the small male cell has the active part of finding the egg, this again is a wise provision of nature, whereby this proportion vastly increases the chances of natural fecundation.

If only 1 scallop arrives at maturity from 3,000,000 eggs, it is sufficient, under normal conditions, to perpetuate the species. Naturally there is a vast destruction of eggs and young scallops, an important part of which is due to the loss of eggs through non-fecundation, *i.e.*, the eggs and spermatozoa not meeting in the water. There are a great many chances in nature against fertilization of the egg. Scallops may be some distance apart and the spermatozoa must travel far before they can meet the egg. Water currents, winds and other weather conditions may prevent this union. Fertilization is partly by chance, as the male cell can only be attracted to the egg from a short distance. Thus, if it were not for the abundant supply of sex products the race of scallops would soon be exterminated.

In artificial fertilization a large number of the eggs are not fertilized, and, failing to develop, soon decompose and pollute the water, thus causing the death of the more advanced larvæ. This shows that perhaps all the eggs given forth at one time from the scallop are not ready for fertilization and cannot develop, and it may be supposed that, under natural conditions, an indeterminable per cent. of the extruded eggs are incapable of development.

(*b*) *Self-fecundation.* — *Pecten irradians* is hermaphroditic, *i.e.*, both sex elements are found in the same individual. Pelseneer (9) asserts that: "In hermaphrodite mollusks the spermatozoa ripen before the ova; the hermaphroditism is therefore protandric. The hermaphroditism also is not self-sufficient, and the ova of one individual must normally be fertilized by the spermatozoa of another individual." *Pecten irradians* is an exception to this in that both the eggs and spermatozoa mature at the same time, and that self-fertilization frequently occurs although it is not the common method of reproduction.

In nature it is not usual for scallops to produce both male and female cells at the identical moment, and self-fertilization is therefore not as common an occurrence as when scallops are confined in aquaria. Scallops often shoot eggs and spermatozoa within as short an interval as 15 to 30 minutes apart. In numerous cases self-fertilization has been observed during the spawning experiments. The spermatozoa and eggs of the same scallop have been artificially mixed, and the early embryological stages followed. Whether these self-fertilized eggs would develop into mature scallops was not determined, as the development was only followed as far as the trochosphere larva, up to which period it was normal. Drew (1) and Risser (2) also have made observations on the self-fertilizing powers of the individual *Pecten irradians.*

Fertilization of the Eggs of Two-year-old Scallops. — In spite of the fact that the second spawning of the scallop occurs during its old age, and that the majority of this species do not reach a second season, the eggs of two-year-old scallops may be fertilized and pass through the normal cleavage stages. Although there were some indications that the subsequent development under artificial conditions is not as satisfactory as that of the younger scallops, there is no proof that their development under natural conditions is anything but normal, or that they cannot produce hardy offspring. Naturally, as the two-year-old scallops are few in number their offspring are not numerous. Under artificial conditions as compared with the younger scallops they do not seem to produce spawn so readily and fewer larvæ in proportion are raised to the early swimming stage. These observations cannot be considered as conclusive, as the special Powder Hole set of 1907, already referred to, during 1909 furnished as healthy spawn as the 1908 set.

Embryonic Development.

The early life of *Pecten irradians* can be separated arbitrarily into two main divisions, (1) the embryonic or sub-veliger life, which comprises the development of the animal until it acquires a shell; and (2) the post-embryonic life of the young scallop before it attains adult characteristics.

The post-embryonic life is further subdivided into the (*a*) early veliger stage, when the animal is a free swimming larva with a straight hinge line (Fig. 17); (*b*) late veliger or prodissoconch stage, distinguished by the curved hinge and development of gills and foot (Fig. 18); (*c*) the dissoconch stage, where notable changes occur as a result of the "setting," that is, adjustment by spun byssus threads; (*d*) plicated stage, where the ridges and the furrows characteristic of the adult shell appear.

The embryonic development of *Pecten irradians* is in many respects so similar to that of its large relative, *Pecten tenuicostatus Mighels,* the giant scallop, so ably described by Dr. Gilman A. Drew (1) that it is difficult to present a complete account without a repetition of many interesting facts. For this reason special emphasis has been placed on the points of difference between the two species, and only general consideration given those of common interest. In reporting upon this phase of the life history of *Pecten irradians,* it is perhaps worthy of mention that the results here embodied, imperfect as they are, have been obtained from hundreds of scallops under different conditions and from four years of successive observations.

The Development of the Egg.

The development of the egg after fertilization is by the usual process of cell division, whereby the single ovum is transformed into a living mass of tiny cells. Like most lamellibranchs, in which fertilization takes place externally to the parent, the scallop develops by the normal process of unequal cell division, and its subsequent growth as far as the prodissoconch stage is similar in nearly every respect to the development of the clam, oyster and quahaug.

The Polar Cells (*Figs. 4, 5*). — The first noticeable change in the external appearance of the egg occurs about thirty-three minutes after it is laid. At one part of the egg, which from this time forth becomes the so-called animal pole or region of the greatest activity, appears a small translucent globule, 1/10 the diameter of the egg. This is known as the first polar cell, and is soon followed by a second body of similar nature, which pushes out behind the first in such a manner as to separate it from the egg. Both adhere to the egg by protoplasmic strands, such as described by Drew (1). With *Venus mercenaria* (the quahaug or hard-shell clam) the polar cells form beneath a thin membrane, and are held to the egg by strands from this source. Such a covering is not well marked in the scallop egg, which appears naked, and the protoplasmic strands may possibly have a different origin. The polar cells contain no yolk granules, as is shown by their transparent appearance. They remain with the egg through all the varied stages of cell division, and can be seen still adhering to the first ciliated larvæ, evidently disappearing during the early swimming stage.

The Yolk Lobe. — About ten minutes after the first polar cell is formed, the opposite side of the egg, now known as the vegetative pole, elongates, giving to the egg a pear-shaped appearance. The constriction at the small end is the so-called yolk lobe (Fig. 5) which forms a few minutes previous to cleavage. *Pecten irradians* differs somewhat from *Pecten tenuicostatus* in regard to the time of formation of the yolk lobe. In the case of the latter species, Drew (1) has shown that the yolk lobe appears previous to the polar bodies, and that it becomes prominent when the second polar body is formed, only to disappear and again to become prominent when the egg cleaves into two cells. The yolk lobe in the former was not seen until after the formation of the polar cells, and not until just before the first cleavage did it become markedly prominent. It forms in about three minutes, and is completed one minute before the first cleavage takes place.

The First Cleavage. — Soon after the formation of the yolk lobe and the differentiation of the egg into the animal and vegetative poles a constriction takes place parallel to the longitudinal axis of the egg, dividing the broad end into two unequal cells, the smaller one-half the size of the larger, with the polar bodies between them (Fig. 7). The actual time consumed from the beginning to the completion of the first cleavage varies from two to twelve minutes, but usually it takes about three minutes to effect the change. This first division occurs forty-six minutes after the egg is fertilized.

The action of the yolk lobe during this division is somewhat peculiar.

Previous to the first cleavage the egg has taken on a pear-shaped appearance, due to the formation of the yolk lobe. During cleavage this lobe in many of the eggs became so constricted that the dividing egg had a three-celled appearance. Then it gradually disappeared, in one case in the course of seven minutes, leaving only a large and small cell. The form of the different eggs during cleavage varies greatly, some dividing with scarcely the appearance of a yolk lobe, others with prominent constrictions.

The next cleavage (Fig. 8) divides the egg into four cells in a vertical direction, and passes through the animal pole nearly at right angles to the first cleavage plane, and a little to one side of the center. This division forms three small cells and one large, the latter holding the nutritive or yolk part of the egg, originally contained in the region of the yolk lobe. The second cleavage occurs from fifty-five to eighty-one minutes after fertilization, the average time being sixty-seven minutes.

The third division (Fig. 9) is in a horizontal plane, dividing the four cells into eight. The four upper cells, which lie next to the polar bodies, are much smaller than the lower ones, and from this time forth are designated as the micromeres, while the large lower cells are known as the macromeres. During the process of cleavage the upper layer of cells twists 45°, so that they alternate with the lower cells, furnishing an excellent illustration of the spiral cleavage so common in nature. The time of arrival at the eight-celled stage varies from fifty-eight to one hundred and ten minutes after fertilization, the average being about eighty-one.

From this time on the micromeres divide rapidly into smaller and smaller cells, during which the egg passes successively through sixteen, thirty-two, sixty-four, etc., celled stages, finally forming a layer around the macromeres. The average time of the sixteen-celled stage (Fig. 10) is about one hundred minutes after fertilization. Cell division continues until the single primitive ovum has become a compact mass of small cells surrounding four large cells, the macromeres, resulting in a type of the epibolic gastrula, which later becomes a true invagination by the further division of the macromeres. From a surface view the animal is merely a rounded mass of cells, still bearing the two small polar bodies (Fig. 11.) Soon the inner layer of cells forms an infolded cavity, the archenteron or primitive digestive tract, which opens to the exterior. The micromeres now make up the ectodermal, the macromeres the endodermal layer.

By this time the surface cells have developed cilia, and the animal acquires the power of locomotion (Figs. 12 and 13). It is important that the scallop become active at this period of its existence, as otherwise it would perish. In the laboratory the majority of the eggs settle to the bottom of the glass dishes until this stage is reached. Doubtless in nature the egg, unless held in floating masses or kept in suspension by the currents, falls to the bottom, where it remains until it acquires cilia. The majority probably perish before they reach the swimming stage, either through not being fertilized or because of settling on unfavorable bottom.

The swimming period is reached from nine to twelve hours after fertilization, ten hours being the usual time. Little change has taken place in the size of the animal, and the entire scallop is hardly larger than the original egg. Development is rapid during the swimming period, not so much in size as in change of form from the early swimming gastrula to the trochosphere larva. There are three phases of development in changing from the early gastrula to the advanced trochosphere. (1) The animal is a mere rounded mass of cells covered with cilia. (2) The body has elongated, the blastopore or primitive mouth becomes more noticeable, and the cilia instead of being general are confined to a special portion of the body, which later proves to be anterior end (Fig. 14). In the course of two hours after phase 1, the cilia on the frontal cell at the anterior end of the body elongate until they attain seven-ninths the length of the body (ordinary cilia measure one-fifth the length of the body), and unite to form a bundle called the flagellum, which guides the swimming embryo. Ordinarily it has the appearance of a single last or whip, so closely are its parts united, but as many as six individual cilia have been counted in this bundle. The anterior end of the animal has in the mean time become larger and heavier, while the posterior half has elongated, giving the scallop a top-shaped appearance. (3) The third phase is marked by another invagination on the dorsal side of the animal, directly opposite the blastopore. This is the primitive shell gland which secretes the shell. Pelseneer (9) in considering lamellibranchiate mollusks as a class says of the shell gland: "During its extension it gives rise to a saddle-shaped cuticular pellicle, which becomes calcified at two symmetrical points, right and left of the middle line. These two centers of calcification eventually form the two valves of the shell. . ."

The transition from the early swimming gastrula to the advanced trochosphere is well illustrated by the development of the swimming powers of the young scallop. As soon as the embryo has acquired cilia it starts with a rolling motion, at first slowly, but later faster as it increases in strength, turning over and over on the bottom of the dish. This simple method of changing position is by a rotation on the longitudinal axis which might be compared to the movement of a top before it totters over. The embryo rotates in one place or hutches along in random directions. The rate of this action varies greatly, anywhere from five to twenty turns being counted in ten seconds. The cilia soon perform the functions of swimming organs, and the little animals rise through the water towards the surface, where they can get a better supply of oxygen. The first swimming movement is a compound motion consisting of simple rotations plus revolutions. The prevailing revolution is clockwise, but the motion is intermittent and the direction can be changed at will. With the development of the flagellum, a definite direction of motion arises. The animal nearly always swims with the flagellum anterior, although one case has been observed where the animal swam in a reverse direction for a short distance. Possibly the flagellum serves to increase the speed, which becomes so rapid that it is difficult to follow the animal with a microscope of 41 magnification. The motion is now effected in a straight line by spiral revolutions along the longitudinal axis of the animal. This final motion is probably the culmination of the previous aimless rotations.

The Shell Gland. — The formation of the shell gland, which occurs twelve to fourteen hours after fertilization, marks a decided change in the character of the young scallop (Fig. 15). In the course of a few hours a thin transparent shell grows slowly over the animal, until it completely envelops the soft parts. At first the shell is so small that it scarcely covers the whole of the animal, which can be seen swimming through the water partly covered by the two thin valves. This shell is formed by the secretion from the shell gland, which becomes calcified at two points, forming the two valves. The hinge line at this early stage is flat and straight. At the same time, with the spreading of the shell, various changes of more or less importance, both in the anatomy and in the habits of the young scallop, have taken place, giving rise to a period in its development known as the veliger stage, perhaps the most critical and important period of its existence.

The Veliger Stage.

When reared in the laboratory the embryos reached the full veliger (shell) stage between seventeen and forty hours after fertilization, according to the temperature. Presumably the same time is true in nature, although the rapidity of development varies with the external conditions. The length of the veliger stage is likewise dependent on temperature and environment, the usual duration being about five to six days. During this period numerous changes of more or less importance take place, and the late veliger is an essentially different animal from the early form. It will be necessary, therefore, in describing the veliger stage, with all its involved changes, to arbitrarily divide it into two phases, the early (Figs. 16 and 17) and the late veliger (Fig. 18); and in describing the anatomical changes it will be more satisfactory, after a brief survey of the essential features of each phase, to trace the development of the individual organs separately.

The chief characteristics of the early veliger (Figs. 16 and 17) are: (1) an equivalvular shell slightly inequilateral, without definite structure, with a straight hinge line, no umbones being present; (2) a velum or ciliated swimming organ; (3) a primitive mouth lined with cilia, leading into a cavity in the center of the body, the stomach, and an abbreviated intestine with a posterior anal opening; (4) an inconspicuous mantle; (5) anterior adductor muscle alone present; (6) size .093 millimeter. The increase in size from the trochosphere stage is due to the formation (Fig. 16) of a cavity between the body and the shell.

The late veliger is characterized by: (1) a shell of the same structure, marked by prominent umbones directed posteriorly; (2) a well-developed foot which has succeeded a degenerated velum as the swimming organ; (3) a more complex digestive tract, with palps, and a coiled intestine; (4) a conspicuous mantle; (5) a posterior adductor muscle, and the appearance of several gill bars; (6) size, .18 millimeter.

In studying the life history of nearly every large lamellibranch which begins its life external to the parent, there is a gap between the anatomical changes of the early and late veliger periods, as it is a difficult stage to procure specimens for study. It is only possible in this history of the scallop to give the changes in the different organs by comparing the early and late veligers, as we have not been able to identify with certainty the intermediate forms on account of the large number of species which so closely resemble each other, as they are collected in the plankton net at the surface.

The Shell. — The veliger shell of the Pelecypoda or lamellibranchiate mollusks has been aptly given the name prodissoconch by Jackson (4) to distinguish it from the succeeding shell, the dissoconch. With the scallop, I have taken the liberty to apply this term, which properly includes all of the veliger stage, to merely the late veliger, at which time it has acquired a form markedly characteristic of the scallop. Hereafter, when speaking of the prodissoconch shell, it refers only to the form of shell typical of the late veliger, as it remains differentiated from the succeeding dissoconch stage. In the early veliger, the shell consists of two valves of homogeneous structure joined dorsally by a ligament in a slightly concave hinge-line.

The change from the flat hinge veliger (Fig. 17) to the completed prodissoconch (Fig. 18), which marks the end of the veliger stage, is quite pronounced. The straight hinge line has given way to one of slight curvature, while the valves by their growth have formed prominent umbones, hiding the hinge line from lateral view. The umbones point posteriorly, but are less prominent than in the case of the oyster. The left valve is more convex than the right, and the right umbo is less prominent than the left (Fig. 19). In the completed prodissoconch and probably in the early veliger ten pairs of teeth can be seen along the hinge line, five on each side of a central slit (Fig. 22). The question of teeth has always been of interest in the classification of lamellibranchs. These are later either obscured or absorbed by the growth of the shell. The teeth of one valve fit into the depressions of the other, adding strength to the hinge. The shell remains homogeneous, except for fine lines of growth parallel to the free edge. Its calcareous composition is shown by effervescence when tested with acid. The scallop differs from *Anomia glabra* at this stage by having no byssal notch in the shell.

The Velum. — The veliger derives its name from the larval swimming organ or velum peculiar to this period of its life. This organ, situated in the anterior part of the shell, consists of an elliptical pad, .046 millimeter in length, with a border of short vibrating cilia, and supporting in its center a long flagellum. It is capable of extension and contraction, whereby it can be thrust out of the shell or drawn in quickly by means of retractor fibers, which are fastened to the shell near the posterior part of the hinge, so as to give a direct backward pull. Two fibers go to the ends of the velum, the third to the center. When contracted, the velum folds in to the form of a bell, the round ciliated edges curving toward the central part, which bears the flagellum. When expanded, the velum opens like the unfolding of a flower, the ciliated edges curling outward. When the velum is extended outside the shell, as the animal swims, the whole mass shifts ventrally, leaving a clear space between the hinge and the body. The flagellum serves during this period as a sensitory organ or feeler. The velum is of great use in swimming, and can rapidly propel the young scallop through the water by the lashing of its cilia in a manner similar to the action of oars in a boat.

The development of the velum can be traced from the ciliated region of the early gastrula, and the organ is a direct modification of the anterior ciliated area of the trochosphere larva. The frontal cilia, with the long central flagellum, have become more centralized and stronger, while the ciliated arc has formed a muscular pad capable of extension and contraction. The flagellum and cilia of the veliger stage are identical with those of the trochosphere, the only change being a modification of the supporting area.

While the transition from the veliger to the footed larva has never been completely observed in the scallop, it is doubtless identical with that of the clam, which is here described. This change takes place by the atrophy or degeneration of the velum and the simultaneous development of the foot. Several stages can be observed during this transition period: (1) the primitive veliger, with no foot or at best a rudimentary projection posterior to the mouth; (2) a reduced velum and a half-formed foot; (3) a small velum and a nearly complete foot; (4) no velum and a perfectly developed foot. During this period the mouth has advanced anteriorly and dorsally, following the disappearing velum, which vanishes in the region of the palps.

Habits. — Swimming in the earlier veliger stage is wholly by the velum, while later this organ is assisted by the foot. The very young veliger is less active than the older larva, and is usually found at the bottom of the dish with valves widely open and velum partly protruded. In this case, the movement merely consisted of turning in a circle, as the velum was not thrust out far enough to enable the animal to swim rapidly in a straight course. Only when the velum can be completely extended does the larva attain full swimming powers.

When the velum is fully developed the animals become rapid swimmers, and can be found in great numbers through the water, more especially near the surface, where they can be taken in a net of silk bolting cloth. When placed in a glass aquarium, if left undisturbed, they can be seen by the naked eye as white specks as they swim through the water. If the dish is subject to any sudden jar, such as a sharp tap with a pencil, the young scallop quickly pulls in the velum and settles to the bottom with closed shell. After a brief interval the animal extends the velum with a hesitating jerky movement, until it is fully expanded, and then resumes swimming. The usual direction is with the velum ahead, the cilia on the edges lashing with a rowing motion which propels the animal in the same manner as a boat is propelled by a man seated in the bow. There is also a turning motion, which whirls the larva anterio-posteriorly in either a clockwise or anti-clockwise direction.

The Foot.—As the animal passes into the late veliger stage the swimming powers of the velum degenerate, while the foot with its ciliated tip becomes the only organ of locomotion. The footed larvæ swim by a kicking movement of the foot. It is natural to suppose that there is a transitory stage where both the velum and the foot are used. The foot, the most useful organ of the young scallop, makes its appearance in the prodissoconch stage, and for a long time serves as means of locomotion for the animal. It is a long, flexible organ, made up of both longitudinal and circular muscles, and entirely covered with fine cilia. On its tip or distal end are long cilia, comparable to the little tuft or cluster posterior to the mouth in the early veliger. The long cilia are at first useful in swimming, but as the animal becomes larger they become relatively less important. The tip of the foot is slightly cleft, as is shown for an older scallop (Fig. 27). On both sides of the foot in a median position are two vestibules, with several small granules rotating inside. These are the otocysts or organs of equilibrium. On the dorsal side of the foot, one-third the distance from the proximal end, is a prominence with a cleft opening, the byssal gland, the function of which has not culminated at this stage. The foot is capable of great extension by the contraction of the circular muscles, and is drawn in by the contraction of the longitudinal to lie in its normal curved position within the shell (Fig. 18).

The Adductor Muscles.—The primitive veliger has but a single adductor muscle, the anterior. In the dissoconch stage, the posterior adductor is the only one present, the anterior having disappeared. As is stated by both Jackson (4) and Drew (1), there must be an intermediate stage where both are present. I have obtained no actual proof of this, but in all probability a dimyarian stage, *i.e.,* having two muscles, must have been reached in the course of development.

The Gills. — The early veliger has no gills. They first begin to develop coincidently with the formation of the foot as simple bars or ciliated filaments, capable of extension and contraction from the dorsal point of attachment. Starting from beneath the stomach they lie in folds along the upper part of the foot. When first seen, at the beginning of the degeneration of the velum, they scarcely consist of two folds, but before the velum has disappeared they number from four to five. The edges of the folds are lined with active cilia which keep up an incessant motion. These primitive bars, as seen in the prodissoconch (Fig. 18), are the paired beginnings of the inner gills. The outer gills develop at a later stage.

The Mantle. — At the time of the formation of the gills the mantle becomes noticeable as a thin, transparent covering just under the shell, although it has been functional before this period. By the time the dissoconch stage is reached, the free edge has thickened into fine folds and is lined with small cilia.

The Digestive Tract. — The digestive apparatus of the early veliger consists of a funnel-shaped mouth lined with active cilia, leading into a broad sac, the stomach, also lined with minute cilia, from which arises a two-lobed liver. The intestine is merely a straight tube opening posteriorly. With the prodissoconch veliger the digestive tract is obscured by the growth of the liver, which has assumed a greenish yellow color so that the coils of the intestine are difficult to distinguish. The mouth has travelled forward in a dorsal direction, the edges apparently having formed the palps, while the ciliated funnel has become the œsophagus. The intestine now has one or more coils, and, in order to carry on the more complicated process of digestion, opens dorsal to the adductor muscle.

Summary of Veliger Stage.

	Early Veliger.	Prodissoconch Veliger.
Shell,	Straight hinge,	Prominent umbones.
Velum,	Present,	Degenerate.
Foot,	Absent,	Present.
Gill-bars,	Absent,	Present.
Mantle,	Invisible,	Visible.
Mouth,	Ventral position,	Anterior position.
Palps,	Absent,	Present.
Stomach,	Simple sac,	Simple sac.
Liver,	Small,	Large.
Intestine,	Straight,	Coiled.
Adductor muscle,	Anterior,	Posterior.
Size,	.093 millimeter,	.18 millimeter.

The Dissoconch Stage.

The young scallop now enters upon the third stage of its development, the period of byssal attachment, which is comparable to *youth* in man. From structural differences of shell, which sharply distinguish it from the prodissoconch, it has been called by Professor Jackson (4) the dissoconch stage. The anatomical changes are so complicated that for the purpose of description several arbitrary subdivisions, illustrating successive periods of development, have been made. A table of these phases is appended in chapter VII. In the general description of the dissoconch period, especially in the section on anatomical development, reference is made to these subdivisions.

The chief characteristics of the dissoconch stage are the habits of byssal fixation and crawling. In a preliminary report the writer was led to include an intermediate stage between the free swimming veliger and the attached scallop, that of a free crawling existence. Later investigation has shown that the last two stages practically coincide, and that no line of distinction can be drawn. Evidently the power of crawling is supplementary to byssal fixation, and is of great service to the animal when it wishes to change its location or is torn away from its point of attachment. That young scallops have the power of byssal fixation immediately following the prodissoconch or at the very beginning of the dissoconch stage is shown by those attached to the raft spat boxes, described in chapter VII. In many of these scallops the dissoconch growth, scarcely one day old, had just started, yet they at once attached themselves, by a fine byssal thread, to the sides and bottom of glass dishes.

The subsequent changes in anatomy and shell formation can be more readily attributed to a complete change in habits, such as the assuming of a stationary life after a free-swimming existence, than the transition from swimming to the intermediate crawling stage, such as has been suggested by other investigators. Knowledge of the byssal attachment in the early part of the dissoconch stage shows that there is an abrupt change of life at this period, and gives a new interpretation to the structural differences.

The Set. — The oyster, according to Jackson (4), still possesses a velum when it "spats," or attaches itself at the end of the prodissoconch stage, and no foot has developed. "The preliminary fixation," he states, "is probably effected by means of the reflected mantle border, as described by Ryder, and is then immediately succeeded by a cementing conchyolin attachment at the extreme edge of the lower left prodissoconch valve." The scallop, on the other hand, before it sets has lost its velum and has developed a muscular foot, which acts as a swimming organ during the latter part of the prodissoconch stage. The set is made, not by any fixation of the shell, but by a fine thread, called the byssus, formed by a gland in the foot (Fig. 30). It is interesting to note that in each case the attachment, though entirely different, comes at the end of the prodissoconch period, and that the organs of attachment and locomotion, owing to the absence of the foot in the oyster, are strikingly dissimilar.

The Shell. — The shell of the dissoconch stage (Fig. 19) is sharply separated from the prodissoconch by a well-defined growth line and by different shell formation. The prodissoconch has a smooth homogeneous structure lined with finely concentric lines of growth. The new growth is of an entirely different character, as the right or lower valve acquires a prismatic structure (Fig. 41), such as was described in Ostrea and Pecten by Jackson (4), in which each prism is separated by an intervening space. The structure on the left or upper valve, while not prismatic, is readily discernible in appearance from the prodissoconch. The first indications of coloring in the shell appear during the latter part of this period as little dashes of yellow or brown. The dissoconch shell has a smooth, even appearance, with no plications, and separated by regular concentric growth lines, which are used by the writer to mark off certain sub-stages. Probably these growth lines, as yet not eroded by action of water or subsequent growth, denote daily periods, tides or other intervals in shell formation.

With this stage the hinge becomes for the second time a straight line. During the first three sub-stages it is narrow, hardly four-sevenths the width of the animal, but later it increases relatively in width, until at the beginning of the plicated stage it is nearly the same length. In the early stages the hinge line is not absolutely straight, but inclines slightly upward at both ends. The inside of the hinge line is set with teeth, as described for the prodissoconch veliger (Fig. 22).

The form of the scallop gradually changes during the dissoconch period, as it grows from .18 to 1.20 millimeters. At first the shell rounds out anteriorly, while posteriorly it breaks directly down from the hinge line with a slight curve (Figs. 19, 20). The left or upper valve elongates anteriorly a slight distance beyond the right, covering in this region the byssal notch of the lower valve (Fig. 19). At a slightly later stage (Figs. 25, 26) the shell has formed in this region a "pseudo ear," which disappears as the animal grows larger, and again reappears at the size of 1.50 to 2 millimeters to form the true "ears" on both sides of the shell. Meanwhile, the posterior part of the shell has increased slightly faster than the anterior, causing the prodissoconch to assume a position anterior to the center (Fig. 28). Toward the close of the dissoconch stage the scallop loses its elongated form and takes on a semicircular appearance (Fig. 31). The various changes in form from the early veliger to the 2 millimeter scallop are shown in Fig. 77, which consists of eleven concentric camera outlines of different sized scallops.

The dissoconch scallop differs from the adult, in which the two valves are equal, by having the right or lower valve smaller than the left and less convex. This is undoubtedly a direct adaptation to its method of life during this period, the flat lower valve offering ease and assistance in crawling and attachment. *Anomia* offers an excellent example of the flattening of the lower valve in an attached animal, and the rounding out of the upper. The same is true of *Pecten irradians* to a slighter extent, as it is not attached so firmly nor for so long a period as *Anomia.*

The most interesting feature of the shell formation during this period is the development of the byssal notch and groove in the anterior part of the lower valve. The notch is the name applied to the indentation (Figs. 19–21), while "groove" refers to the hollow formed by the growth of the notch (Fig. 25). The notch first makes its appearance close to the prodissoconch, indicating that it starts at the time the animal "sets." By the time that phase 5 is reached a tooth-like process has formed on the notch (Fig. 29). These increase to three in number at the end of the dissoconch stage, and go as high as five or more in the plicated period. Similar teeth are found on the byssal notch of scallops less than one year old, as new ones are constantly forming, while the old are covered by the growth of the shell. Old scallops rarely have teeth on the byssal notch. If the shell is broken along the byssal groove in an adult scallop an entire ridge of these teeth can be seen where they have been covered by the growth of the shell. The use of these teeth is unknown, except that they are closely associated with the byssus, as is described in chapter IV. under the habit of byssal fixation.

The name byssal notch is probably derived from the fact that the byssus comes out of the same indentation in the adult. Perhaps at this stage a more appropriate name would be foot groove, as that organ, in crawling or in spinning the byssus, is thrust out of the opening. There is some difference of opinion as to whether the byssus or the foot is the cause of the formation of this notch. Jackson (4) says that it is formed by the folding back of the mantle, resulting in retarded growth in that locality (Fig. 21). Whether the foot or the byssus thread was the cause of this retardation cannot be stated definitely, although probably both are functional. Although the foot appears before the dissoconch stage it is used as a swimming organ. The byssal notch appears immediately after the prodissoconch stage, corresponding with both the byssal attachment and the use of the foot as a crawling organ. Therefore it can safely be concluded that the byssal notch is characteristic of this period, and is formed by the combined action of foot and byssus.

The Internal Anatomy. — With the development of the shell, corresponding changes have taken place in the internal anatomy, rendering the scallop better adapted to its new mode of life. Adult characteristics are now manifest, and the animal can be readily recognized as a scallop.

The specific development for each set of organs is given in detail under the section on "Anatomical Development," and it is only necessary to give here a brief résumé of the more important changes.

As the animal has entered upon an alternately stationary and crawling existence, the foot has become relatively the most important organ, and during the early part of the dissoconch stage reaches its maximum development in size. The ciliated tip and muscular body render it an active organ of locomotion, while the byssus gland provides the scallop with a means of attachment. The mantle, at first a simple, curtain-like fold with ciliated edges, becomes more specialized by the development on its outer edge of a few tentacles and eyes, which give it greater sensory functions. The four folds of the inner gills of the prodissoconch increase to twenty-two, and the outer gills make their appearance before the dissoconch stage is completed. The digestive organs increase in size, the liver becoming the most prominent, while the intestine elongates so that the anal opening is on the postero-ventral side of the adductor muscle. The posterior adductor muscle, which through this period has been capable of great expansion, as is shown in Fig. 23, so that the shell is often opened to an angle of 90°, has grown larger in circumference and has taken a more central position. The heart, consisting of a ventricle and two auricles, with its supplementary circulatory system, now first becomes conspicuous (Fig. 27). Altogether the internal anatomy of the young scallop has passed through the transition period from babyhood to the adult, and is now ready to take on the final characteristics of the mature scallop.

The Plicated Stage.

The plication stage, as the name suggests, marks the beginning of the radiating ridges or furrows which give to the scallop its beautiful fan-like appearance. These plications do not increase in number as the animal grows older. Figs. 33 and 34 show the beginnings of the plications in the shell, while Figs. 36 and 37 show a later stage. In the early plicated stage the form of the scallop is semi-circular, the height and width being approximately the same, while the hinge line is nearly equal to the width. The hinge line is now straight, but markings exist in the shell showing the former downward. slant toward the prodissoconch, which in the early part of the plication period is asymmetrical, but later attains a median position, before it is covered by the rounding umbones of the shell. The true "ears" of the adult make their appearance as indentations on the lower sides of the hinge line, anteriorly and posteriorly, when the scallop has attained about 2 millimeters in size. During this stage they are much less pronounced than in the adult, while the hinge line itself is relatively longer, nearly equaling the width of the shell.

The byssal notch, which inclines slightly upward toward the prodissoconch, has now become deeper and is lined with several teeth along its inner border. The number varies from one to six or more, the older teeth being less pointed than the last formed. In Fig. 39 there is a secondary furrow dorsal to the main groove, and a serrated structure near the hinge line, consisting of seven sharply pointed teeth, the origin and use of which are unknown.

The dorsal view of the shell of Pecten at this stage (Fig. 38) shows the relative size of the umbones and the hinge line. The left valve is deeper than the right and the umbones point slightly posteriorly. The line of separation of the prodissoconch and dissoconch growth is sharply marked, showing how the two valves, which were close together during the prodissoconch stage, have been spread apart by the new growth of the valves. This period is just previous to the disappearance of the prodissoconch, either by the wearing away of the shell or by the growth of the shell.

The exact duration of the plication stage cannot be given, as the transition to the adult is gradual. Perhaps the end of this period should come when the animal has attained general adult characteristics. If such a definition be taken, the arbitrary size may be assigned as 4 millimeters, for by that time the visceral mass is well defined, completing the adult anatomy of the scallop. Unless some standard were taken, it would be impossible to tell just when the plication stage ceased and adult life began. Another view would have the plication stage followed by a period of youth, and consider that the adult life was not reached until the animal was a year old. This, perhaps, is a better division, although the characteristics of the youth and the adult are practically the same.

The Internal Anatomy. — Few new organs arise during this stage, which is mostly concerned in the development of those already formed. The most prominent feature is the appearance of the visceral mass with the reproductive organs, which are first noticeable at the size of 3 millimeters. The visceral mass grows down from the ventral surface of the foot, which becomes relatively smaller with the growth of the animal.

At the size of 3 millimeters, the mantle has increased by the formation of a set of guard tentacles, which are situated on the perpendicular flap. The eyes have increased until they number sixteen or more on each lobe of the mantle, while the tentacles have correspondingly increased in size and number. The circulatory and the nervous systems have become more complicated, to meet the requirements of the growing animal, which now has acquired the power of swimming by valvular contraction. The digestive system has expanded, the palps becoming ruffled around the mouth, and the intestine elongated in the region of the visceral mass. The adductor muscle has increased greatly in size and can be seen to consist of two distinct portions. By the completion of the stage, the animal has attained all the organs and characteristics of the adult scallop.

Anatomical Development.

In order to insure a unified and connected narrative, it was thought best, even at the risk of repetition, to trace the development of each organ or set of organs separately. Wherever opportunity is given the reader is referred to other portions of the report for supplementary reading. In tracing the outline of the early life history of the scallop the shell has been taken as the unit of description, and therefore its development need not be treated separately, and only the soft or internal parts of the animal need exemplification. Constant reference is made to the various stages outlined in the table in chapter VII., and to the illustrations, so as to present a connected account without unnecessary description.

The Mantle. — A description of the structure and functions of the mantle of the adult scallop is given in chapter II., and it is only necessary to recapitulate certain points which bear directly upon its development. The mantle is a thin bilobed membrane closely lining the interior of the shell and enfolding the body of the animal. The free edges form thickened flaps, which are brilliantly colored and lined with rows of sense organs, eyes and tentacles. The functions of the mantle are: (1) shell secreting, as the growth of the shell is due to the secretions from the mantle; (2) protective, as it enfolds and guards the body, and is largely instrumental in swimming and feeding; (3) sensitory, as the numerous tactile appendages and the circumpallial nerve render it sensitive to the slightest stimulus.

There is a steady development from the primitive mantle in the young scallop to the highly specialized organ in the adult. It can be deduced, from the changes which take place during the embryological and post-embryological development, that the early ancestor of the scallop did not have such highly specialized functions, which only developed when the animal assumed its present dangerous mode of life, where it depends upon its nervous mechanism to warn it of impending danger.

The primitive mantle of the young scallop is a simple bilobed fold joined along the hinge line, and is first visible in the prodissoconch or late veliger stage. In the early veliger, although probably present to enable the formation of the embryonic shell, it was not noticed. It evidently attains prominence during the prodissoconch stage as a definite mantle, common to all lamellibranchs, similar, except for the crenulated edges, to that of the adult quahaug. At this time it appears entirely separate from the degenerate velum, whereas in the early veliger it was indistinguishable. The animal can extend the mantle slightly beyond the shell, and by means of retractor muscles withdraw it to about two-thirds its natural size. Even at this early period the mantle serves as a sensory organ, as the edges are lined with minute cilia and simple folds are already noticeable on the borders.

During the dissoconch or attachment stage, the mantle first takes on characteristics which differentiate it from the early stages of other forms. The edges become more folded and knob-like projections gradually form at definite places on the border, some to form tentacles, others the eyes of the scallop. (The development of the eyes and tentacles will be considered separately under "Sensory Organs.") The retractor muscles become stronger, and the mantle is now capable of greater extension and contraction, withdrawing at points where irritated. As the animal grows larger the number of retractor muscles of the mantle increase and are attached in a widening semi-circle far down the interior of the shell, so that only the outer portion of the mantle hangs free.

Another important functional change takes place when the so-called flap of the mantle is formed. This is a thin outgrowth in a perpendicular direction along the entire edge of the mantle, except just beneath the "ears" near the siphonal openings. The flap, when first formed during phase 6, is entirely plain, but soon is ornamented with a row of small tentacles called by Jackson (4) "guard tentacles." With the formation of the guard flap the animal has become a specialized scallop, differing from other lamellibranchs. The valves are now held apart, when resting, in such a way that the opposite flaps almost close the intervening space. Water can be taken in and shot out of the shell, giving the scallop the power of swimming.

Closely allied in function with the guard flap is the formation, during phase 5, of what is known as the pseudo-siphon, which arises as a transparent conical projection from the median posterior border of the mantle. This organ is formed by the concrescence of the mantle edges, and is not a true siphon, as is found in the clam and quahaug. Functionally this pseudo-siphon acts as an excurrent canal to eject water from the shell. Although it is not used for the purpose of swimming, as is the case with the same region in the adult scallop, it assists the animal at this period of life in crawling, as simultaneously with the contraction of the foot a stream of water is ejected from the pseudo-siphon. After each flow of water the siphon is retracted again, to be extended when the next stream is forthcoming. The pseudo-siphon disappears before the scallop reaches adult size, and is evidently only functional during the crawling period.

The mantle, particularly the edge, is beautifully hued with many colors. The mantle of the scallop at first is a transparent white, which gradually takes on the colors of the adult mantle. The intensity of the color varies greatly in the different scallops and is as unexplainable as the variety of colors in the shell.

The Sense Organs. — The scallop has a well-developed sensory system of specialized parts, each of which contributes to the maintenance of life and to the protection to the animal.

(*a*) *Tentacles.* — The tentacles in the adult scallop line the border of the mantle. There are two kinds: (1) the large, highly extensible tentacles, lining the outer edge of the mantle, called by the writer "mantle tentacles" to distinguish them from (2) the inner or "guard tentacles," which lie on the edge of the perpendicular mantle flap. The "mantle tentacles" comprise several rows, apparently without any definite arrangement in the adult. When extended they have the appearance of long, slender white bars covered with minute conical projections, each tipped with a hair. The "guard tentacles" differ from the former in extensibility and function. They extend nearly the entire edge of the mantle flap, except in the region of the two siphonal openings below the "ears," and evidently act as strainers to keep out foreign substances from the mantle chamber.

The first specialization of the mantle border, the tentacles, appear when the growing condition of the animal demands sensitory functions. They appear soon after the scallop passes the size of .5 of a millimeter, just previous to phase 5, when they can be seen fairly well developed. The first tentacles were noted as conical papillary projections .04 of a millimeter in height, tipped with single cilia (Fig. 44a) on the border of the ciliated mantle. Soon another rises close to the first, or more likely there is a division into two with a granular core between (Fig. 44b). The growth continues by repeated subdivisions and the extension of the core part of the mantle until a colony of these projections is formed (Fig. 45), covering a single tube of blood spaces, nerves and tissue, the tentacle proper. The papillary projections radiate from the stalk in such a manner as to give it the appearance of a pineapple (Fig. 46). Such projections are noticeable on the tips of the tentacles during stage 5 (Fig. 29).

The first tentacles to form are in the ventral region of the mantle (Fig. 27). When the young scallop has nine large tentacles on each mantle lobe, it has seven eyes, which alternate with tentacles. At this stage there are nine slight secondary tentacles which arise between the large ones and in definite relation to the eyes (Fig. 29). As the scallop grows the tentacles increase rapidly by this method of interpolation, with the result that there finally is apparently no definite arrangement of tentacles and eyes. The first nine tentacles may be styled primary, as they are much larger than the others, which, taken in the order of their occurrence, are called secondary, tertiary, etc. It is interesting to note (Fig. 29) that no primary tentacle is near the central region of the pseudo-siphon, but that there is one on each side. In scallops of 1½ millimeters these tentacles when extended measure two-thirds the height of the animal. The "guard tentacles," on account of their function, are quite different in appearance from the "mantle tentacles," being less extensible and heavier.

There are several uses for the tentacles of the young scallop, especially the primary, which are not functional in the adult. In *floating,* the small animal opens the shell, extends the tentacles to full length, and, turning the body with right valve uppermost (the reverse of the natural position), maintains itself on the surface of the water. This habit has been observed in numerous cases in the aquarium in which scallops were confined. In scallops over 1 millimeter it appears to be accomplished by the spreading of the tentacles.

Observers, as Jackson (4), have stated that the animal is assisted by the tips of the tentacles in crawling, more particularly in climbing, during which the tentacles cling to the sides of the glass. Whether the extension and clinging of the tentacles is any great help to the foot in climbing is a matter of doubt, but they undoubtedly rest on the glass and are extended during both swimming and crawling.

The chief function of the tentacles is sensory. Often the tentacles of the adult do not respond to external stimuli, as would naturally be supposed, and in the case of repeated stimulation often fail to react at all. In scallops of 2 millimeters the tentacles may be made to contract separately by mechanically stimulating one at a time. This nervous reaction is not general, but if the whole animal is suddenly jarred all the tentacles are withdrawn with surprising swiftness. The tentacles of scallops of this size render the animal more sensitive than the smaller scallops, which do not have the full development of the tentacles. Thus the sensory nature of the tentacles is proven, and the subsequent inactivity of the large adults must be accounted for in other ways.

(*b*) *The Eyes.* — The most prominent feature of the mantle border is the fringe of brightly pigmented eyes, which are thickly scattered along the edge. In the adult there is great variation in the number, size and order of arrangement. These eyes are comparable with those of higher animals, and evidently have a sensory function.

As stated by Drew (1) the eyes are closely allied to the tentacles, and are in fact derived from the same source, being nothing more than modified tentacles. Their situation, origin, time of appearance, arrangement, all indicate that the eyes and tentacles are fundamentally the same.

The eyes make their appearance during phase 5, when the first or primary set is developed just after the primary tentacles are formed. The two lower or ventral eyes are formed first, then the eyes near the hinge line, and the intermediate ones soon after, numbering seven on each lobe of the mantle. The color of the eyes varies at this age from a brown to a blue. As can be seen in Fig. 29, the primary eyes and tentacles are arranged definitely, the eyes being situated on slight projections on the outer fold of the mantle between the tentacles. The successive development of the eyes is like the tentacles by the formation of secondary, tertiary, etc., sets between the primary eyes, at first alternating with the tentacles, but later apparently without definite arrangement. Although the visual function of the scallop's eye has been a matter of much dispute, there is but slight question that the eye has its use as a sensitory organ.

(*c*) *The Otocyst.* — The otocyst, or organ of equilibrium, is situated in the foot in the young animal. It is first seen in the scallop of the prodissoconch stage as two vestibules of small size, one on each side of the foot. Inside the circumference is a clear fluid in which several small granules are constantly revolving (Fig. 20), evidently due to ciliary action. These remain prominent in the foot as long as that organ is relatively the largest part of the body, but are gradually lost sight of in the visceral mass of the adult scallop.

The Gills. — The gills form during the transition period from the early veliger to the prodissoconch stage, when they are observed as simple primitive folds lined with vibrating cilia. At the beginning of the dissoconch stage the gill is a bar folded into four simple filamentous processes, covered on the outer edge of the folds by rapidly stroking cilia (Figs. 18 and 20). Later stages show that the bar filaments are added ventro-posteriorly, first appearing as bud-like processes. The gills then consist of simple bar filaments so arranged with the longer ones dorsal that the whole gill has a semi leaf-like appearance. At the end of the dissoconch period these filaments number between 20 and 25, while the more mature dorsal bars became enlarged at the free end, due to their turning back upon themselves. At this time there are two gills, one on each side of the body, which are the inner gills of the adult. This later growth marks the beginning of the inner lamella although the filaments are still separate. The scallop is about 1 millimeter (about 1/25 of an inch) in size at this time.

The next change is the formation of two outer gills, which mark the characteristic structure of the adult. Just previous to the appearance of the outer gills the animal has two inner gills of about seventeen filaments. Small "buds" arise on the upper edge at the posterior end of the gill, and increase rapidly in size and number. It is curious that the development of the outer gills starts at the posterior instead of the anterior end, exactly reverse to the formation of the inner gill. In a 1¼-millimeter scallop sixteen filaments were counted on the outer gill, in a 1.8-millimeter scallop twenty-eight, and by the time the animal had reached the size of 3 millimeters the gills had the same appearance as in the adult. The inner gills are reflected inward, the outer gills fold outward to form the second lamella.

The later changes are more complicated and not so conspicuous. The filaments appear to become united, but on close examination this union is found to be due to the interlocking of ciliated discs on the posterior and anterior sides of each filament, giving the appearance of interfilamental cross bars. The filaments are joined in groups or bands of seven or eight. A 4-millimeter scallop has about ten bands, a 5-millimeter specimen twenty-five. The lamellæ are also attached at intervals by a fine septum.

The gills are at all times very sensitive. When touched with a pencil they immediately contract. If a few drops of formalin are placed in the water near a small scallop a sudden clapping of the valves frequently shoots out a detached portion of the gills.

The Adductor Muscle. — According to Jackson (4) the revolution of the axis has brought about the loss of the anterior and retention of the posterior adductor muscle in the adult Pecten. Naturally, as with the oyster, there is one period of life, the early veliger stage, when the anterior adductor is present. Then follows an intervening stage where both are presumably present, and finally, by the time of the dissoconch stage, the anterior adductor has disappeared. Sharp (15), like Jackson, favors the view that the mechanical shifting of the axis of the shell has caused the atrophy of the anterior and the subsequent enlargement of the posterior adductor. In the adult the muscle is formed of two parts, a large anterior and a small posterior division. The relative increase in size of the muscle between 3 and 10 millimeter scallops is more rapid than the formation of the shell, the muscle increasing sixteen times, the shell only eleven times, in volume, and is possibly due to the need at this period of a larger muscle.

The Foot. — As the functions of the foot are given in chapter IV., under "Locomotion" and "Attachment," little needs to be said here. From the relatively largest organ in the scallop during its dissoconch stage, the foot rapidly becomes smaller, owing to degeneration and lack of use, until in the adult it is but a small projection on the antero-dorsal surface of the visceral mass.

The Visceral Mass. — The degeneration of the foot marks the growth of the visceral mass, which contains the reproductive organs and the coils of the digestive tract. It is first noticeable to the naked eye in the 3-millimeter scallop as a mere speck on the ventral surface of the foot. The reproductive organs are the last to mature and the last to be of use to the animal before its decline, which theoretically starts at the completion of spawning. Even at this early stage it is covered with the black pigment so prominent in the adult. A white streak running along the anterior edge marks the situation of the testes. The rest of the mass is covered with the pigment. The surface area of this mass for a 13-millimeter scallop is ten times greater than for a 3-millimeter animal. The intestine does not form a part of the mass until the scallop has attained a size of 8 millimeters, when the coils are enveloped. The visceral mass continues to increase in size until in the adult it is the largest part of the body.

The Digestive System.

(*a*) *The Palps.* — The palps are formed soon after the disappearance of the velum, and there possibly may be some connection between the two as the velum disappears in the vicinity of the palps. At first they are simple folds, as in the average lamellibranch, and not until later do they assume the ruffled form which is characteristic of the adult.

(*b*) *The Mouth and Œsophagus.* — The primitive mouth and œsophagus in the veliger consisted of a simple ciliated funnel leading into the stomach. At this period the edges of the mouth were covered with cilia, and the palps had not made their appearance, the only fundamental difference between the mouth of the veliger and of the adult.

(*c*) *The Stomach.* — The stomach of the veliger can be discerned beneath the liver through the transparent shell. The walls are lined with cilia. The adult stomach is more specialized by the formation at the posterior end of the articulating receptacle for the head of the crystalline style, by its larger size, and the ridges and folds which line its inner surface. Its development is gradual with the rest of the soft parts of the scallop, but cannot be traced in the young scallop after the veliger stage, owing to the dark covering of the liver.

(*d*) *The Liver.* — The liver appears in the veliger stage as two glands on each side of the stomach, and rapidly spreads out to cover that organ, so that in the developed veliger the most conspicuous object is the large liver mass in the center of the animal, with its granular colored appearance. As the scallop grows older, the liver takes on a darker color, which in the adult is an extremely dark brown, whereas in the young scallop, even up to 15 millimeters, it is a light brown or occasionally a yellow brown.

(*e*) *The Intestine.* — The intestine of the veliger when first formed is a simple tube curving downward and backward from the stomach. In a few hours the digestive processes have necessitated greater use of this organ and it has accordingly elongated by forming a coil in the upper part of the mantle chamber above the stomach and liver. The entire length of the tube is lined with cilia, and the food particles can be seen rotating within. The successive development of the intestine, exclusive of the formation of the crystalline style, which lies in a folded groove in the portion near the stomach, is chiefly that of elongation by means of coiling. When the scallop attains the size of 8 millimeters the coils of the intestine are inclosed by the visceral mass, or rather are seen to be enfolded in that substance, and are carried ventral as the mass increases in size. The anal opening passes during this development from a position dorsal to the adductor muscle to a more ventral situation in the adult, thus further increasing the length of the digestive tract, which passes through the central chamber of the heart.

Coloring of the Shell.

The numerous color variations in the shells of young scallops render them conspicuous among other objects on the tidal beaches. Scallops are found of all shades, ranging from the plain color to the striped varieties, with hardly two alike, and are on this account often gathered for ornamental or decorative purposes. The popularity of the scallop shell is ancient, as history tells us that this shell was the device on the shield of many a crusader, and that through all ages it has been regarded as an object of beauty.

Naturally, various questions on the subject of shell coloration arise, such as (1) the nature of the coloring matter; (2) where and how it appears; (3) the variations; (4) do scallops change color? (5) is color due to inheritance or environment? In connection with the growth experiments on young scallops the following notes were made.

Coloring Matter in the Shell. — In scallops from 3 to 10 millimeters the brown coloring matter is the predominating shade. When mounted on a slide after having been treated with acid the colored shells leave a brown outline of various intensities on the glass, according to the depth of the color, while the pure white are barely discernible in outline, showing that the brown coloring matter resists the action of the acid. Other colors, as black and red, are of different origin and disappear under the action of acids.

The Appearance of the Color. — The lower or right valve of the scallop shows the color best. The upper valve is usually darker, of plainer hue, and covered with growths such as eel grass, sea lettuce, Enteromorpha and numerous smaller plant forms. In the young scallops the color of the two valves is the same, and only when the upper becomes coated over is any difference apparent. In the adult the lower valve is much lighter in color than the upper.

The time of appearance varies greatly. Albino scallops, which do not seem to have any coloring matter in the shell, are found in all sizes up to 1½ inches. As they grow older the pure white color takes on a yellowing or grayish hue. Scallops the size of the head of a pin may have more color than scallops the diameter of a lead pencil. The prodissoconch is unpigmented; occasionally in the dissoconch stage little spots of color make their appearance, but no decided coloration takes place before the plications begin to form, when the scallop assumes in a minor degree the color patterns of the adult.

Color Variation. — The color of the shell varies greatly, especially with the young. All varieties from a pure white to a grayish-black, as well as a red variety, can be distinguished. The common marking is a mottled or striped appearance, undoubtedly the intermediate forms between the pure color types, as it is possible to arrange a series of shells showing these gradations. The color marking of the young scallops offers an excellent field for the student of variation.

Young scallops from ¼ to 10 millimeters can be readily divided into two main classes, using color as a basis of separation. Some are dark brown with a white fringe, while others range from a light yellow to a transparent white. It seems strange that scallops of the same set and size should present so much difference in color, and that different colors are often found on the same place of attachment.

In white scallops 2 to 3 millimeters a yellow pigment is frequently found in the grooves between the ridges, whereas in the adults these furrows are colorless. Yellow markings are found on these small scallops below the hinge line in scattered patches about the umbo.

Do Scallops change Color as they grow older? — In 1906 the following experiments were made: Scallops of the 1906 set, ranging from 10 to 20 millimeters, were obtained from Stage Harbor, Chatham. These were sorted according to color and placed in wire baskets and suspended from the raft at Monomoy Point. On Sept. 7, 1906, they were put on the raft, and on Oct. 23, 1906, the color changes noted. A similar experiment was made with smaller scallops, about 3 millimeters in size, from August 15 to September 15.

These two observations indicate that there is a slight change in color from white to medium and from medium to dark, or that the scallop shell acquires as it grows older a darker shade. The dark scallops always remain the same, while the light-colored ones gradually take on a darker hue which never becomes very intense. Scallops between 3 and 12 millimeters vary in deepening their color, some requiring one week, others three, before any appreciable change is noticeable.

Is Color hereditary or due to the Environment? — The color of the shell seems to be an inherent quality and not influenced radically by the environment. An orange-colored scallop is always orange color, as has been shown by keeping record of the same colored scallops in wire baskets, and a small orange-colored scallop will always remain the same color, no matter how large it becomes. Color is not wholly unaffected by environment, as modifying changes occur; but in the main it is a constant quantity. The nature of the surface to which the scallops are attached does not seem to determine the color of the shell, as on light-colored wooden boxes 150 out of 1,100 scallops were dark colored, while the remainder of the scallops, which measured from 2 to 3 millimeters, were of a lighter hue. This shows that environment does not regulate the color formation of the shell, as both dark and light colored scallops are found on the same surface. It is perhaps worthy of notice that the majority, 86½ per cent., were light colored, while the rest, only 13½ per cent., were dark. The conclusion is that environment, while perhaps tending to modify the coloration, does not determine the true color of the scallop, which is an inherent quality in the animal.

An interesting experiment could possibly be made in regard to color inheritance if certain mechanical difficulties in the line of artificial propagation could be overcome. It would be of scientific interest to know whether scallops of a certain color would transmit this color to their offspring, and if so in what proportions. To accomplish this it would be necessary to have inclosed spawning ponds in which the scallops of the required color could be separated from the rest. At present, owing to the difficulties in the breeding of scallops, this is not possible, and an experiment of this nature will have to be postponed until artificial breeding is more fully perfected.

CHAPTER IV. — HABITS.

The story of the scallop would hardly be complete without some mention of its interesting and curious habits, which not only explain the anatomical structure, but also throw further light upon the life history. The methods of life of the young scallop are for the most part different from those of the adult, and are typical of stages in the development of the animal. A change in the function of an organ causes a corresponding change in its form, and practices once useful are discarded for others better adapted to the needs of the growing animal. Throughout early life can be traced a steady development, culminating in the adult method of life. For this reason the habits of the young, with the exception of swimming and resting, have been considered separately in the following chapter, and as far as possible arranged in logical sequence.

Attachment.

After the free swimming period of its early existence, one of the most prominent habits of the young scallop is the power of *attachment,* which occurs at the completion of its embryonic existence. This function not only proves a great help in growth, marking a new era in shell formation, but renders the immature animal less liable to attack from its numerous enemies.

The Set. — The "set" takes place when the young scallop attaches itself to any foreign object by means of threads secreted from a gland in the foot. The animal, at the proper time, settles or strikes against some object in the water, and clings to the point of attachment with its foot until the thread or byssus is spun. The frequency of "set" on eel grass is best explained by the hypothesis that the swimming scallop at this critical period of its life is carried by the current against the upright blades, where it clings with the foot until the byssus thread is formed. Larger scallops have been observed to swim to the sides of the aquaria and support themselves on the slippery glass by the foot alone until the attachment by the byssus was accomplished. The great numbers of young scallops found on the sides of spat boxes lowered from a raft moored in 20 feet of water show that the means of first attaining this attachment was by clinging with the foot when the animal came in contact with the box.

Young scallops attach themselves to eel grass, shells, stones, etc., but are generally first noticed by the fisherman on eel grass or sea lettuce, where they remain until they reach adult age. Scallops are found on both the upper and the under side of eel grass, usually 3 to 6 inches from the bottom being the locality of the heaviest set. Ulva (sea lettuce) seems to offer a better place of attachment than eel grass, as it may be carried for miles by the currents and "seed" scallops may be transferred in this way from one locality to another. Shallow flats covered with thick eel grass are usually the most productive of heavy "sets," although the exposed nature of these flats during the winter often causes a severe mortality among the young scallops.

The exact conditions governing the set in any one locality are difficult to observe. The primary requisite is something to which the attachment can be made. This is usually eel grass. In a number of cases heavy "sets" are found in the still water on the sides of a swift current. This is often the case at the entrance to harbors where eel-grass flats line the channel. The spread of the incoming or outgoing waters carries with it the young larvæ, which, striking the eel grass in the still water, settle upon the waving blades.

The Byssus (Fig. 43). — The young scallop after its free swimming existence attaches itself by slender strands of hard, gelatinous material to the first suitable object with which it comes in contact. This bundle of threads is called the byssus, and is similar in function to the anchoring strands, the "beard" or "weed," of the common black mussel. The number of fibers composing the byssus depends upon the size of the scallop and the length of time attached, as but one thread is formed at a time, and the total number is not at once completed. As the scallop increases in size, the number of strands increase in proportion to the added weight. The environment may also determine the strength of the byssus, as scallops exposed to the strong winds and wave action necessarily need more anchoring strands.

The byssal threads pass from a gland in the foot out through an indentation in the lower or right valve of the scallop to the surface of the foreign object to which they are attached by minute discs. This indentation, directly under the anterior "ear," is the so-called byssal notch, which has already been described in chapter III. Along this groove are little projecting teeth or knobs, which develop in the later part of the dissoconch stage soon after the attainment of the byssal attachment. The use of these teeth is not known, but appears to be related to the byssal habit. Possibly they are of use in separating the strands. In scallops under one year of age these teeth number four to five, but in the majority of old specimens they are entirely absent, evidently disappearing when the byssus becomes practically useless, as the last formed teeth are rounded instead of sharply pointed. The manner of disappearance is readily shown by breaking the valve along the byssal groove and observing the line of teeth which have been enveloped in the adult shell. As they are formed at the same time that the byssus becomes functional, and disappear when that organ is no longer of use, there seems little doubt that their use is closely correlated with that of the byssus.

The following excellent description of the process of byssal fixation is given by Jackson (4): —

Lying on the right valve, the foot is extended on the surface of the dish, the flattened distal portion taking a firm hold as if about to crawl. This position is maintained for a moment or two and then the foot is withdrawn within the body; by the motion of retraction it draws out, or spins, the byssal thread, which the creature had fixed to the surface of the dish while the foot was laid closely against it. Soon the foot is again extended, pressed flatly against the dish, and another byssal thread is spun. The second byssal thread is always attached at a point a little removed from the point of fixation of the first thread; sometimes the two are separated by a distance of two or more millimeters. Additional threads may be spun; but three was a common number with specimens in confinement. Those on the bar, especially the larger individuals, frequently spun a large number of threads in the byssus. The byssal gland is situated in a proximal cleft-like depression in the foot separate from the more distal cleft-like depression which serves the animal in crawling, so that between the two there is a slight interspace without a cleft. Frequently when forming the byssus the foot may be arched up in this interspace, the hold being maintained by the tip of the foot and at the same time the byssal cleft being pressed closely against the glass, so as to make the fixation of the byssal thread. While spinning the byssus the scallop is preoccupied, and pays little attention to pricks or stimuli which at other times would meet with immediate response.

The following notes, which give additional information as to the length of time, were made on a 6-millimeter scallop confined in a small aquarium (Figs. 58–60).

The scallop lay in an unnatural position on its left or upper valve on the bottom of the glass dish. At 10.15 it extended its foot perpendicular to its body, lashing it to and fro with a wavy motion, until it was extended to its full length. Then, at 10.15½, it placed the tip on the bottom in a cautious manner. Soon after attaching the tip the scallop contracted the foot, snapping its valves in such a way as to force a jet of water from the posterior edge of the shell. This movement forced the body ahead with a partial turn. The scallop thereupon withdrew the foot, shooting two additional jets of water from the posterior pseudo-siphon. During these maneuvers a one-stranded byssus had been formed and was completed by 10.17. The byssus gland, meanwhile, had been in contact with the bottom of the dish, and the thread was formed by the opening of the groove and the hardening of the horny material by contact with water. Another scallop of the same size was twice observed to spin a byssal thread in four minutes, each time swimming through the water with foot extended in the interval between the attachments.

Period of Attachment. — The scallop can cast off the byssus at will, and soon spin another. The threads are broken off at the byssal gland, where they are closely united, and left adhering to the object of attachment (Fig. 43). This habit is altogether voluntary or under the effects of external stimuli. The early life of the scallop thus consists of a series of attachments and dislodgments, with intervening periods of crawling or swimming.

The power of byssal fixation is first noticeable at the beginning of the dissoconch stage, when the young animal is found on eel grass and other objects. The free swimming period of the veliger has just passed and the scallop has entered upon a new existence, that of crawling and attachment. The scallop retains the power of byssal fixation throughout life, but seldom makes use of it after the first year. Scallops fifteen to sixteen months old have been frequently observed fastened to eel grass and to each other, showing that byssal attachment even at this late period in life is by no means uncommon. Perhaps scallops over one year old find little use for the byssus, as, owing to their size, there is less danger of their washing ashore in heavy winds. A twelve-month scallop has been seen to attach itself to the bottom of the aquarium twice within forty-eight hours.

Observations on the Attachment. — The byssal thread is strong and flexible, as the 6-millimeter scallop when firmly attached can be revolved at least 360° without breaking the strands (Figs. 52–54).

A curious attachment was noticed in a 2½-millimeter scallop on Aug. 3, 1908. The scallop was hanging by a byssal thread apparently from the surface of the water. The distal end of the byssus seemed attached to a small bit of mucus on the surface of the water, which was bowed down by the weight of the scallop. The valves of the little animal were apart, the tentacles extended, and the foot was lashing around with a wavy motion. The point of attachment was touched with the tip of a pencil, whereupon the byssus stuck to it so that the scallop could be raised to the surface and towed around the dish. The pencil point was then lowered gently in the water and the scallop remained suspended from the surface as before. This was repeated with the same result. The pencil was thrust through the water until it touched the scallop, which cast off its byssus at once.

Young scallops swim with the foot extended, and if the foot comes in contact with an object, such as the side of the aquarium, the animal claps the valves rapidly, as if to keep its balance until the foot becomes firmly attached. The movement might be likened to the fluttering of a hen when flying on to a roost. The foot is then drawn in, and the animal remains hanging to that corner of the shell by means of a quickly spun byssus. If the scallop strikes the side of the aquarium with any other portion of its body it does not have the power or perhaps the intelligence to swing the body around so that the foot will strike the glass. This observation shows that the scallop of 2 millimeters and over gains its position on the sides of the aquarium as frequently by swimming as by the more laborious method of crawling up the sides.

Value of the Attachment. — The value of the byssus as a protective factor is at once apparent when one considers the rough conditions to which the scallop is often subjected. If it were not for some means of holding fast to the eel grass or other supports, the heavy storms would wash the small animals ashore. So possibly this power has been developed by natural selection for the protection of the scallop. Also, nature has acted wisely in making the attachment and climbing powers of the scallop supplementary, as the climbing habit is necessary to enable the scallop to reach a place of attachment, or, when attached, to find a better location.

Spat Collecting. — The attachment period in the life of the scallop naturally offers the best opportunity for the capture of "seed." When this period of life is reached in the case of the oyster, the planter puts into the water large quantities of shells, on which the young oyster may "set" or permanently attach itself by a calcareous fixation. The scallop, unlike the oyster, has no power of calcareous fixation, and the byssus is not a permanent attachment. If found desirable, old nets, frayed rope, boxes, etc., hung in a moderate current, should furnish an excellent means of collecting spat. Although scallop larvæ were plentiful in the water, no natural set on the eel grass occurred during the summer of 1906 in the Powder Hole at Monomoy Point. Nevertheless, on boxes and frayed rope, lowered for spat collecting from a raft, 1,200 small scallops were obtained in a few square feet of surface. At the present time there is no distinct need of spat collecting, as "seed" is superabundant in many localities. The young dissoconch scallops usually are attached by one byssal thread.

Locomotion.

The young scallop depends greatly upon its powers of locomotion to enable it to maintain the struggle for existence, to seek new fields and to escape its enemies. Early movement is shown by the swimming of the ciliated embryo, an entirely distinct process from the same function in the adult scallop. Between intervals of attachment it moves by crawling with the foot either along the level or clinging to perpendicular surfaces, a considerably slower method than the earlier habit. Later, the swimming powers of the adult gradually appear, although the scallop still maintains its crawling powers. There is a gradual development in its methods of locomotion comparable to changes in its life, each of which are adapted to the special needs of the animal.

Crawling. — The scallop, long before it lost the faculty of swimming with its foot, had the power of crawling, although it did not wholly rely upon this method. When the body became too heavy to swim successfully with the foot, the animal depended entirely upon the latter means of locomotion. Later, when the swimming habits of the adult made their appearance, the young scallop used both, assisting the act of crawling by shooting a stream of water from the posterior edge of the shell in unison with the contraction of the foot. Crawling is accomplished by three muscular actions of the foot, extension, holding and contraction

(Figs. 55–57). Before starting to move the scallop projects its foot, waving it several times around, as if to reconnoiter. Then, suddenly becoming bold it stretches out this organ in a decided manner. The foot is elongated about the length of the body by the contraction of the circular muscles, which is called a "thinning wave" by the German. The free end is firmly set by a sucker-like arrangement, and a "thickening wave," caused by the contraction of the longitudinal muscles, passes toward the shell. The foot movement is roughly comparable to the creeping of an earthworm. The shortening of the foot jerks the shell forward, the movement being strengthened by the clapping of the valves, which send out a current of water posteriorly from the pseudo-siphon, as is indicated by the moving specks of dirt in the water. The valves shut when the longitudinal muscles contract and open with the contraction of the circular muscles, giving a jerky motion to the crawling.

The scallop may change its direction in crawling by setting the tip of the foot to either side of the line of motion. When the foot contracts the shell is swung around very effectively. As the animal has never been observed to crawl backward, a frequent maneuver with young clams and quahaugs of this age, it probably reverses its direction by a series of these movements. The animal often changes its base of crawling from the face of the right valve to the free edges of both valves. In this case the valves are so tilted that the posterior portion of the free edge is uppermost, thus making the anterior posterior axis perpendicular to the surface on which it crawls. (The above observations were made on 1 to 2 millimeter scallops.)

An early dissoconch scallop (phase 4) was observed to take a peculiar position on the bottom of a watch glass. It raised itself on to the edge of the shell with the anterior end high in the water, the foot extended, waving back and forth. Whether it did this by other aid than the lashing of its foot could not be ascertained, but it gracefully rose on edge. A similar maneuver was observed in a 1½-millimeter scallop. Evidently this habit is useful in turning over when the young scallop finds itself on the wrong valve.

In a young scallop about 1 millimeter in size (phase 5) the following rate of traveling was observed. The heart beats faster when the scallop is crawling than when the animal is resting. Occasionally all visible cardiac movement ceases for short periods during the resting stage. The rate of beat when crawling is about 100, when resting 85, per minute. The first series of continuous movements permitted the animal to cover the space of 5 millimeters in thirty seconds. On a second trial the scallop was able to cover the same distance in twenty seconds, taking six movements. Taking an approximate average the scallop would be able to cover 1 inch in two minutes, or thirty times its length, if it traveled consecutively.

The crawling stage can be divided into three periods: (1) swimming and crawling by means of the foot with its ciliated tip; (2) the true crawling stage, where locomotion is by means of the foot; this is found only in the early dissoconch scallop and is of short duration; (3) crawling with the foot and swimming by a clapping of the valves, as in the adult. The actual use of the foot for crawling covers a long period, as the animal continues to creep more or less until it reaches a size of 1¼ inches, when the foot becomes too small for this purpose.

Climbing. — Climbing rather than horizontal crawling seems to be the natural instinct of the young scallop, which seems to prefer going up the sides of an aquarium to crawling over the bottom. Young scallops 0.6 to 0.8 of a millimeter, placed in a glass dish, climb up the sides until they find a place for attachment by the byssus, crawling over or around obstacles with equal readiness. A needle was placed before a crawling scallop, and it climbed up this for several millimeters before it found a resting place. The usual point of attachment is just below the surface, but the scallop may encase itself in a drop of water somewhat above this level. The scallops do not climb out of the water, as evidently the siphon helps the foot in the work of climbing and it is impossible for the animals to lift the increased weight of the body.

Scallops do not progress with such rapidity as in crawling, as the animal is forced to support its weight when making each extension of the foot. In the larger scallops the action of the foot is aided by the tentacles, which at times seem to offer support as the animal rests against the sides of the glass dish. The pseudo-siphon on the posterior side of the mantle aids by forcing a jet of water from the shell at the same time that the foot contracts. Evidently the scallop maintains its position for the most part by means of the foot, which makes a double bend so that a second part near the byssal gland touches the surface. Possibly by using this portion as an elbow, in the same manner as when the byssus is formed, it is able to cling to the support. Ordinarily the lift comes directly upon the end of the foot, as scallops have been observed hanging on the sides of the dish by merely the tip, and to pull themselves up by the contraction of the foot alone. Part of the contracted foot then rests on the glass, and the distal end lengthens out, searching for another resting place.

It was observed that 25-millimeter (1-inch) scallops could climb for a distance of 4 to 5 inches on a smooth, perpendicular surface. The larger scallops were not so active as the smaller, and the 25-millimeter size seems to mark the end of the climbing activity of the animal, the foot evidently being unable to support the heavier body.

The use of the climbing power is connected with the attachment of the scallop. Whenever the animal is shaken from its point of location it can climb back to another perch on the eel grass. There seems no selection in the climbing instinct, only a tendency to mount upwards. It is also possible, when the set strikes the eel grass, that the scallops may have to climb to get their proper positions. If it were not for the ability to climb upon the eel grass again, many detached scallops would undoubtedly perish.

Turning Over. — The young scallop (Figs. 49–51) possesses several resources by which it may orient itself when placed on its upper valve. There are two general means, one by help of the foot and the other by the clapping of the valves. With the small scallop the use of the worm-like foot is the primitive method of getting into a natural position. When scallops from 1 to 1½ millimeters are placed on their left valve, they at first appear uneasy. After a few moments the animal thrusts out its foot, waves it around as if seeking a foothold, and finally applies the cleft tip to the bottom of the glass dish with a twisting motion. By this movement the shell is pulled so that the hinge line is resting on the bottom of the dish (Fig. 50), and the scallop pries itself over in the opposite direction, naturally falling into its right position. This operation is frequently aided by a slight opening and shutting of the valves. The quickest way of turning over in case of the older scallops is by clapping the valves, which flips the animal from one side to the other. The animal may turn in a lateral direction on the hinge, but the usual turn is anterior or posterior, either toward the foot or away from it. Another means is to swim with foot extended, usually landing proper side up.

Rate of Traveling. — Observations were made on the rate of traveling of 3-millimeter scallops, placed both on the right and left valves. Scallop A, resting in an unnatural position on the upper (left) valve, compared with scallop B, resting on the lower valve, did not exhibit as great speed or travel so great a distance. Although young scallops do not seem to be as uncomfortable as the old when placed on the left side, they do not move so rapidly as in a natural position. Out of 19 consecutive moves scallop B showed 11 greater and 7 less than scallop A, while one was the same distance. Scallop A traveled a total distance of 190 millimeters in thirty minutes, but actually gained only 37 millimeters, owing to its random movements. The same irregularity, in spite of its greater speed, which is accounted for by the foot having a more direct line of tension for the single left retractor when the animal lies on the right side, was noticed on scallop B. The animals may move for some time without going far, and may even return to the exact place of starting. The distribution of scallops at this age is probably determined more by wind and current than by any movements of the animal itself.

Swimming. — The first attempt at swimming occurs when the surface cells of the scallop embryo acquire cilia. The succession of rotary, circular and straight line movements of the larva have already been described for this period, and likewise for the early veliger, with its ciliated velum or swimming organ. Also, the change from the swimming veliger to the larva which swims by a kicking motion of the foot has been given in chapter III.

The adult swimming characteristics appear at the beginning of the plicated stage, after the mantle has become specialized. During and just previous the scallop has passed through a stage in the evolution of swimming, which, though closely associated with crawling, is the bond that shows its relationship with other lamellibranchs, such as the clam and quahaug. It is the "pseudo-siphon stage," so named from an organ formed by the edge of the mantle on the posterior side of the animal. In crawling, water is ejected from this opening with sufficient force to throw the animal ahead. It is interesting to note that this movement is the first indication of swimming in the animal, and that it is comparable to similar conditions in the other shellfish, which have fully formed siphons in the adult. The description of the adaptability of the anatomical parts of *Pecten tennicostatus* (Mighels) for swimming, as given by Drew (1), applies equally well to *Pecten irradians,* and is here quoted: —

Pecten is one of the ablest swimmers among lamellibranchs. The whole structure of the animal is modified for this purpose. The valves have become rounded in outline, flattened and comparatively light. The anterior adductor muscle has been lost, and the posterior adductor muscle, which is very powerful, is situated near the middle of the body. The cartilage has become well developed, so the shell may be opened quickly when the muscle relaxes, and the hinge line is straight, so there may be no unnecessary strains in opening and closing the shell. Each gill is attached by one lamella only, so water in the temporary cloacal chamber may be thrown out without injuring the gills, and the gills and margins of the mantle are provided with muscles to withdraw them from the margins of the shell when the shell is closed. Furthermore, the margins of the mantle are provided with infolded ridges and with circular muscles, so it is possible to direct the current of water which issues from the shell in the required direction.

The only striking difference in the swimming of the young plicated scallop and the adult is the extension of the foot by the former, possibly a characteristic retained from the old method of swimming with the foot. In all the swimming of the young the foot is thrust out to its full extent, and possibly assists the animal through the water, either by its waving motion or by its cilia.

The following excellent account of the method of swimming of the adult Pecten is given by Jackson (4): —

It is best to study the swimming in young Pectens some 3 centimeters high, as at that age it is more easily seen than in adults, and does not differ from what may be observed in them. Lying on the bottom, with tentacles extended, the scallop suddenly folds the guard tentacles back so that they lie closely against the outer border of the perpendicular mantle wall. The valves are then closed by a quick action of the adductor muscle and water is forcibly expelled. The first water expelled is driven out posteriorly in the direction of the arrow A (Fig. 61), and if this were the only or the main direction in which a current is expelled the animal would by impact of water be impelled in the opposite direction or anteriorly; but the action of swimming is more complicated than this would indicate. When the valves have closed to a slight extent the borders of the two thick, perpendicular mantle walls come in contact and then no more water passes out as indicated by arrow A, but instead, during further closure of the valves, it is forcibly ejected from the lower border of one ear, where the mantle wall is low and thin, as indicated by the arrow B (Fig. 61).

The water expelled at the point B is the most forceful current and probably of the greatest volume; by its means the creature is impelled in the direction of the arrow C. The valves open quickly and clap again. The second time, as before, the first water is driven out posteriorly; but when the mantle walls come in contact, the direction of the excurrent water is again changed, and is forced out from the lower border of one ear, in the direction of the arrow D (Fig. 62); being the strongest current, it impels the animal in the direction of the arrow E. This striking difference is noted, viz., that at successive claps the water is driven out from alternate ears, first on one side and then on the other. The resultant action of the several currents and successive claps, illustrated in Figs. 61, 62, is, therefore, to drive the animal in the direction of the free borders of the valves, or posteriorly. It is due to the alternate expulsion of the water first from one ear and then from the other, as described, that the animal presents a succession of zigzag jerks in swimming. The direction of the current alternately to the two ears appears to be voluntary, as scallops can scuttle over the bottom of a dish in a sidelong direction by successively expelling the water at each clap from one and the same ear. The action of the first current of water expelled posteriorly, before the mantle walls come in contact, gives the animal an upward jerk, and it is in virtue of this jerk, combined with the momentum in a posterior direction, that it maintains its position on the surface of the water, and also the high angle to the surface which it presents in swimming. The current driven out posteriorly in the initial closure of the valves is so powerful that water may be squirted by adults to the height of five inches or more from the surface by this action.

A few additional observations upon the swimming habit may not be out of place. Scallops acquire the power of swimming at an early age, as they are able to swim in the manner described above soon after they attain 1 millimeter in size. The swimming habit is adopted when the scallop becomes less proficient in moving with the foot, owing to the increasing weight of its body.

Scallops are capable of movements in other directions than described in the above paragraph. Specimens 8 to 10 millimeters in size, when approached ventrally with the point of a pencil, snap their valves together and dart back in a dorsal direction, evidently to get away from the pencil, which they allow to get within reach of their tentacles before moving. The water is expelled with a quick squirt from the ventral portion of the valves. The distance covered on the back dart was about 10 millimeters. This observation was made several times on different scallops, and is interesting, as it shows that the scallop can force water from different parts of its shell, in this case exactly at right angles to its usual direction. Darts can likewise be made in either an anterior or a posterior direction, showing that the body can be forced in any desired course by changing the point of expulsion of water from the shell. This habit is of a protective benefit to the animal, as the ordinary method of locomotion would be such as to carry it to an advancing enemy rather than allow its escape by a backward "shoot." This method is closely associated with the tactile functions of the tentacles, and it is only when stimulated that the scallop makes use of it.

Resting.

The young scallops as well as the old have periods of rest, during which they probably feed or merely lie inactive. There are three kinds of rest: (1) the scallop attached by the byssus; (2) lying unattached on the bottom; (3) floating on the surface of the water.

Attachment. — This position has been defined under "Byssal Attachment," and only the appearance of the scallop needs description. The animal is probably in a feeding position, the mantle with its tentacles is extended, the heart beats slowly, and the food particles rotate in the digestive tract. In this position the animal is keenly sensitive to stimuli and if touched closes its valves at once.

Resting on the Bottom. — During the intervals of crawling the young scallops often rest on the bottom for a long time. Even in this resting position part of the internal anatomy is constantly moving. The cilia in the gills, in the digestive tract and on the foot are always lashing, while the foot is often restless and writhes within the shell. The tentacles are generally extended and the shell gapes slightly open. The heart action is less rapid than in crawling and at certain times seems to have ceased.

The natural resting position of the adult scallop is on the right valve on the bottom. Very seldom, and then only owing to accidental overturning, does it rest on the left valve. Often on a coarse sand bottom, especially in winter, the scallop excavates a shallow hole in the sand and lies passive, half concealed in its burrow. This habit may be protective in severe winters.

Drifting. — Scallops frequently drift just below the surface of the water, with the right valve uppermost, some with shells nearly closed, others with tentacles and foot extended (Fig. 47). The foot evidently needs to grasp some object before the animal can control the direction of the motion. If one of the drifting animals is jostled with a needle it sinks to the bottom, probably taking in a little water. Scallops as large as 10 millimeters have this habit of floating, and scallops of 6 millimeters are often found with tentacles widely spread out. The reverse position of the animal, the right or lower valve being uppermost, is not so unnatural as may seem at first, as it can be likened to the crawling of a fly on the ceiling. The surface of the water acts as a wall upon which the scallop, with its extended foot, can rest. Pecten and Anomia have been observed apparently crawling, right valve up, on the surface of the water in the same manner as on the bottom, only in a reversed position, evidently in a similar manner to snails, by mucous secretion.

In the case of the small scallops, the tentacles, which appear to support the larger scallops, are not essential for floating. Very small dissoconch scallops, before the formation of tentacles, have the floating habit, and do not depend, therefore, on the tentacles to support them. The habit of floating is useful in that it probably allows the scallop the opportunity to get a better supply of oxygen, and to be carried from one locality to another or from one stalk of eel grass to the next by the current.

Migration.

Many remarkable stories concerning the movement and migratory habits of the common shallow-water scallop have long circulated among the fishermen. Several writers have described schools of scallops in the act of skipping and swimming over the surface of the water, and have attributed to this species the migratory powers of fish. Scallops are reported to traverse many miles, passing from one part of the coast to another, continually on the move. Unfortunately, these stories have arisen from incomplete observations, which, supplemented by the use of the imagination, have credited the scallop with powers it never possessed. Indeed, so much has been said concerning the swimming powers of the scallop that people have come to believe that the scallop should be considered as a migratory fish.

While the basis of these reports is correct, there has been much exaggeration. The scallop has the power of migration only in a limited sense, and although capable of swimming never traverses far. In a small bay or harbor it is possible for the scallop to move to various parts, especially if there is a strong current, but extended and definite movements never occur. Swimming is a frequent diversion of the scallop, which, after lying quietly on the bottom, suddenly takes a slanting "shoot" through the water. The scallop is not built for continuous traveling, as it seems to need periods of rest between each flight. The average distance covered in a single movement is about 10 feet, while often it is much less. The longest flight ever noticed by the writer was about 25 feet, which is an exceptionally long distance for the scallop to traverse at one time. Occasionally a series follow in quick succession, but more often many hours elapse between them. As the scallop is incapable of making continued flights for any distance its migratory movements, if such it has, are limited to certain definite areas, and never extend over a large territory.

A swimming habit of the scallop, which undoubtedly gave rise to the mistaken idea that they swam in schools on the surface of the water, can be observed particularly toward evening, when the scallops in the shallow water rise to the surface, shoot a jet of water in the air, and then, closing their shells, sink to the bottom. This fact has given rise to another popular fallacy, that the scallop has to come to the surface to breathe. The real explanation of this peculiar habit lies in the swimming of the scallop. In swimming water is taken in by opening the valves, and is then ejected on either side of the hinge line. The scallop, in traveling through the water, is forced to take an upward slant to keep moving, and in shallow water the animal soon rises to the surface. Not being able to take in any more water by opening its valves, the animal gives one final squirt, and sinks to the bottom with closed shell. This strange habit of the scallop is readily explained as the natural result of the sudden ending of its swimming.

The idea that the scallop makes a definite migration from shallow to deep water during the warm months of the summer, and returns to the shallow water in the fall, has spread widely. Where this idea could have arisen is impossible to state, but it has always been considered as an established fact. As far as could be discovered by the experiments and observations, the idea is wholly erroneous. Scallops have never been seen to make any such definite migration during the summer, and monthly records have been kept of scallops in the shallow water in as many as fifteen localities in the State, with the result that no movement of any kind was observed during the whole season. Not only were observations made for one year, but for a period of three consecutive years, which seems to conclusively indicate that no such migration ever takes place.

There are several possibilities for the irregular movements of the scallop, and the element of chance has a great deal to do with its traveling. If a bed of scallops happens to be in a swift current the scallops may be carried along by the strength of the current, whenever the animals rise in the water. As this is usually a tidal current the distance traveled is not far, and the opposite tide washes them back to the starting place. The scallops in a heavy wind are rolled along the bottom and in this manner are carried some distance. This method of migration likewise depends on chance, and is only applicable to scallops in shallow water, where they are unprotected by eel grass. Many scallops are yearly washed ashore, which is sure indication of the force of the waves and helplessness of this bivalve. Undoubtedly this is the most extensive means of traveling, and is probably the only one of importance. A third method of migration is possible when the young scallops are attached to eel grass by slender byssal threads. When the eel grass is torn up the young scallops drift with the wind and tide for long distances. In this way localities that have not had scallops for years can again be restocked, Ingersoll (8).

The scallop is short lived, very few ever reaching the two-year limit. The majority, therefore, have only one spawning season. If any adverse natural condition, such as a severe winter, kills off the small "seed" scallops for that year, the total crop for the following year will be exterminated, as it is a case where there is only one set of scallops spawning at a time, and generations so follow generations that all the scallops which are to furnish the spawn belong to the same set. In this way the scallop crop of any locality is often wholly exterminated, and it takes years before it can again assume its former proportions. Thus the uncertainty of the scallop crop makes it appear that the scallops migrate from one town to another, as one town will have an abundance one year, perhaps followed by a poor season, while the reverse may be true for neighboring towns. So what has apparently been considered a migration is in reality no migration at all, but is merely due to the short life of this interesting mollusk.

There are several facts that substantiate the non-migration of the scallop. While none can be termed actual proof, nevertheless they furnish strong evidence that the scallop as a rule does not travel far from its native place. It was found almost impossible to obtain definite data on the movement of the scallops, as there was no accurate way in which to observe them in their native haunts. One attempt was made which gave results of negative quality. About 400 tagged scallops were liberated in Nantucket harbor in such a location that they would have to cross the channel to get to the scalloping grounds. The scallops were tagged with copper wire through the "ear" of the shell, which did not hinder to any extent their movement, and were liberated in October, at the beginning of the scallop season. Careful watch was kept by the scallopers on the fishing grounds, but none were ever found, indicating that they had not traveled. They were so located that the least traveling would have carried them to some part of the scalloping territory. The possible errors were: too few scallops, interference of the tags with the traveling and the possibility that they were carried to other places than the scalloping grounds, or that they were overlooked by the scallopers.

While there is much difference of opinion among the fishermen as to the movement of the scallop, the majority believe that there is little or no traveling, basing their claim on the fact that they find scallops in the same place the year round, and that the beds shift but little. New beds seem to spring up when the eel grass is rolled away, but the scallops probably have been there always, or have been carried a short distance by either wind or tide, and have not come from miles away, as has been frequently supposed.

In all the observations made by the Massachusetts Department of Fisheries and Game on the habits of the scallop records have been kept of the different sets in many scalloping localities in the State, and no case of extended migration has been recorded. It has been impossible to make as extended observations in the deep water as in the shallow, but there is every reason to believe that the same conditions hold true, in spite of the fact that the scallops can more frequently be carried by the current.

A further fact of interest in this connection is the distinction between the two sizes of scallops, the large channel or deep-water scallop, and the small shallow-water or eel-grass variety. These two are the same species, but, owing to the better growing conditions in the deep water, the channel scallop is much larger in size. If the scallop were a migratory form, and would travel first to deep water and then to shallow, there would be no well-marked distinction between these two groups, as all scallops would be approximately the same size. This fact furnishes excellent proof that there is no such thing as definite migration.

In conclusion, the matter can best be summarized by stating that while the scallop is capable of swimming through the water by its own exertions, it can never travel any great distance in this way, and that there is no such thing as definite voluntary migrations. While no exact proof can be obtained there is not sufficient evidence to show that the scallop ever travels, and the weight of the evidence implies that there is never any migration. The only possible traveling of the scallop is caused by forces external to the animal, such as wind, current, storms, etc., and is merely a matter of chance. This cannot be styled in any sense a true migration, and there is little evidence to show that any considerable distance is traveled by this means.

The non-migratory habit of the scallop is of importance to the scallop planter if in the course of future events cultural methods are ever applied. It is also of great importance to the town, as no town may feel that their scallop crop will travel to the borders of the neighboring township. The scalloping towns can rest assured that, if the scallop crop is once within their borders, there is slight chance that it will ever leave.

Recovery from Injury.

Scallops are frequently found with twisted and warped shells, or other deformities. Jackson (4) reports finding scallops with portions of the mantle missing, evidently from the attacks of predacious fish. Occasionally small fish about 1 inch in length are found within the scallop shell. In many of the growth experiments, where the scallops were kept in confinement in wire baskets, the growth was abnormal, as the shell grew in a variety of shapes, owing to the manner of resting against the wire. To observe their recovery from injury, scallops were treated in a variety of ways: (1) four scallops were unhinged by breaking the ligament; in three days' time three were dead, one was alive; (2) small holes were bored in shells of three scallops: all were dead in three days; (3) five with adductor muscle badly strained: in three days two were dead, three alive; (4) three with valves cracked lengthwise: in three days one was alive, two were dead; (5) one with valve cracked along byssal groove: alive two weeks later but shell not mended; (6) three with small piece cut out of mantle edge; in three days two were alive, one was dead. The result of these mutilations shows that the scallop, although not as hardy as the clam or quahaug, is capable of repairing minor injuries inflicted by enemies, and only succumbs to the more severe hurts.

Feeding Habits.

The feeding habits of the scallop are similar in many respects to those of the other shellfish, as all lamellibranchs obtain their food by means of the gills, which act as filters or strainers. The clam and quahaug lie beneath the surface of the soil and reach the water by a fleshy extension of the mantle, known as the siphon. The scallop has no siphon and its method of life is such that it does not need an organ of this nature. When in a natural position for feeding, the animal rests on the bottom on its right valve, the shell gaping open at an angle of about 20°. Closely lining the inside of the two valves is a thin fleshy substance, the mantle, described in chapter II. When extended, the edge, lined with papillose tentacles and brightly colored eyes, passes beyond the shell, while another portion, consisting of a perpendicular flap, surmounted with a row of closely set guard tentacles, acts as a curtain to nearly close the intervening space between the open valves. Instead of the specialized siphon of the clam, which is in reality only a part of the mantle, the scallop makes use of the entire ventral area of this fold to take in its food, with the result that a continual stream is passing in through the mantle and going out at a definite locality in the posterior side of the shell. This portion of the mantle is destitute of guard tentacles, and, when the walls are closed together, forms a pseudo-siphon.

The food of the animal, as more fully described in the report on the food of the lamellibranchiate mollusks, consists largely of certain microscopic plants, called *diatoms*. These tiny forms are extremely varied in size and shape. They are easily recognized by their silicious cases and beautiful markings, which have won for them the name of "the jewels of the plant world." They are found in the water everywhere in more or less abundance, and are filtered out by the scallop from the water which bathes its gills.

The four gills, which were described in chapter II., in addition to aëration of the blood possess the important function of straining food from the water. Lying free in the body cavity, they are constantly surrounded by the flowing water, which passes through and around the filamentous bars. When examined under a microscope the gills are found to be covered by small hair-like cilia, lashing in a definite direction. These cilia cause currents of water to pass over and through the gills, while other cilia between the filaments act as minute sieves to strain out the food particles, which are at once cemented together with a mucus and propelled by the ciliary action toward the popularly called "backbone" of the gills, or the dorsal edge. Here they are taken up in a more definite channel and swept with increasing velocity toward the upper end of the gills to the lower edges of the palps. The palps are ridged and furrowed like the gills, and the food is transferred to the mouth by means of these "lips." If an excess of food or foreign matter is caught by the gills, the animal, by a complicated mechanism, as described by Kellogg (3), is able to cast it off.

The effete matter from the digestive tract is carried out from the shell at the posterior pseudo-siphon. The waste in transverse section has the appearance of a three-leafed clover, Jackson (4), and is of uniform length. When the scallop lies feeding in the aquarium, the feces pass out at regular intervals of about a minute, suggesting a nearly constant need of food. The constant flow of water through the shell shows that the other parts, such as mantle, visceral mass, etc., must likewise be ciliated as well as the gills, in order to force the flow of water in one direction, an entirely different arrangement from the ejection of water by the mantle in swimming.

Sensory Powers.

The exact reactions of the scallop to light and other external stimuli have never been worked out, and there remains a wide field for investigation on these points, especially in regard to the effect of light. The following are a few meager observations which it is hoped may interest some one to take up the study of the sensory powers of the scallop.

The scallop is sensitive to a sharp tap or sudden jar. When small 6-millimeter scallops are attached to the sides of glass dishes, the valves remain open, tentacles extended. A sharp tap on the outside of the jar directly over the animal causes it to retract its tentacles, but after repeated tapping the creature does not seem in the least disturbed, as the tentacles remain extended. All motions outside the glass dish were unnoticed by the scallop.

At times the adult scallop is quite sensitive; again, the same stimulus does not excite the animal. Evidently it has various moods. Jackson (4) states that when spinning the byssus the scallop appears undisturbed by pricks, etc. As cold weather comes on the animal becomes less active and fails to respond with its former alertness.

The eyesight of the animal has aroused considerable comment. The eyes, so far as concerns the gross anatomy, closely resemble those of the higher animals, and are connected to the circumpallial nerve by short nerve fibers. To what extent the animal can see is a question. Observers have stated that scallops lying on the eel grass notice a person wading through the water and swim off. Whether this is due to sight or to the disturbance of the water is uncertain. It is true that movements in the water have more effect than those outside, and the effect of shadows on the scallop may cause it to withdraw its tentacles. The approach of enemies is readily recognized by the scallop, which scuttles out of harm's way. Whether this is from sight or other modes of sensation is as yet undetermined.

Veliger scallops apparently are not sensitive either to dark or light. With scallops of 2 millimeters and over, in which the eyes or tentacles are developed, different results were obtained. A few tests were made with animals of this size in small dishes, covered with black paper, except in certain places for the admission of light at the will of the operator. Many of the results were negative, but a slight heliotropic (toward light) tendency was evidenced.

The young scallop under 3 millimeters evidences little preference for different colors. Tests along this line have given negative results, as the distribution on areas of different color seemed at random.

Scallops will live in waters that have a density of 1.010 or greater, one-half salt to one-half fresh. This has been tested by observations in different localities and by keeping the animals in aquaria with various densities. The scallop, compared with the clam and quahaug, succumbs more readily. In aquaria, where these burrowing mollusks will live indefinitely, it is often difficult even with running water to keep the scallop alive for more than two to three weeks.

Enemies.

Owing to its free life and activity the scallop is beset by relatively few enemies, as compared with the oyster, or, more properly speaking, suffers less destruction from the same adversaries. Nevertheless, there are certain species which prove dangerous and cause the scallop a continual struggle to maintain its existence. Naturally in the early life of the scallop the destruction is much greater, and it is necessary to divide the enemies of the animal into two classes: those which menace (1) early life; (2) adult.

Enemies of the Young Scallop. — In the early life of the young scallop it is not so much the active animal enemies as the adverse natural conditions that destroy the embryonic larvæ. When the fact that only one of the several million eggs liberated by the adult spawning scallop ever reaches maturity is considered, the extent of the destructive powers of nature becomes strikingly manifest. The early life of the animal is the critical period of its existence, and it is at this point that the young must be shielded from their enemies. The active enemies of the young larvæ can be enumerated: fish, other shellfish and animals of similar nature which suck down the larva for food, the adult scallop often treating her young in this manner. Later in life, when the young scallop is discernible to the naked eye, the starfish, crabs, sea fowl and other predacious animals feed upon it. Scallops of nearly 1½ inches in size have been taken from the crop of an eider duck by John H. Hardy, Jr., of Chatham.

But the force which causes the vast destruction is not accounted for by these active enemies. It is broader and farther reaching in its influence. It is nature, with her vast adverse conditions. Severe weather, storms, sudden changes in temperature and in salinity of the water during the spawning season, sewage and other contamination, may bring about the destruction of the floating larvæ. The localities of set are such that only a limited area is available for the retention of the spat. Eel-grass-covered flats are best adapted for the set, and other localities generally prove unfruitful. The larvæ, uniformly scattered through the water, are washed hither and thither, relatively few ever setting on good ground, the rest either washing ashore or being buried on slimy and unwholesome bottom. Thus the infant mortality is especially great and only a very few escape the perils of the embryonic stage of their existence. These few are now at the mercy of the elements until they have attained sufficient size to enable them to take care of themselves. On the eel grass they are constantly in the danger of washing ashore. When the set is on shallow flats, for example, the Common Flats of Chatham, the scallops are nearly exposed at low running tides, and thus often are killed by the severe winter frosts and ice. Even when in deeper water, the "anchor frost" is said to destroy them in great numbers, but fortunately this condition is rarely found.

Enemies of the Adult. — The adult scallop has several natural enemies, including man, both active and passive, as well as being subject to the adversities of nature, for the scallop, by reason of its specialized anatomy, is most susceptible of all economic mollusks and readily succumbs to an unfavorable environment.

(*a*) *The Starfish.* — The starfish (*Asterias forbesii*) is probably the most destructive pest of the scallop fishery, and has proved a source of great annoyance and loss to the scallopers. Fortunately the inroads of this pest are chiefly confined to one section of the State, Buzzard's Bay, and although the animal is found in some abundance along the south side of Cape Cod and at the islands of Nantucket and Martha's Vineyard, it is not so serious a menace to the industry. Many of the Buzzard's Bay fishermen attribute the decline of the scallop fishery in those waters some eight years ago to the invasion of the great numbers of starfish at that time. From reports by the fishermen the scalloping grounds were literally paved with starfish, and it was utterly impossible for the scallops to escape destruction. It is well known how destructive the starfish is to the oyster beds, and undoubtedly the scallops would not be able to escape so great a number and must have suffered severely. Capt. James Monahan of Wareham cites the following instance: "In the fall of 1898 I located a bed of seed scallops so thick that half a dredge full could be obtained at a single drift. Next year I went to the same place, and on casting my dredges found them full of dead scallops, shells and starfish in great number." He estimated that in that one locality 1,000 bushels perished.

During the season of 1907–08 nearly every boat from Wareham saved the starfish, and instead of throwing them overboard, as was previously the custom, carried large numbers to the shore. Under the old method of carelessly returning these pests to the waters they were scattered over a wider area from the boats. For two seasons previous to 1907–08 it is said that the starfish had been decreasing, and that the return of the scallop fishery after an absence of seven years was due to this decline. Many scallopers and oystermen are anxious for State appropriations for the removal of these pests.

The method of attacking the scallop (Fig. 70) is similar to that used on the oyster, *i.e.*, opening the shell by means of a steady strain exerted in opposite directions upon the two valves. The starfish surrounds the scallop with its long arms or rays, five in number, and clasps it in its embrace, generally in such a way that the mouth of the starfish rests just above the byssal notch of the scallop, and the arms are closely attached to the shell by the tube feet or suckers. By exerting a steady pull with its numerous suckers, and by the tendency to straighten out the long arms, the animal exerts a strong and steady strain on the adductor muscle, which, though well adapted to resist a sudden pull, gradually tires and relaxes. The starfish has the advantage, as, having five arms, it can rest some of them and yet keep on pulling, while the scallop has only one muscle and has to exert a perpetual strain. Then a curious phenomenon is noticed. The starfish rolls out its stomach and allows it to flow into the interior of the scallop, where it digests, outside its own body, the soft parts of the scallop. When the meal is completed the stomach is withdrawn, and the clean scallop shell left with gaping valves.

Small starfish seem to be the most active in this work of destruction, and the "seed" scallops are the most frequent objects of their attack. The only method of reducing this pest, as extermination is practically impossible, is for the scallopers to carry the starfish taken in dredging to the shore. The oystermen, who suffer more severely from the inroads of the starfish, most commonly use a tangle or mop which is dragged over the oyster beds, the "five finger" becoming easily entangled. The starfish are then either thrown into boiling water or carried ashore.

(*b*) *The Oyster Drill.* — Where the scallop is not found the oyster drill (*Urosalpinx cinerea*) (Fig. 68) is generally present. This little gasteropod mollusk, next to the starfish, is the most destructive enemy of the scallop and oyster, and is found in nearly every scalloping locality. Scarcely more than an inch in height and of an innocent grey color it has proved a source of trouble to the oysterman, owing to the impossibility of thoroughly removing it from the oyster beds.

Its method of attack is to crawl upon the upper valve of the scallop and then pierce a hole in the thin shell, scarcely larger in diameter than a needle, by means of a tiny ribbon-like tongue armed with fine teeth. When the boring is completed the animal sucks out the contents of the shell. Scallops have been found destroyed by the drill bearing on the shell a row of globular egg cases which the drill had deposited. It is during this process that the scallop has an advantage over the oyster. The latter is fixed and immovable, the former is capable of movement, and by a few well-directed flaps of the shell can in many instances throw off the intruder and escape destruction. The numerous half punctures in many living scallops bear witness to the inability of the "borer" to finish its task.

A few observations upon the length of time it takes to bore and eat a scallop were made at Monomoy Point with a view of determining the actual extent of destruction. Scallops were confined with the drills in boxes with netting tops. Different numbers of scallops and drills were used for over a month. As many as five drills have been found on one scallop not in confinement, and as many as two or three are of common occurrence (Fig. 95). The conclusion arrived at from these observations was that it took from four to six days for the drill to pierce the shell sufficiently to eat the contents, and that the meal was consumed in about the same amount of time. At this rate the drill could only eat about three large scallops per month, even if nothing interfered with the operation, and in the long run the amount of destruction would be extremely slight. While the unnatural condition of the confined animals may have made the process slow, the limited area afforded the scallop but slight chance to escape from its enemy and so partially offsets any error.

(*c*) *Nassa obsoleta.* — The third active enemy of the scallop is perhaps hardly to be classed under that head. It is the scavenger of the tidal flats, the little black winkel, *Nassa obsoleta,* which has the important duty of cleaning the flats. The actual damage done by this animal is comparatively small, as it is not an inhabitant of the same localities as the scallop as a rule, being found between the tide lines. Nassa is commonly thought to be of little damage to living shellfish, though it is known to eagerly devour any dead or broken specimens. Although the damage is of little account the method of attack is so interesting that it will bear relating. The scallop when resting on the bottom with tentacles extended is at times extremely sensitive, and then again less so. Nassa possesses an extremely well-developed sense for finding food and gathers around the scallop in numbers. Then a concerted action takes place, whether intentional or by accident, but it occurs time and time again. One Nassa forces itself between the valves of the unwary scallop, which at once close with a snap, but only part way, as the little winkel has formed a wedge between the valves which permits the entrance of more of its kind, which rapidly fall to eating the contents (Fig. 94). While we cannot attribute this mode of attack to any reasoning powers of the small creatures, the fact remains that 17 out of 500 scallops, confined in a pen 10 feet square, in two weeks' time were killed in this way. However, under natural conditions this would be impossible in the open. The scallops were observed continually to flirt off the crawling Nassa by snapping the valves, and in this way were able to protect themselves.

(*d*) *Passive Enemies.* — The scallop has besides these active enemies other passive foes which perhaps do not accomplish so much apparent damage but affect the growth of the animal and in some cases result in its death. Such are the enemies which use the same food and retard the growth by depriving the scallop of sufficient nourishment. All other shellfish, both valuable and of no importance, come under this head. Another class of passive enemies are the ectoparasites on the scallop shell, the sea weeds, such as Enteromorpha, Ulva lactuca, etc., barnacles, Serpula (worm tubes), Anomia, Crepidula, oysters from one to two years old, Acmæa, etc., which not only partake of the same food but hinder the movement through the water, and in cases like the oyster and serpula, by their growth in time kill the scallop, in the case of the former by weight of shell, with the latter by binding edges of the valves together.

(*e*) *Man.* — While the main cause of the decline of the natural clam, quahaug and oyster beds is overfishing by man, the decline of the scallop fishery cannot be so considered. The scallop has a short life, hardly 25 per cent. passing the two-year limit; so it does no harm to capture the marketable scallops which are over sixteen months old, as the scallop spawns when one year old and dies a natural death usually before it reaches a second spawning season. When only old scallops are taken, as is generally the case, it is probably *impossible* for man to exterminate the scallops by *overfishing.* Unfortunately, in certain localities in the past there has been a large capture of the "seed" scallop, viz., the scallop less than one year old, which has not spawned. This has worked the ruin of the scalloping in these localities. The capture of the spawners for another year merely makes the next year's set so much smaller, and causes a rapid decline.

As a rule, it is hardly profitable to catch the "seed" scallop, owing to its small size. But a direct relation can be established between a high market price and the capture of seed. When the market price is high and scallops are scarce, it becomes profitable to catch the young "seed." The present scallop law now defines a "seed" scallop and forbids its capture. By protecting the "seed" scallop, the State has done all that at present appears expedient to insure the future of the industry; the rest lies in the hands of the towns.

So, while the scallop has declined in certain localities, and the decline has been hastened by unwise capture of the "seed" scallop, the main decline of the fishery cannot be attributed to wholesale overfishing, as it is impossible to overfish if only the old scallops (over one year old) are taken; for, unlike most other animals, the scallop usually breeds but once, and its natural period of life is unusually brief. These scallops, if not taken, will die, and prove a total loss; so every fisherman should bear in mind that, as long as the "seed" scallops are protected, severe fishing of large scallops is not likely to injure the future scallop industry.

The adult scallop has to contend against the same adverse physical conditions of nature that beset the young animal. Severe winters, storms, anchor frosts, etc., work destruction upon the helpless scallop. Exposure to low tides, as on the Common Flats of Chatham, and on the north side of Cape Cod; exposure to sewage contamination, as in New Bedford harbor; exposure on an open coast, as is occasionally the case on the south side of Cape Cod; sudden changes in the salinity of the water, *i.e.,* by flood waters; the distribution of tides and currents; the temperature of the water; the nature of the bottom, — all affect the life of this mollusk, and render its existence precarious.

The very nature of the scallop's period of life renders it peculiarly sensitive to adverse conditions, and places difficulties in the way of its natural propagation.

As the scallop dies before reaching its second birthday, only one set of scallops spawn in any one season. There are never two generations of scallops spawning at one time. I quote from Ingersoll (8) in this connection: —

This represents a case where the generations follow one another so rapidly that there are never two ranks, or generations, in condition to reproduce their kind at once, except in rare individual instances, since all, or nearly all, of the old ones die before the young ones have grown old enough to spawn. If such a state of affairs exists, of course any sudden catastrophy, such as a great and cold storm during the winter, or the covering of the water where they lie for a long period with a sheet of ice, happening to kill all the tender young (and old ones, too, often) in a particular district, will exterminate the breed there; since, even if the older and tougher ones survive this shock, they will not live long enough, or, at any rate, will be unable to spawn again, and so start a new generation.

The set of young scallops is abundant in shallow water upon the eel-grass flats, which often, as is the case of the Common Flats at Chatham, are exposed at extremely low tides. A severe winter often kills off all the "seed" thus exposed. In this case no spawn is obtained the following summer, causing the suppression of the scallop fishery in that locality for at least a few years, and possibly its permanent extinction.

The low temperature during the winter, particularly in the shallow waters and on the exposed flats, is often destructive to the adult. Scallops have been observed in zero weather frozen, with shells full of ice, as they lay on the exposed flats at Parker River, Yarmouth. Undoubtedly many die, but many recover from being frozen, as shellfish will live if properly thawed out. In the severe winter of 1904–05 the entire crop of scallops was killed on the Common Flats, Chatham, and in 1906–07, 40 per cent. of the "seed" on the Stage Harbor flats, Chatham, succumbed to the ice and cold. Often the ice settling on the flats carries with it the scallops, or leaves them in a dying condition. Low temperatures, tides and currents work together, as the scallop, rendered inactive by the coolness of the water, is at the mercy of the elements, and is readily washed ashore, to perish on the open beaches or high flats.

Popular Fallacies.

Many interesting but erroneous ideas concerning the habits of the scallop have arisen among the fishermen, and a brief mention of several will bring this chapter to a fitting close. The length of life of the scallop has always been a perplexing question. While the majority of the scallopers have drawn correct conclusions from their practical observations, a few still maintain that this mollusk lives for a long period of years. Arguments to this effect are based chiefly upon the foreign growth, which is abundant on the shells of the old scallops. Successive layers of Crepidula (quarter deckers or sweetmeats) piled one on top of the other on the shell are claimed to denote a yearly period for each new animal, and large barnacles, worm tubes, etc., are considered as indicating a long period of development, while in reality these bodies are the result of only a few months' actual growth.

The idea that it was necessary for the scallop to come at least once a day to the surface to breathe arose from seeing the animals rise in shallow water to the surface when swimming. Such a conception appears absurd when it is known that the scallop possesses gills like a fish and is not an air-breathing animal. Numerous misconceptions as to its migratory, swimming, attachment, feeding and other habits have prevailed during past years, and it is sincerely hoped that this chapter on habits may aid in clearing many misunderstandings about the life of the scallop.

CHAPTER V. — GROWTH.

The rate of growth of the scallop, besides being of popular interest among the fishermen, has an important bearing on the development of the fishery. Owing to its intimate connection with practical scallop culture, a detailed study of the rate of growth comprised a large part of the investigation. In addition to extending the knowledge of the fisherman and defining the proper relation of growth to protective legislation, several facts of biological interest have been brought out by the experiments, and although not at present of practical importance, they are likewise included for the benefit of persons interested in the study of the Mollusca.

In the determination of the average growth of any shellfish it is difficult to make definite statements, as the natural conditions, which influence development, are varied. The rate of growth for one body of water is different from the growth in other localities, unless the same conditions are present, instances of which occur but rarely in nature. This fact not only has rendered difficult the concise presentation of the subject, but also has necessitated a manifold duplication of the experimental work in order to satisfactorily cover the conditions in Massachusetts waters. Therefore, the reader must understand that the general figures given in the following pages do not hold true for individual localities and are but the averages for certain sections.

Methods of Investigation. — The natural conditions of the scallop grounds in Massachusetts are dissimilar to the Rhode Island waters, Buzzard's Bay being the only section at all approximating the conditions in Narragansett Bay. These differences will be brought out later by a comparison with the growth experiments of Risser (2) on the Narragansett Bay scallops. The variety of conditions presented in the different localities of Massachusetts necessitated an extensive series of experiments, covering the same ground and in several instances with results at variance with the observations of Risser.

The opportunities for solving the rate of growth of the scallop under a variety of natural conditions were especially favorable owing to the diversity of the different scallop grounds. The average rate of growth for the different sections in the State, as here presented, is the result of three years' continued observations on sets of scallops under various environments. Excellent facilities for detailed work on the growth and length of life for a period of four years were afforded at Monomoy Point in the nearly landlocked harbor, the Powder Hole, and a large share of the experimental observations, many of which could never have been obtained elsewhere, were made in this locality. Inclosed in a natural aquarium, the scallops could be followed from birth to death under conditions many of which were under the direct control of the operator.

The general work consisted of two parts: (1) at Monomoy Point on the scallops confined in the Powder Hole; (2) records of the growth of the different sets at different localities along the southern coast of the Commonwealth. The investigations were first started in July, 1905, and continued steadily through 1906 and 1907. Records were also maintained in several localities for 1908 and 1909, while the work at Monomoy Point was continuous for the whole period. During this time records of the complete sets of 1904 (second year), 1905, 1906, 1907, 1908 were made at Monomoy, and for the State in 1904, 1905 and 1906. Another division of the work of a different nature can be made: (1) experiments in artificial culture, where the scallops were confined in pens of wire netting at Monomoy, Marion, Monument Beach and Chatham; (2) records of the growth under natural conditions on the scallop grounds by measuring large numbers of scallops. A description of the methods of work, details of measuring, construction of pens, marking of scallops, etc., is given in chapter VII.

General Growth. — The shell or exo-skeleton of the scallop is commonly considered the growing part and any increase in its size indicates the development of the animal. New shell formation is the direct result of a previous corresponding growth in the soft parts, whereby an extension of the shell is necessitated. In the following experiments the shell has been considered as typifying the development of the body, and all measurements have been recorded on this basis. The quality of the meat and the fattening of the tissues, so important to dealer, are not considered under the subject of growth, but are discussed in connection with the "eye" in chapter VI.

Shell formation by the secretion of the thin mantle lining the inside of the shell has been described in chapter II. The shell is built almost entirely of lime salts (principally the carbonates), which is obtained in some unknown manner from the water. It appears that the amount of lime in solution in the water is an important factor in the rapidity of growth, but is not as essential as the nourishment of the soft parts by the microscopic food. The actual increase in the rate of growth by an excess of lime is but slight, as the shell formation naturally depends upon the growth of the soft parts, and the difference is only evidenced by the increased weight of the shell in localities rich in lime salts. The lime supply varies somewhat in the different localities, and its efficiency is largely dependent upon the circulation of water.

In considering the rate of growth the matter of food is of chief importance. Within limits the growth of any mollusk is directly proportional to the amount of food it consumes. Scallops situated in good feeding localities will grow much faster than those less fortunately located. The food as stated in chapter IV. consists of microscopic plant forms, called diatoms, which are uniformly distributed through the water. Naturally the abundance of diatoms in any locality and the circulation of water or current are the two external factors in the development of the scallop.

Growth of Scallop compared with Other Economic Bivalve Mollusks. — The limited life and active habits of the scallop require a quick maturity and light shell, which make its growth the most rapid of the economic bivalves. Arranging these mollusks in order of rapidity of growth, scallop, clam, sea clam, oyster and quahaug, we find that they are likewise placed in respect to the weight of their shells, the lightest shell corresponding to the fastest growth. From this we can formulate the general rule that the growth of any shellfish is directly proportional to the weight of the shell, which not only seems to hold true for the different species, but is applicable to varieties of the same species; *i.e.*, a thick-shelled clam grows more slowly than a thin "paper" shell variety.

Variations in Growth. — Many variations are found in the growth of scallops. In no two localities is the size identically the same, as can be seen by comparing Buzzard's Bay, Cape Cod and Island scallops. This variation may be called sectional, and can be attributed to the difference in environment, which also applies to local conditions. There is also variation in the sets, the average of one year differing from the succeeding or preceding years. The size of a scallop is due to two main factors: (1) its time of birth, either at the beginning or end of the two months' spawning season; (2) the conditions under which it lives, whether favorable or unfavorable for rapid growth. Primarily the environment and secondarily the time of the set determine in a great measure the life of this mollusk. There is another type, individual variation, which is important to consider in presenting the results of the growth experiments, as it proves that correct results can only be satisfactorily obtained by records of large numbers of scallops. Risser (2) remarks on the remarkable uniformity of the individuals of the set in Narragansett Bay. No such uniformity has been found under the more diverse conditions in Massachusetts waters, and in individuals of the same set, especially in the young scallop, variations as great as from ½ inch to 2½ inches have been found at the same time and place. Between these extremes all grades can be found converging toward the average. Even when scallops of the same size are confined in pens their growth varies, a fact that can only be attributed to the individual traits of the animal.

Growing Months. — Man passes through four arbitrary periods in life, childhood, youth, manhood and old age, attaining his actual stature during the first two, and only adding more flesh as the years pass. The scallop, on the other hand, continues to increase in size during the adult period, and in fact up to the time of its death has not lost the power of growth, although the shell formation in the old scallops is somewhat slower than in the younger specimens. But the scallop only grows half the time, as all shell formation is accomplished during the summer months and no increase in size is found during the cold weather. This gives the scallop a resting time between the period of youth and adult, and again during its old age, as the average life of the animal is from twenty to twenty-six months.

In following the life of the scallop born in July, growth ceases during December and is again resumed May 1 of the following year, when the temperature of the water has reached 45° to 50°F. The same scallop ceases growth in the fall, usually in the latter part of November (slightly earlier than the young set of that year), when the water has again fallen below 45°. Thus, every scallop has two periods of growth, corresponding to the two summers of its existence, and two resting periods during the winters. The cause of this cessation of growth is explained under the topic "Effect of Temperature."

By monthly measurements of the scallops confined in pens at Monomoy Point during 1906, the relative value of each month was calculated and the variation in growth for different parts of the summer was determined. In the following table each month is given a numerical number, representing the gain per cent. for the month, the entire year being considered as 100 per cent. (Figs. 84, 85): —

Month.	Per Cent.	Month.	Per Cent.
January,	-	August,	20.39
February,	-	September,	20.08
March,	-	October,	18.94
April,	-	November,	2.15
May,	19.76	December,	-
June, [1]	8.33		100.00
July, [1]	10.35		

[1] Decrease in June and July due to spawning.

Length of Life. — Briefly stated, the normal life of the scallop is from twenty to twenty-six months, relatively few scallops passing the two-year limit.

Previous to 1906, when this problem was first satisfactorily solved by the commission, the question most often propounded by the practical scallop fisherman was, "How long does the scallop live?" In spite of the diversity of opinion, which credited the scallop with living anywhere from two to five years, the majority of the scallopers believed that two years marked the limit of its life, a view which coincided with the results of the investigation. Both Ingersoll (8) and Risser (2) agreed with this view, but were unable at the time of writing to furnish definite proofs. So it fell to our lot to obtain, through a series of observations covering several years, the necessary data for the actual substantiation of the popular theory, and for the establishment of proper legislation for the fishery.

The method of work consisted primarily of continued observations on the sets of 1905, 1906 and 1907, following each from birth to death. The greater part of the work was done in connection with the growth experiments in the different scalloping areas, but more particularly with the scallops confined in the Powder Hole at Monomoy Point, where favorable opportunity was afforded for obtaining data on the life of the scallop. An inclosed, protected body of water, forming a natural aquarium of five acres, from which the scallops could not escape; unmolested, owing to its being leased by the State for scientific investigation; a natural scallop bed with all normal conditions, yet small enough for direct control and observation, — were all factors which rendered the Powder Hole of especial advantage for the solution of this problem. Three sets of scallops were closely followed from birth to death under natural conditions, free from many natural enemies and the interference of man, and practically unable to escape. Likewise, scallops were confined in wire pens for two successive seasons and the actual death-rate of the old and young scallops compared under the same conditions.

The life of the scallop can be arranged in four arbitrary stages: (1) embryonic life or babyhood, from the time the egg becomes a living organism until the animal attaches to the friendly blade of eel grass; (2) adolescence, or the period ending when it first spawns at the age of one year; (3) the adult period, from twelve to twenty months, during the later part of which it is ready for the market; (4) senility or old age, from twenty months until the animal dies.

This last period, that of senility, is the important factor in considering the length of life of the scallop, as it is the time of physical decline. Old age is marked in the scallop by (1) slower growth and a slight thickening in shell formation for those specimens which live over twenty-three months; (2) a degeneration in the large adductor muscle or "eye," shown by flabbiness and diminution in relative size; (3) an increasing amount of foreign growth on the shell. One or more of these signs may be absent in individual specimens, but all are true of the general type. Old scallops are more sensitive or susceptible to adverse conditions than the scallops a year younger, and perish under conditions which would be survived by the latter.

The period of senility has no definite beginning. Possibly the scallop is on the decline during its adult life, having reached its maximum at the spawning season, and then, having outlived its usefulness, awaits death. One of the fundamental principles of nature according to the old school, as applied to the lower animals, is that life exists only so far as it concerns the reproduction of the species, and that animals, such as the mayfly, live only until they reproduce, and then perish.

But with the scallop we have the interesting case of an animal which spawns but once and yet lives for nearly a second year, perishing just on the verge of another spawning season, — an exact contradiction to this principle. This apparent phenomenon might be explained in two ways: (1) that a few second-year scallops are useful, as they spawn twice; (2) that probably the shallow-water scallop (*P. irradians*) once had a longer life and more than one spawning season, as its cousin the giant scallop (*Pecten tenuicostatus* Mighels), and that the present *Pecten irradians* is a decadent species.

About the first of March the adult scallops begin to die, and this period, when the average scallop is twenty months old, is taken as the arbitrary beginning of the period of senescence. In the natural scallop beds the majority of the scallops are caught by this time, while the remainder sooner or later die a natural death, a large proportion perishing before May or before the twenty-second month. This fact is well known to scallopers who fish late in the season, and there have been striking instances of large beds suddenly perishing, as at Dennis in March and April, 1905. After May the length of life is variable, some scallops passing the two-year limit (July) and occasionally living until the following October and November (twenty-seven and twenty-eight months), but the majority of these die before the twenty-fourth month (July). Exact data upon this subject were obtained from scallops which had been under observation in wire pens at Monomoy Point for two years. Records of death-rate from old age show that, of 465 scallops alive May 1 (twenty-two months), 32 per cent. remained by July 10 (twenty-four months) and only 6 per cent. August 2. In July these scallops would have been two years old. Scallops one year old, confined under similar conditions, showed only a slight mortality.

It is, therefore, fair to assert that under natural conditions, when unmolested by the scallopers, but 20 per cent. reach the two-year mark, whereas on the scalloping grounds, unprotected both from nature and man, the percentage of old scallops which reach two years is much less than in the inclosed Powder Hole at Monomoy Point, and in all probability the total which pass the two-year limit is under 10 per cent. All rules have their exceptions, and frequently instances occur where scallops of twenty-eight months (recognizable from two growth lines and general appearance) are found. In every scalloping ground an occasional scallop of this age or older is dredged. More particularly, in certain localities small beds of scallops which have passed the age limit, are occasionally found, but usually the number in the bed is small. Several small beds and one large (Common Flats, Chatham, 1908) have come under the observation of the writer, who by no means claims that the two-year limit is a hard and fast rule, but rather that there are often exceptions, which, however, form but a small per cent. of the whole.

The age limit of the scallop ranges from twenty to thirty months. We find that the variation is due to several causes: (1) the spawning season, which makes possible a difference of two months in the age; (2) the environment, favorable or unfavorable, which lengthens or shortens the period of life; (3) seasonal differences, as during a mild winter the old scallops are under less strain than during a severe season; (4) the rate of growth and consequently the size of the scallop, as the small, slow-growing scallops apparently live longer than the large. This was noticeable with the set of 1907 at Monomoy Point, which grew very slowly, as compared with the sets of previous years, owing to the partial closure of the opening to the ocean and the consequent lessening of circulation in the Powder Hole during 1908. These scallops in the summer of 1909, when two years old, were scarcely larger than yearlings, and lived until the following September before they began to die, at least six months longer than the normal. In previous years in the Powder Hole a small per cent. of the scallops had lived until May and a still smaller number until August (twenty-five months), but this was the only set, as a whole, to pass to the twenty-sixth month, a fact probably explained by their small size and freedom from foreign growth.

The above statements are based on the following facts: —

(1) The writer has been able to find very few old scallops (twenty-seven months) during the fall dredging in waters of the Commonwealth. The scallop fishermen report in each locality the same result, with the exceptions above mentioned. This narrows the limit from general practical observation to twenty-seven months.

(2) The reports of fishermen upon the death of scallops in the last of the winter and in the spring, as well as the great destruction of beds at Dennis, Chatham, etc., prove that the scallop begins to die about the twentieth month of its life. This brings the period of death and decline between the twentieth and twenty-seventh month, or from March until October.

(3) The sets of 1905, 1906 and 1907 were followed from birth to death at the different scalloping sections by observations at stated intervals, and the results, except for the inroads of the scallopers, were conclusively proved by dredging on the scallop grounds.

(4) Detailed study of the sets of 1905, 1906 and 1907 in the Powder Hole, where the scallops were confined for life, shows conclusively that the average length of life is two years, even when undisturbed by dredging.

(5) Records from 500 scallops in pens at Monomoy for growth gave actual figures for death from old age.

The connection between the limited life of the scallop and the spawning season has been considered under the subject of "Spawning," in chapter III., and it is only necessary to again call the reader's attention to the importance of the short life of the scallop in regulating the fishery by law. This knowledge is particularly applicable to protective legislation. The length of life permits but one spawning season, when the scallop is one year old. After spawning the average scallop is valueless for the maintenance of the race, and does not need protection. Thus the scallop under one year old, the "seed" scallop, is the only one that should be protected by law. No legislation is necessary for the scallop past its prime. For this reason restrictive legislation, such as limiting the catch by the town law, except when it is to the pecuniary advantage of the scalloper, to avoid "glutting" the market, is unnecessary, and only works to the detriment of the fisherman, as all scallops not taken will perish before another season. The fisherman should be given freedom in his dredging, provided he observes the all-important "seed" scallop law, as he can catch all the old scallops without injuring in the slightest degree the future industry.

The Growth Line. — The shell of the scallop is increased by calcified secretions of the mantle, which add fine concentric rings to the growing edge. If one observes the shell closely one will find that it is made up of microscopic growth lines, due to the method of growth.

On scallops which reach a second summer there is found a growth line, more or less pronounced, which can be likened to the year marks seen in cross-section of tree-trunks, and is given the name of the *annual growth line.* Growth lines with the oyster are helpful in determining the age, and this line marks the distinction between the adult and "seed" scallop, and has attained considerable prominence as the basis of the "seed" scallop law.

The *annual growth line* is formed in Massachusetts waters about May 1, when the scallops resume their growth after the cold winter months, during which all growth has ceased. Necessarily, during the long period of nongrowth, from November to May, the edge of the shell has become thickened or blunted by more or less wear, and when the new growth is secreted by the edge of the mantle on the inner side of the shell a distinct ridge is formed, marking the separation of the old and new growth. The location of the growth line varies between the limits of 10 to 65 millimeters from the hinge, depending upon the size of the scallop when it ceases growing in the fall. We have already shown that there is a similar variation in the size of the "seed" scallop, owing to difference in its situation and the time of spawning. As a rule, the line is 30 to 40 millimeters from the hinge. In some scallops it is very prominent, while in others it is difficult to discern at first glance; sometimes the shell shows a difference in color between the two parts, at other times both the old and new growth are alike, and it is necessary to run the finger down the shell to determine the ridge. However, these cases are the exceptions, and the average growth line is especially prominent on the lower or right side of the animal, the upper valve usually being covered with numerous growths, both plant and animal, which may obscure the line.

As the formation of the annual line is due to cessation of growth during the winter, it logically follows that any check for a less or greater time will cause slight lines, which are entirely distinct from the annual growth line and are by no means as prominent, being merely heavier concentric layers. Growth lines of this sort can be produced on young scallops at any time by interfering temporarily with their growth. The same scallops repeatedly transferred from the spat boxes on the raft at Monomoy Point, and kept in an aquarium for even as short a period as one day, could be made to produce as many as three or four distinct growth lines. Large "seed" scallops and even adults, when transplanted from Harwich and Chatham to Monomoy Point, always showed the change by the formation of a line of growth.

The growth line is not caused by the spawning season, as has been supposed, since our investigations upon the effect of the spawning on growth indicate that there is no cessation during this period (June and July), and that before the beginning of the spawning there has formed during the month of May about ⅙ of an inch of new shell. All our observations for the years from 1906 to 1909 have shown that the new growth begins about May 1, except for the variation of different years, and that the growth line is formed at a time previous to the spawning season.

Although the growth line appears when the scallop is but ten months old, it can for all practical purposes be considered as marking the first year of the scallop's life. While the spawning season is not completed until about the first part of August, these dates are included in the closed season, which lasts from April to October, and in a general sense the growth line can be associated with the spawning season, and in the open fishing season any scallop with the annual growth line is ready for capture. Risser (2) was the first to advocate the use of the growth line to distinguish the difference between the adult and "seed," while the Commonwealth of Massachusetts was the first to put into force a law based on the growth line as distinguishing the adult from the "seed" or immature scallop, which has not spawned. While we cannot say that every scallop with a growth line has spawned, we can definitely state that every scallop without a growth line has not spawned and is a "seed" scallop. The growth line has thus proved of great practical importance in scallop legislation, which is based on the facts obtained upon the length of life and spawning of the scallop in Massachusetts waters.

Growth during Spawning Season. — The spawning season has the wide limits from June 15 to August 15. The greater part of the spawning is accomplished during June and the first part of July. Corresponding to the spawning period there occurs a slowing in the rate of growth (Fig. 85). Risser (2) has observed a similar occurrence with the growth of Rhode Island scallops, but declared that there is a complete check at this period, and to it attributes the origin of the annual growth line. This report has demonstrated that the growth line is formed at an early period, about May 1, by the resuming of shell formation after the nongrowth of the winter months, and has nothing to do with the spawning season. Likewise, no decided check in the growth of Massachusetts scallops is found during the spawning season, but rather the scallop continues to grow at about half its normal rate. The monthly rate of growth was determined for 1,900 scallops in four wire netting pens at Monomoy Point during 1906. It was found, by considering the entire summer's growth (May 1 to December 1) as 100 per cent., that the growth during May was 19.76 per cent., during June 8.33 per cent., during July 10.35 per cent., during August 20.39 per cent., showing that the rate of growth for the month preceding and succeeding the spawning season was over twice as fast as for the spawning months.

The reason for this slow growth can be attributed to the coincidence with the spawning season, and is best explained by assuming that the activities of the animal were directed for that period upon the propagation of its species, and less energy was used for the secretion of shell. Temperature, the great factor in determining growth, does not have any influence here, as the water during June and July was warmer than during May and colder than August. In fact, all natural conditions affecting the rate of growth were eliminated, leaving the spawning season as the direct cause in the lessening of the rate of growth.

Growth of the Young Scallop. — The young scallop at the age of forty-eight hours has increased in size by the formation of the embryonic shell. Previous to this time the ciliated larva was scarcely larger than the original egg. The period of first shell formation marks the beginning of real growth, which continues for the entire life of the scallop during the summer months. Since the growth during early life has been described in chapter III., it is only necessary to consider the growth after the scallop has become readily visible to the naked eye, *i.e.,* about 1/25 of an inch in size.

The time of appearance of the set depends upon two factors, (1) locality; (2) year. During 1906 the visible appearance of "set" was recorded as follows: (1) Powder Hole, Chatham, August 7; (2) Stage Harbor, Chatham, July 24; (3) Edgartown, August 3; North Falmouth (Buzzard's Bay), July 20; Marion, July 20; showing a difference of fourteen days between two bodies of water not 10 miles apart, and an extreme variation of eighteen days. At Monomoy, between 1905 and 1909, the sets have appeared as early as July 24 and as late as August 7, showing the influence of seasonal change. (These dates do not indicate the first appearance, but when the average set was readily discernible to the naked eye.) Stragglers can be found weeks before and after, due to the length of the spawning season.

The rate of growth of the young scallop is affected by the same natural conditions as the adult. Between the sizes of 1 and 15 millimeters, the average gain per day is 0.5 of a millimeter (about 1/50 of an inch). As the scallop increases in size the actual growth becomes less.

The habit of attachment is of great importance to the scallop, not only occasionally saving it from destruction on foul bottom, but raising it in a position where the little animal can obtain a better food supply, thereby favoring its growth. Eel grass from its abundance proves the most common place of attachment, but is often detrimental to growth by shutting off the circulation of water. In comparing the growth of small scallops in eel grass and outside, the eel-grass scallops show a slower growth.

In summarizing the growth of the young scallop the following points are important: (1) the actual growth begins only with the first shell formation; (2) the time of set varies in regard to (*a*) locality, and (*b*) year; (3) the growth up to 15 millimeters averages 1/50 of an inch per day; (4) growth becomes less and less as scallop increases in size beyond the 15 millimeter mark; (5) power of attachment aids growth; (6) conditions governing growth are the same as for adult; (7) growth of the young is faster than for yearling scallops, both in (*a*) actual gain, and (*b*) in volume.

Growth of the Average Massachusetts Scallop. — Owing to the variation in the growth of the scallop in the different localities, it is difficult to strike more than an approximate average for the size of the yearly sets and the typical Massachusetts scallop. Two classes of scallops are found, (1) the shallow-water or eel-grass scallop, and (2) the deep-water or channel variety. The following tables are compiled from the average growth in the different localities for a period of three years. The height of the scallops is given in millimeters, 25.4 millimeters being equivalent to 1 inch.

The Average Scallop.

Set.	Average Size (Millimeters).		Per Cent. Gain in Volume.
	May 1 (Ten Months).	December 1 (Seventeen Months).	
1904,	33.40	60.99	632.75
1905,	37.50	62.30	525.78
1906,	31.82	60.51	678.04
Average,	34.24	61.27	612.19

Size of Scallop (Millimeters).

Date.	1904.	1905.	1906.	Average.
Aug. 1,	2.00	2.00	2.00	2.00
Sept. 1,	12.40	13.76	11.82	12.66
Oct. 1,	22.64	25.34	21.61	23.20
Nov. 1,	32.30	36.26	30.78	33.11
Dec. 1,	33.40	37.50	31.82	34.24
May 1,	33.40	37.50	31.82	34.24
June 1,	38.85	42.20	37.49	39.51
July 1,	41.15	44.27	39.88	41.77
Aug. 1,	44.01	46.84	42.85	44.57
Sept. 1,	49.64	51.90	48.70	50.08
Oct. 1,	55.18	56.88	54.46	55.51
Nov. 1,	60.40	61.76	59.89	60.68
Dec. 1,	60.99	62.30	60.51	61.27

Growth in Various Localities. — The growth of the scallop is largely determined by its environment. Owing to the diversity of natural conditions within small bodies of water more definite conclusions can be drawn from special localities than by comparing one locality or section with another, owing to the difficulty of determining the average growth for so large an area. Nevertheless, it is of interest to compare the growths in the different parts of the State in a general way, without making too fine a distinction between the individual towns. The following figures are based on a large number of measurements of several sets: —

Size of Scallops (Millimeters).

Date.	The Islands.		The Cape.		Buzzard's Bay.	
	Nantucket.	Edgartown.	Chatham.	Monomoy.	North Falmouth.	Marion.
Aug. 1,	2.00	2.00	2.00	2.00	2.00	2.00
Sept. 1,	10.85	10.10	12.43	12.61	13.77	16.29
Oct. 1,	19.57	18.09	22.71	23.05	25.36	30.36
Nov. 1,	27.79	25.62	32.40	32.90	36.30	43.64
Dec. 1,	28.72	26.48	33.50	34.02	37.54	45.15
May 1,	28.72	26.48	33.50	34.02	37.54	45.15
June 1,	34.53	32.34	38.72	39.33	42.59	49.94
July 1,	36.98	34.81	40.92	41.57	44.72	51.96
Aug. 1,	40.02	37.88	43.65	44.35	47.37	54.47
Sept. 1,	46.02	43.93	49.03	49.83	52.59	59.42
Oct. 1,	51.93	49.88	54.33	54.23	57.77	64.29
Nov. 1,	57.50	55.49	59.33	60.32	62.58	68.88
Dec. 1,	58.13	56.13	59.90	60.90	63.13	69.40

Comparison of the Different Sets. — In the second table given under the average Massachusetts scallop a comparison of the different sets can be found for the whole scalloping district. A better idea of the variation can be given in comparing the sets for four years in the same locality, the Powder Hole: —

Set.	Number.	Size (Millimeters).	
		May 1.	December 1.
1904,	200	34.55	61.59
1905,	300	34.00	62.90
1906,	300	28.09	59.35
1907,	500	21.50	42.50

The 1907 set was peculiar in showing a much slower growth than the previous sets. This was due to the partial closure of the entrance to the Powder Hole during the summers of 1907 and 1908, which deprived the scallops of the circulation of water which they formerly had. This peculiar set has already been discussed in connection with the length of life of the scallop, as nearly all reached the age of twenty-seven months.

Comparison with Rhode Island. — A comparison of the rate of growth of the different sections in Massachusetts with the Narragansett Bay scallops shows that the average Massachusetts scallop is much smaller and less rapid in growth than its neighbor, except in the Buzzard's Bay section, where the conditions more nearly approximate Narragansett Bay. This difference is probably due to the warmer water, which permits earlier spawning and more rapid growth. The Rhode Island figures in the following table are taken from the report of Jonathan Risser (2) in the Rhode Island Commission of Inland Fisheries, 1904: —

Size of Scallops (Millimeters).

Date.	Rhode Island.	Buzzard's Bay.	Cape Cod.	Islands.	Average Massachusetts.
Oct. 2,	42.00	27.86	22.88	18.93	23.20
Dec. 4,	44.50	41.35	33.76	27.60	34.24
Jan. 11,	55.00	41.35	33.76	27.60	34.24
March 20,	56.80	41.35	33.76	27.60	34.24
April 21,	58.80	41.35	33.76	27.60	34.24
May 30,	60.00	46.27	39.03	33.44	39.51
July 1,	60.00	48.34	41.25	35.90	41.77
Aug. 1,	62.75	50.92	44.00	38.95	44.57
Sept. 18,	71.60	59.02	52.31	48.94	53.42
Oct. 16,	79.00	63.38	57.06	53.89	58.11
Nov. 16,	81.00	66.00	60.10	56.83	60.98
Dec. 3,	86.00	66.27	60.40	57.13	61.27
Jan. 11,	85.00	66.27	60.40	57.13	61.27

Age and Growth. — With the exception of the winter months (December to May), during which no growth takes place, the scallop continues to increase in size until its death. The proportionate growth as determined by the volumetric increase steadily diminishes after the period of first shell formation (the veliger or embryonic shell). On the other hand, the actual gain in inches or millimeters is approximately constant for the first summer, then slowly decreases during the second and even third, provided the animal lives beyond the two-year limit. The point is well illustrated by the following experiment: scallops of the 1904, 1905 and 1906 sets were suspended in wire cages under similar conditions from a raft at Monomoy Point for a period of fifty-three days during the summer of 1906 (Fig. 86). The smaller (younger) scallops showed a greater capacity for growth both in actual increase and in volume. The 1904 set gave an actual increase of 2.10 millimeters in height, or 112 per cent. in volume, a return of less than 1⅛ bushels for every bushel planted; the 1905 set 3.94 millimeters in height, or 125 per cent. in volume, a return of 1¼ bushels; the 1906 set 10.86 millimeters in height, or 309 per cent. in volume, a return of over 3 bushels. From these figures it is evident that the "seed" (1906 set) gave about twelve times the growth in volume of the yearlings (1905 set), and twenty-five times the growth of the 1904 scallops, which had lived beyond their allotted life; and that there is a successive decrease, both numerically and volumetrically, in the rate of growth with the aging of the scallop.

Environment and Growth. — Two great factors influence all animal and plant life, — heredity and environment. In the case of the scallop, environment seems to possess the greater influence on the variation of the species, as varieties are more dependent upon the natural surroundings than upon hereditary characteristics. By environment is meant the natural conditions within which the animal lives, and which determine its struggle for existence. The question of food, enemies, exposure, protection, situation in large or small bodies of water, in or out of tidal currents, temperature, etc., are all factors influencing to a more or less extent the life and habits of the scallop, making it large or small, heavy or light shelled, firm or poor meated, etc. Particularly with marine animals does environment largely determine size, shape, habits and rate of growth.

With many aquatic animals larger specimens of the same species are found in the great bodies of water than in the small, showing that the area of water, either by a more plentiful food supply or in other ways, determines the general size. Looking at the matter from a different standpoint, that of current, it seems that scallops which have the greater amount of water passing over them (which can be compared to residence in a larger area) are larger and of faster growth than the scallops which do not have the same volume of water.

(*a*) *Growth in Respect to Current.* — The most important factor in shellfish growth is a good current of water. The use of the word current does not mean necessarily a rapid stream or an exceedingly swift flow, but a good circulation of water over the bed.

The chief office of the current is as a *food carrier.* The scallop obtains its nourishment from microscopic plants, called *diatoms,* which are found throughout the water. The amount of this food is approximately uniform, and the scallops situated in a current naturally receive more food than those in still water. With mollusks the growth is directly proportionate to the amount of food, and the scallop receiving the most food increases in size most rapidly. A homely comparison can be made by likening the scallop in the current to the man seated at a moving lunch counter, who is able to continually obtain a new supply of food, while his neighbor at the stationary table (the scallop in the still water) is limited to the food within reach. For all practical purposes current means food, and within limits the increase in current indicates the increase in the amount of food, thus furnishing an index for the rate of growth. Theoretically, other factors enter into the problem, such as (1) variations in the amount of food in different localities; (2) the feeding capacity of the scallop, since beyond a certain maximum value an increase in current means no increase in the amount of assimilated food; (3) the freedom of the water from contamination and silt, which impedes the feeding powers of the animal. The shellfish culturist can take the current as his guide for planting, and follow the rule that, as long as the flow of water does not harm the planted shellfish in other ways, the swifter current gives the faster growth.

Current not only brings food to the scallop but also furnishes the lime in solution which is utilized in building the shell, a process as essential in the growth of the scallop as the nourishment of the soft parts by the food in the water. The amount of lime in solution varies in different waters, but this difference is largely obviated by the changes in the current. As an example, a scallop will grow no faster in water rich in lime which is comparatively stagnant than it will in water relatively much poorer where there is a stronger current.

The third office of the current is a purely sanitary one. It sweeps away the decaying vegetable matter so destructive to scallops situated in thick eel grass, and all other poisonous débris which would otherwise kill the scallops by contamination, or at all events would check their growth.

The relationship of current to growth has been experimentally shown in several ways, all of which demonstrate that in the case of the scallop current is the main essential for rapid development. The following observations and experiments are cited as confirmatory evidence: —

(1) *Eel-grass v. Channel Scallops.* — In observing the catch from the scallop beds, it was recorded that the larger scallops always came

from the deep water or channel, while the smaller were taken in the eel grass or shallow water. This difference held true to such an extent that the scallop fishermen could tell by the appearance of the scallop from what section of the bed it came. The shallow-water scallops are much smaller, usually proportionately thicker, and have not the large "eye" and fine appearance of the channel scallops, which are preferred by the scallopers. From a study of the natural conditions of the scallop beds, it appeared that this difference in growth was not due to the mere change in the depth of water but was due to current. The channel scallops on clear bottom receive better circulation of water than in the eel grass, which cuts off nearly all flow of water. Places were found where scallops in deep water without current showed no more growth than the shallow-water variety, while, on the other hand, shallow-water scallops situated near the mouth of an estuary where the tide flowed swiftly back and forth were nearly as large as the deep-water variety. Therefore, while the general distinction between large and small scallops appears to be merely that of deep and shallow water, the fundamental reason is the presence or the lack of current.

(2) *Penned Scallops at Monomoy Point.* — Two pens were located in the Powder Hole at Monomoy Point in 1906. The first was located in an unfavorable situation in shallow water, in thick eel grass which shut off all circulation. The second pen was located in a more favorable situation, where the eel grass was thin and a gentle circulation was caused twice a day by the inflowing of the tide. This pen was situated close to the shore and was by no means adapted for more than ordinary growth. In comparing the growth of the two pens from May 1 to August 1 for the same sized scallops it was found that pen 1 gave a gain in volume of 12 per cent., while pen 2 furnished an increase of 35 per cent. for the same sized scallops, or nearly three times as fast as pen 1. This furnishes a concrete example of the effect of the lack of circulation, as other conditions were very similar in the two pens, which were situated only a short distance apart, in the same depth of water, and about the same distance from shore.

(3) *Basket Growth on Raft and on Shore.* — Scallops of the 1906 set were obtained from Stage Harbor, Chatham, Sept. 7, 1906, and suspended in wire baskets from the raft (Fig. 79), and in pen 2 near the shore. The scallops on the raft, which was located in the deepest part of the Powder Hole, received the best circulation of water and showed a surprisingly fast growth. The difference is brought out by comparing the raft growth with the natural growth of the Stage Harbor set for the same time, and for the basket growth in pen 2 of the same set of scallops. The gain from September 7 to November 22, a period of seventy-six days, was 17.28 millimeters for the raft, 14.08 millimeters for the Stage Harbor scallops, and 10.40 millimeters for the shore. Considering the raft growth as 100 per cent., Stage Harbor would be

81.48 per cent., and the shore 60.18 per cent. The actual gain in volume for each locality would be raft 662 per cent., Stage Harbor 475 per cent., shore 293 per cent. (Fig. 88).

(4) In comparing the growth of penned scallops during 1906 at Chatham, Powder Hole, Monument Beach and Marion in reference to the natural conditions, the pens with the best circulation of water invariably showed the fastest growth, as can be observed in detail by referring to the table under artificial growth.

(5) *The Stage Harbor Set.* — An excellent opportunity for observing the effect of current on the growth of young scallops was found at Stage Harbor in 1906. The set was located at the entrance to Stage Harbor on a flat extending about 90 yards from the east shore to the channel, which curves close to Harding's Beach, on the opposite side. Thick eel grass covered this flat except near the channel, where it grew scatteringly. The water at mean low tide is from 6 to 9 inches deep over most of the flat, gradually deepening at the edge of the eel grass toward the channel. The rise and fall of the tide is about 2½ feet. At low course tides the greater part of the flat is exposed. The difference in the flat is mostly due to the tide, which sweeps in and out of the harbor at every rise and fall, so that there is a strong current always running in the channel. The result is to give that portion of the flat near the channel more current than the portion further away, and the part near shore hardly any. The young scallops were evenly distributed over the flat, although the channel portion was not so heavily set. The growth of scallops of the 1906 set was followed by dividing the flat into three sections, passing from the shore to the channel, each roughly 30 yards wide, and by measuring the average size of scallops in each of these sections at different dates. Four measurements were made, Oct. 26, 1906, April 4, 1907, May 1, 1907, and July 1, 1907. By calculating the difference in the rate of growth and size at each date, the following figures were obtained. Giving the area near the channel (the area of fastest growth) 100 per cent., the middle portion would have a value of 87.04 per cent., while the shore section would have 77.79 per cent. These figures conclusively show the effect of location on the growth of scallops, as in this case scallops of the same set manifested a much greater growth when situated near circulating water. Placing the same in measurements as taken July 1, 1907, when the scallops were exactly one year old, we would have in current portion scallops 42.81 millimeters in size, middle, 37.77 millimeters, shore, 32.95 millimeters, showing a difference of nearly 10 millimeters between the current scallops and the shore, possibly 70 yards apart and of the same set. Computing the growth of the standard scallop (25 millimeters) for each of these areas for a definite period, the following comparative gains in volume, 482 per cent., 280 per cent., and 146 per cent. were obtained (Fig. 87).

(*b*) *Growth and Soil.* — It is impossible to state definitely the exact effect of soil upon the growth of the scallop. The character of the bottom apparently affects the growth but little, as the scallop rests only on the surface and is constantly shifting its position. In this way the scallop is different from the quahaug and clam, which lie buried under the surface. While the adult scallop is little affected by the nature of the soil, the young scallop would soon perish in soft mud were it not attached to eel grass during the early period of its life. The best bottom seems to be a tenacious sand (sand with a slight mixture of mud) with thin eel grass. The most common type, that of the shallow flats, is of a sandy nature with various thicknesses of eel grass. In the case of the large channel scallop, the soil is either sand, gravel, hard mud, shells, with but little eel grass.

The only means of influencing the growth is by the action of the organic acids in certain soils which affect the chemical composition of the lower valve, the only part of the scallop in contact with the soil. Sometimes in cold weather the scallop sinks down in little hollows in the soil, bringing more surface in contact with the bottom. Fortunately, localities of injurious nature are of infrequent occurrence on the scallop grounds and are limited in extent.

(*c*) *Growth in Eel Grass.* — The soil indirectly affects the growth of the scallop by the production of eel grass, which is found in more or less abundance on the scallop beds. Eel grass, especially on the shallow flats, occurs either as (1) thick clusters with open spaces intervening, (2) thinly scattered or (3) thick masses. Only in the last case is eel grass a serious check to growth, as it then cuts off a proper circulation of water, which is the main essential for rapid development, although in the other two types there is more or less interference, according to the thickness of the eel grass. By a comparison between growth on clear sand bottom and in thick eel grass, where other conditions were approximately the same, the scallops on the clear bottom show a greater rapidity of growth than those within the grass, showing that the difference was mainly due to a lack of circulation.

(*d*) *Effect of Temperature.* — The factor next in importance to current in determining the growth of the scallop is temperature. The scallop needs a temperature over 45° F. for growth, thus differentiating the growing months (May 1 to December 1) from the winter months (Fig. 89). Naturally, cessation of growth would be attributed to a lack of food. While by actual count there is a decrease in the amount of food (diatoms) in the water about December 1, it is not sufficient to account for the cessation of growth at this date. Indications point to the fact that the activity of the scallop in procuring food has declined, as the animal has become sluggish with a lowering of the water temperature, and during the winter months remains inert on the bottom, nestling in little hollows in the sandy soil.

Waters of high temperature usually show more rapid growth, probably due to (1) the earlier start in the spring and longer season, (2) more rapid growth throughout the summer months from an increased food supply. Diatoms multiply more rapidly in warm waters and the food supply is consequently greater. The effect of temperature can be seen by comparing the scallops of Cape Cod and Buzzard's Bay. The former do not attain the size of the latter, which are the largest scallops produced in the Commonwealth. The same comparison holds true between Rhode Island and Massachusetts, as in the warmer waters of Narragansett Bay the scallops develop more rapidly. While in both cases other natural conditions play an important part, it is only fair to assume that temperature is a most important factor.

(*e*) *Growth and Salinity.* — The oyster is extremely sensitive to changes in the salinity of the water, both in regard to spawning and growth. The growth of the scallop, on the other hand, is not materially affected by these changes. A sudden decrease in salinity, as after a severe rain, often kills young scallop larvæ, and transferring scallops from water of one density to another during the breeding season has been found to check the spawning.

Scallops are found in waters ranging in density from 1.010 to 1.027, *i.e.*, an equal mixture of salt and fresh, as in mouths of rivers, to extreme salinity. Rough experiments have demonstrated that scallops live and grow equally well between these limits, and that any differences in growth are due to other conditions.

(*f*) *Depth of Water.* — The question of the most favorable depth for growth is of importance to the scallop planter. In nature scallops are found at any depth, from flats exposed at low tide to 60 feet, although the usual limits are less than 25 feet. In too shallow water severe winters destroy the sets, so the scallop should be deep enough to escape the ice. As shown by the channel v. eel-grass (shallow water) scallop, the greater growth occurs in the deep waters; but, as has been stated, this is essentially due to the better circulation in the channel.

Scallops were suspended in wire baskets from the raft in the Powder Hole at different depths during the summer of 1906. The water was 20 feet deep. Four baskets, each containing 100 "seed" scallops about 20 millimeters in size, were suspended for seventy-six days at 6, 7, 8 and 9½ feet from surface. When measured a regular decrease of about one millimeter per foot was found, the 6-foot basket evidencing the greatest gain, and the rest less in definite order, ending with 9½-foot basket. These figures indicate that the best depth for this particular locality was about 5 feet from the surface. Similar experiments with older scallops gave negative results.

Artificial Growth. — The greater part of the growth experiments on the scallop were conducted under the artificial conditions that would be employed in scallop culture. In order to record the rate of growth correctly, it was necessary to have some means of confining the scallops. This was done in three ways: (1) pens of wire netting; (2) wire cages; (3) an inclosed body of water, the Powder Hole. Only the first two can properly be considered artificial, as in the Powder Hole the scallops were in their natural environment. The records were taken at monthly intervals, three measurements being taken of each scallop.

The pens were located at Monomoy Point, Chatham, Nantucket, Monument Beach, Marion, and in the Annisquam and the Essex rivers. The size of the pens ranged from 40 to 400 square feet, either of sufficient height to extend above the average tide, or covered with a netting to prevent the scallops escaping. The posts were made of 2 by 3 feet joists firmly fixed in the soil and placed at sufficient intervals to hold the netting taut. Wire netting (1¼-inch mesh) and old seines were used, the greatest difficulty being to secure the bottom firmly, which was done by base-boards and by fastening the netting in the sand with long wooden pegs. (A complete description of the construction of the pens is given in chapter VII.) It is only fair to state here that pens can probably be improved in such a manner that better results can be obtained, and many of the difficulties of artificial culture can be eliminated.

(*a*) *Artificial compared with Natural Growth.* — For some reason the scallops in the pens do not grow as rapidly as the unconfined scallops in the same locality. This is proved by a comparison of the growth of penned and unpenned scallops in the Powder Hole in 1905, and also by the table of comparative growths in the pens in the various localities during the summer of 1906. In the first case the growth approximated 14.30 millimeters for the penned, as compared with 25.04 millimeters for the unpenned, showing a gain of 10.74 millimeters, or 75 per cent. The average growth from five pens was 16.77 millimeters, as compared with 26.29 for the unpenned, showing a difference of 9.52 millimeters, or 56.8 per cent. It seems peculiar that merely limiting the range of the scallop should have this detrimental effect upon its growth. Several explanations are in order: (1) lack of food by overcrowding in the pens; while this is a very probable explanation, as the scallops were much thicker in the pens than without, it does not seem to hold true for the pens which contained but few scallops, as these no wise differed from the others; (2) the accumulation of seaweed and other plant life on the meshes of the netting, which prevented the proper degree of circulation; (3) the lessened activity of the scallop as compared with the freedom of those without, *i.e.*, lack of exercise. Probably to no one of these explanations can be attributed the whole cause, but rather that all three are more or less involved.

This fact, when applied to scallop culture, is important, as the planter would naturally be desirous of at least attaining as good a growth, if not better, than under natural conditions, and yet if he confines the scallops in small pens he is unable to obtain a maximum yield. There is no reason to believe that this difficulty cannot be overcome by the construction of improved pens, and by requisite care in cleaning. On the other hand, as is stated in chapter VI., under "Artificial Culture," scallop culture can only be successfully conducted in inclosed bodies of water, since the expense of erecting pens would offset the profits. Pens should merely be used to hold the immediate catch for market and rarely utilized for rearing purposes.

Penned and Unpenned Scallop Growth in 1906.

Location.	Penned.		Unpenned.	
	Gain (Millimeters).	Gain in Volume (Per Cent.).	Gain (Millimeters).	Gain in Volume (Per Cent.).
Powder Hole,	15.84	406.00	28.90	965.00
Chatham,	24.25	726.00	26.40	831.00
Monument Beach,	16.00	411.00	25.59	790.00
Marion,	11.00	280.00	24.25	729.00
Average,	16.77	456.00	26.29	828.00

(*b*) *Results from Artificial Growth.* — The greater part of the points enumerated in this chapter were obtained from the experiments upon confined scallops, which, although merely approximating natural conditions, were the only means available for arriving at definite conclusions upon the growth of the scallop. For comparative work and as supplemented by definite observations on the natural beds, they proved of great value in respect to the following: (1) length of life; it was necessary to confine the scallops to ascertain the duration of life, which results were supplemented by use of tagged and unconfined scallops; (2) the growing months and the relative economic value of each month, mainly determined from the pen experiments at Monomoy; (3) the comparative rate of growth of the different sizes, determined from pen and cage experiments; (4) growth during the spawning season; (5) the effect of environment and natural conditions which affect the rate of growth, resulting from (*a*) currents, (*b*) soil, (*c*) eel grass, (*d*) temperature; (6) density; (7) depth of water. These were determined by a comparison of the natural conditions for each pen and the effect which each had upon growth.

Among others, the following facts have been demonstrated by artificial growth experiments: —

(1) *Scallops transplanted to Waters North of Boston.* — Three pens were planted in May, 1906, two of these in the Essex River and one in the Annisquam River, with scallops brought from Cape Cod. Unfortunately, no records could be obtained as the pens were swept away by the swift tidal currents of the north shore rivers, and no trace of the

scallops were obtained. Undoubtedly there are but few places in these rivers where the temperature and other conditions are such that transplanted scallops can live. As a whole, the region is unsuited for the scallop and no industry can ever be expected.

(2) *Deformity of Shell of Scallops grown under Artificial Conditions.* — Scallops confined under artificial conditions frequently show deformities. In nature, deformities in shell occur occasionally, usually being due to the loss of part of the secreting mantle or by contact with some object. The young "seed" scallops confined in the wire cages furnished three types of deformity: (1) a general type, the ratio of width to height being much greater than in the normal "seed;" (2) the thickness of the caged "seed" exceeded the thickness of the normal scallop; (3) many individuals in the cages showed indented shells, angular projections corresponding to the position in which they had rested in contact with the wire sides, and numerous other malformations occasioned by their cramped quarters. All these factors operated against perfect work in recording the growth of the caged scallop.

(3) *Growth of Small and Large Scallops of the Same Age.* — The size of the "seed" scallops of any set vary greatly, but by the time they are ready for market the size is more nearly uniform for scallops under similar conditions, *i.e.,* there is less individual variation. One of the surprising facts noted was that the penned scallops, by the increased rapidity of growth, caught up with the larger before the season was over. In one pen two lots of scallops which on May 1 measured 38 and 46 millimeters respectively, by December 1 were each 60 millimeters in height, the smaller scallops having made up the difference of ⅓ of an inch, and had a gain in volume of 477 per cent., while the 46-millimeter scallop had only increased 249 per cent. in volume (Fig. 90). In several cases this fact was observed and substantiated, likewise from measurements of the natural scallops, showing that the scallops which are backward in growth the first year, either from poor location or late spawning, when placed under favorable conditions have a greater potential energy for growth than the larger "seed," and practically make up the loss in the first season by increased gain during the second.

(4) *Individual Variation and Heredity.* — Each scallop has its individual characteristics. Take any number of scallops of the same size, no matter how few, and let them grow for a month or more. When measured considerable variation will be found, in spite of the fact that all the scallops had the same advantages and were under the same conditions. It is due to the individual variation in the growing powers of the different scallops, such as, *e.g.,* their capacity for feeding or shell secretion, and is primarily the result of either injury or heredity. Individual scallops have been marked and it has been found that generally a slow-growing scallop will keep the same rate during the entire season, in spite of changed position.

(5) *Overcrowding.* — Overcrowding tends to decrease the general rate of growth, as too many mouths are drawing from a limited food supply, and unless there is considerable circulation of water the amount per capita is limited. The stronger the current the greater number can be planted per square foot. The wire cages suspended from the raft demonstrated the effects of overcrowding. Under uniform conditions "seed" scallops averaging 21 per cubic foot gained 21.45 millimeters in height, or 1,092 per cent. in volume, in seventy-six days, while those averaging 153 per cubic foot gained 15.59 millimeters, or 659 per cent. in volume, a difference of 433 per cent. In this case the circulation of water was excellent, yet the difference was decidedly marked.

(6) *Cage v. Natural Growth for Small Scallops ("Seed").* — The 1906 set on the raft was recorded by confining some in wire cages of small mesh, increased in size as the scallops became larger, and by measurements of the scallops which naturally were attached to the different spat boxes. The result was that the caged scallops gained only 15.70 millimeters between August 17 and November 22 (ninety-seven days), both classes being 3 millimeters in size on August 17, while the natural set gained 29 millimeters in the same period. The difference is explained by (1) lack of food, the meshes of the cage shutting off the circulation of food organisms; (2) abnormal growth, due to deformities resulting from cage environment. It is impossible to overcome these difficulties in obtaining the rate of growth of the scallop from caged specimens.

1905 Set during 1906.

	Powder Hole.		Chatham.	Monument Beach.	Marion.
	Pen 1.	Pen 2.	Pen 3.	Pen 4.	Pen 5.
May 1, 1906, . .	51.00 mm.	45.30 mm.	42.48 mm.	47.50 mm.	50.46 mm.
June 1, 1906, . .	51.85 mm.	48.43 mm.	47.27 mm.	50.18 mm.	52.63 mm.
July 1, 1906, . .	52.27 mm.	49.75 mm.	49.29 mm.	51.60 mm.	53.55 mm.
Aug. 1, 1906, . .	52.80 mm.	51.39 mm.	51.80 mm.	53.40 mm.	54.69 mm.
Sept. 1, 1906, . .	53.83 mm.	54.62 mm.	56.74 mm.	56.80 mm.	56.93 mm.
Oct. 1, 1906, . .	54.85 mm.	57.80 mm.	61.61 mm.	60.19 mm.	59.14 mm.
Nov. 1, 1906, . .	55.81 mm.	60.80 mm.	66.20 mm.	63.15 mm.	61.22 mm.
Dec. 1, 1906, . .	55.92 mm.	61.14 mm.	66.73 mm.	63.50 mm.	61.46 mm.
Gain, ...	4.92 mm.	15.84 mm.	24.25 mm.	16.00 mm.	11.00 mm.
Gain in volume for standard 30 millimeter scallop, .	150%	406%	726%	411%	280%

Natural Conditions.

	Monomoy.		Chatham.	Monument Beach.	Marion.
	Pen 1.	Pen 2.	Pen 3.	Pen 4.	Pen 5.
Size of pen,	15 x 10 feet,	40 x 10 feet,	7 x 6 feet,	10 x 10 feet,	10 x 10 feet.
Location,	Bay,	Bay,	Entrance to harbor.	Bay,	Small cove.
Distance from shore.	30 feet,	20 feet,	270 feet,	20 feet,	150 feet.
Current,	None,	Fair,	Excellent,	Fair,	Slight.
Soil,	Coarse sand,	Coarse sand,	Hard yellow sand.	Gravel, sand,	Soft mud.
Eel grass,	Thick,	Thin,	Very thin,	None,	Thick.
Rise of tide,	2½ feet,	2½ feet,	3.3 feet,	4 feet,	4 feet.
Depth of water,	1½ feet,	2½ feet,	1 foot,	2½ feet,	1½ feet.
Salinity,	1.021,	1.021,	1.020,	1.019,	1.017.
Number of scallops.	610,	2300,	100,	325,	338.
Enemies,	Oyster drill,	Oyster drill,	Starfish,	Oyster drill,	Oyster drill.

CHAPTER VI. — THE INDUSTRY.

While a description of the natural conditions of the beds, the methods of capture and the preparation of the scallop for market may prove of slight information to the fisherman, the general public has little knowledge of the methods used in the fishery. For this reason the following pages are primarily intended for the average reader, although different methods are employed in the various parts of the coast, and often the scallop fishermen in one locality are only familiar with the methods used in their immediate vicinity. In such cases information as to methods in other localities as regards implements, boats, dredges, etc., is an important factor in the development of the industry, and since the aim of this report is the improvement of the scallop fishery, no apology is necessary for the repetition of special parts of the Mollusk Report of 1909.

The Fishing Grounds.

Scalloping territory is a variable asset, as the beds are constantly changing according to the location of the yearly sets, and a description of the grounds for any reason may vary from preceding or succeeding periods. In a general way the location and distribution of the scallop beds are shown on the accompanying map (Fig. 78). For greater detail the reader is referred to the Mollusk Report of 1909.

The scalloping territory, which is entirely confined to southeastern Massachusetts, can be separated into four main divisions: (1) the north side of Cape Cod; (2) the south side of Cape Cod; (3) Buzzard's Bay; (4) the islands of Martha's Vineyard and Nantucket.

North Side of Cape Cod. — While there is some evidence from old records that scallops once existed as far north as Boston, they are not found at the present time further north than Plymouth, where it is reported that within the past few years a few could occasionally be gathered on the eel-grass flats of the harbor. Between Plymouth and Provincetown scallops can be obtained at Barnstable, Brewster, Wellfleet and Provincetown, but no extensive industry is carried on. This section, owing to certain unfavorable conditions, probably never will be suitable for a prosperous fishery such as is maintained on the south side of the Cape.

Natural conditions are practically the same for the entire section. Plymouth, Barnstable, Wellfleet and Provincetown harbors are in many respects similar, except that the two latter have different soil. The chief characteristic is the great rise and fall of the tide, averaging about 10 feet, which leaves exposed at low water vast areas of flats on which the scallops perish during the winter. Another unfavorable factor is the extreme swiftness of the tides, for example, in Barnstable and Plymouth harbors, which cause a continual shifting of the sand bars and wash the scallops upon the flats, where they are at the mercy of the elements. Every form of sea life has its range, and Cape Cod may be considered as the northern barrier in the distribution of the scallop.

The primitive methods of gathering the scallops by hand from the exposed flats, or by pushers and dip nets in the shallow water, is followed. No regular dredging is carried on, and the industry, except during the last two years at Brewster, has not been considered of any importance. The origin of the scallops which wash ashore on the flats of Cape Cod Bay at Provincetown and Brewster is unknown. The fishermen believe that in the deeper waters of the bay is a large bed, which furnishes the scallops that are annually washed ashore. In spite of the fact that this bed has never been located, there is every reason to believe in its existence.

(*a*) *Barnstable Harbor.* — On the eel-grass flats on the south side of the harbor a few scallops can be found at the present time; but there is not a sufficient number to make a regular business, such as was carried on in 1877–78, according to Clark (11). The chances are that a severe winter or some other adverse condition killed all the scallops in this locality, and thus, by destroying the spawners, rendered impossible any future supply.

(*b*) *Orleans and Brewster Flats.* — Along the bay shore of these towns, about ½ mile from the high-water line, scallops are found every winter in more or less abundance, varying from a scant few to a sufficient quantity, as in 1908–09, to make a profitable business for the town of Brewster. The scallops, unless gathered, soon perish, as they lie on the flats fully exposed to the chill of winter.

(*c*) *Wellfleet Harbor.* — Scattering scallops are found near Billingsgate Island, on the north side of the harbor, and east of Jeremy's Point, but no regular fishing is carried on.

(*d*) *Provincetown Harbor.* — On the shore of the east bend of the harbor, toward Truro, scallops are washed ashore in varying amounts by the southwest winds. About fifteen years ago scallops were reported as numerous, and it was not uncommon for a man to pick up 5 bushels at one tide, but since 1900 few scallops have been found.

South Side of Cape Cod. — This section comprises the towns on the south shore of the Cape from Chatham to Mashpee. Here conditions are extremely favorable, except for an occasional southerly blow, which at times is sufficiently strong to wash the scallops in windrows on the shore. Only the shellfish in the exposed waters on the open coast are subject to this loss. The other conditions, such as a small rise and fall of tide (about 2 feet), good circulation of water, suitable bottom and depth of water, are all favorable to the habitation of scallops. On some flats during the low-running winter tides there is considerable exposure, as on the common flats of Chatham, and many scallops perish annually. The greater part of the fishery is conducted on the open coast, at some distance from shore, by dredging, or with "pushers" on the low flats which skirt the shore. Scallops are also plentiful in the inclosed bays which line the shore, such as Stage Harbor, Chatham; Lewis Bay, Hyannis; and Oysterville Bay, Barnstable. The average size of the scallop in this section is 2.13 inches. Few natural enemies are found. Starfish and oyster drills are present, but not in sufficient number to be of material damage. The total area comprised in this section is 12,700 acres.

(*a*) *Chatham.* — Scallops are found only in the southern waters of the town. Between Inward Point and Harding's Beach many acres of eel-grass flats, sheltered from the open ocean by Monomoy Island, furnish excellent grounds for scallops. The entire area of these grounds is approximately 2,000 acres, although this whole territory is never completely stocked in any one year. During the season of 1907–08 the following places constituted the scalloping grounds: —

(1) Island flats in Stage Harbor, on the east side of the channel, opposite Harding's Beach, furnish a number of scallops, which are caught the first of the season, as these flats were near the town. Here the water is not more than 1½ to 2 feet deep at low tide, and thick eel grass covers the greater part except near the channel.

(2) Directly south of Harding's Beach lies John Perry's flat, commonly known as "Jerry's," where there has been good scalloping for many years.

(3) The western half of the Common Flats furnished the best scalloping in 1907–08, as the scallops, though small (6 pecks to a gallon),

were plentiful. These flats run nearly dry on low course tides, and are covered with eel grass. Nearly every year there is a heavy set of scallop seed, which, because of the exposed nature of the flats, is wholly or partially destroyed. The entire set was destroyed in the winter of 1904–05, while 30 per cent. was lost in 1906–07.

(4) On the flats just south of Inward Point was another bed of scallops.

(5) In the bend north of Inward Point scallops were plentiful.

(6) On the northwest edge of the Common Flats scallops can be dredged over an area of 160 acres at a depth of 5 fathoms. These are of good size, opening 3½ quarts to the bushel.

(*b*) *Harwich.* — The scallop territory of Harwich covers an extensive area on the south side of the town, and in some places extends for a distance of from 2 to 3 miles out from shore. Usually the scallops are found, as in the last season (1907–08), outside the bar, at a distance of 3 miles from shore, where they can be taken only by dredging from sail or power boats. The intervening body of water sometimes contains a few scallops in a quantity to make a commercial fishery. The total area of the scallop grounds is about 3,200 acres. The bottom is mostly sandy, with patches of eel grass.

(*c*) *Dennis.* — The scallop grounds of Dennis and Yarmouth are common property for the inhabitants of both towns, while other towns are excluded from the fishery. The West Dennis scallopers fish mostly on the Yarmouth flats at the mouth of Parker River, and between Bass and Parker rivers on the shore flats. There is also scalloping along the shore on the Dennis grounds. These grounds are for the "pushers." Dredging is carried on at Dennisport, and the boats cover a wide territory at some distance from the shore. The town possesses a large area, which either has scattering scallops or is well stocked one year and barren the next. Nearly 2,250 acres of available territory are included in the waters of the town. The flats, which are of sand with thick or scattering eel grass, according to the locality, afford a good bottom for scallops. Were it not for the eel grass, the scallops would perish by being washed on the shore by southerly winds.

(*d*) *Yarmouth.* — The scallop grounds of Yarmouth are on the south side of the town, on the flats which border the shore from Bass River to Lewis Bay. Part of the waters of Lewis Bay belong to the town of Yarmouth, and scallops are found over all this territory. The nature of the bottom is the same as at Dennis and Barnstable. The total area of scallop territory is estimated at 2,250 acres. The scallop grounds of Dennis are open to Yarmouth scallopers.

(*e*) *Barnstable.* — Although the scallop industry on the north coast of the town is extinct, it still flourishes as of old on the south coast. The bulk of the business is carried on here, and nearly all the shipments are made from Hyannis and Cotuit. The grounds of Cotuit are quite small, extending over an irregular strip of 100 acres. The bottom is mostly muddy, and covered with patches of eel grass. All the rest of the bay, where the bottom is more suited for oyster culture, is taken up by grants. This scalloping area, although small, is free to the scallopers of Osterville, Cotuit, Marston's Mills and Hyannis, and even where heavily set it is soon fished out. The scallop territory near Hyannis comprises 2,700 acres, in the following localities: (1) Lewis Bay; (2) near Squaw's Island; (3) Hyannisport harbor; and (4) the shore waters. At Hyannisport small scallops are taken with "pushers" in the shallow water, while large scallops are taken by dredging in the other three localities. Scallops are found in different parts and in varying abundance each year.

(*f*) *Mashpee.* — The scallop territory of Mashpee lies in the Popponesset River and Bay, comprising at most 200 acres. For the last eight years there has been no scallop industry in the town. A few scallops are occasionally gathered for home consumption.

Buzzard's Bay. — The third section comprises the waters at the head of Buzzard's Bay, the most protected and perhaps the most favorably situated of the scalloping localities in respect to natural conditions. The warmth and excellent circulation of the water as it courses in and out of the numerous little bays and inlets are favorable to rapid growth, and render possible the production of the large scallop, averaging 2.73 inches, found in this section. The medium rise and fall of the tide (about 4 feet) and the eel-grass bottom give the scallops abundant protection in contrast to the exposed situation in other localities. In spite of these favorable surroundings great numbers of scallops perish from the severe winters and from the attacks of their natural enemy, the starfish. For seven years previous to the season of 1907–08 the scallop fishery had been a failure in these waters, said to have been due to the inroads of this pest, but since that date it has again become of importance. The scalloping territory comprises 11,100 acres and is situated in the towns of New Bedford, Fairhaven, Mattapoisett, Marion, Wareham, Bourne and Falmouth. The fishing is carried on almost wholly by dredging.

(*a*) *New Bedford.* — The scallop area comprises approximately 400 acres, principally in the Acushnet River and Clark's Cove.

(*b*) *Fairhaven.* — This town shares with New Bedford the scalloping grounds of the Acushnet River, and has in addition a much larger territory around Sconticut Neck and West Island. The grounds comprise about 2,500 acres, most of which is unproductive or productive only at intervals.

(*c*) *Mattapoisett.* — The scallop territory, comprising an area of 1,200 acres, much of which is open and exposed, is in general confined to the following localities: Nasketucket Bay, Brant Bay, Brant Island Cove, Mattapoisett harbor, Pine Neck Cove and Aucoot Cove.

(*d*) *Marion.* — The scallop grounds of the town extend over an area of 1,500 acres, situated on both sides of Great Neck, and extending from the Wareham line to Aucoot Cove.

(*e*) *Wareham.* — Situated at the head of Buzzard's Bay, this town possesses a considerable water area which is suitable for scallops. The entire territory, embracing approximately 2,500 acres, extends in a southwesterly direction from Peter's Neck, including Onset Bay, to Abiel's buoy, and from there to Weweantit River. Scallops are also found in the Wareham River. Scallops are mostly found in the deep water, which makes dredging the only profitable method of scalloping in this locality.

(*f*) *Bourne.* — The available scalloping territory covers approximately 3,000 acres, extending from Buttermilk Bay along the whole coast of the town to Cataumet.

(*g*) *Falmouth.* — Scallops are found in Squeteague Pond, Wild harbor, North Falmouth and in West Falmouth harbor. Scallops are occasionally present in small quantities in Waquoit Bay, on the south shore of the town.

The Islands of Nantucket and Martha's Vineyard. — This section bears evidence of the protection of a fishery by nature and the ability of the inhabitants to foster a valuable industry. In both islands the natural conditions are such as to supply the maximum aid in the preservation of the fishery. The scallop territory, for the most part, lies in protected bays, Nantucket harbor, Cape Poge Pond and Vineyard Haven. Certain parts of the territory are exposed and subject to conditions unfavorable for the scallop, but the greater portion is well inclosed and favorably suited for regulating the distribution of "seed." The rise and fall of the tides is slight, not averaging more than 2 feet. A variety of bottom mostly covered with eel grass is found in all the localities, while the depth of water over the beds averages from 10 to 15 feet, rarely exceeding 25.

In this section, no matter how scarce the supply may be elsewhere in the State, the yield of scallops is constant. While there is more or less variation in the different years, extreme scarcity and superabundance, so common in the other sections, occur here but rarely, and the scallop supply from this locality is considered the most dependable in Massachusetts. The total area comprised in this section is 7,300 acres.

(*a*) *Nantucket.* — The grounds lie both in Nantucket harbor and in Maddequet harbor, on the west end of the island. The former of these is the larger and more important, as the fishery is near the town. When the scallops become scarce in Nantucket harbor, the scallopers adjourn to the fresher beds of Maddequet. Nantucket harbor contains approximately 3,000 acres of scallop territory; Maddequet and Muskeget, 1,500 acres.

(*b*) *Edgartown.* — The important grounds are in Cape Poge Pond and in Edgartown harbor, while occasionally beds of scallops, especially "seed," are found in Katama Bay. These grounds comprise an area of 2,000 acres, chiefly of grass bottom.

(*c*) *Vineyard Haven.* — The scalloping grounds of Tisbury are in the harbor at Vineyard Haven. Only Vineyard Haven fishermen make a business of scalloping here. The scallop grounds comprise an area of 800 acres.

The Present Industry in Massachusetts.

In considering the scallop industry the following points should be noted: (1) It has been necessary to record as scallop area any grounds where scallops have ever been found, in spite of the fact that only a portion of this total area is in any one year productive. (2) The boats engaged in the scallop fishery are but transitory capital, which is utilized, outside of the scallop season, in other fisheries. (3) The quahaug and scallop fisheries in many towns supplement each other, as the same men and boats are engaged in both industries. (4) The length of the season varies in the different localities. In New Bedford and Fairhaven the scallops are mostly caught in a few weeks, as many boats enter the business temporarily. This necessarily gives an excess of invested capital and a small production. In these two towns the number of scallop licenses are recorded, as showing the number of men engaged in the fishery, while as a fact but a small part of these are steadily engaged in the industry.

TOWN.	Number of Men.	Boats.		Extra Dories.		Value of Gear.	Production, 1907-1908.		Area of Scallop Grounds (Acres).
		Number.	Value.	Number.	Value.		Gallons.	Value.	
Barnstable,	39	23	$8,000	-	-	$575	1,530	$2,004	2,800
Bourne,	38	30	15,000	-	-	1,200	12,000	15,720	3,000
Chatham,	107	35	10,650	61	$1,430	1,185	34,615	45,345	2,000
Dennis,	30	9	4,230	9	180	368	2,950	3,865	2,250
Edgartown,	39	26	8,000	-	-	550	17,000	22,270	2,000
Fairhaven,	73 [1]	50	12,500	-	-	1,500	1,300	1,703	2,500
Harwich,	12	7	2,350	-	-	280	2,170	2,843	3,200
Marion,	44	16	5,300	24	250	580	7,000	9,170	1,500
Mattapoisett,	22	19	6,900	-	-	760	5,000	6,550	1,200
Nantucket,	99	47	13,250	20	500	700	20,245	26,539	4,500
New Bedford,	38 [1]	20	5,000	-	-	600	700	917	400
Tisbury,	20	8	3,000	6	90	300	3,000	3,930	800
Wareham,	45	36	10,800	-	-	1,300	10,000	13,100	2,500
Yarmouth,	41	15	3,750	10	200	475	8,000	10,480	2,250
Total,	647	341	$108,730	130	$2,650	$10,373	125,510	$164,436	30,900

[1] Licenses.

The History and Development of the Scallop Industry.

In considering the rise of a fishing industry, it is often difficult to state exactly the year when the industry started, as there are differences of opinion as to how large a fishery should become before it could be justly considered an industry. The scallop fishery has existed for years, but did not become an established industry of the Commonwealth before the year 1872. At that time there was scarcely any demand for scallops and the catch was marketed with difficulty. Since then the market for the scallop has steadily increased, until the supply can hardly meet the popular demand.

It seems almost incredible that the scallop as an article of food should once have been scorned and practically unknown. In former years the majority of people looked upon the highly colored shellfish, with its beautiful shell, as poisonous and unfit for the table, in the same manner as our country fathers considered the "love apple," now the tomato, as only an ornament for the garden. Popular taste and opinion have changed, and the formerly despised scallop is now considered as an important part of our sea food. What has been true with the scallop applies equally well in regard to our future attitude towards sea food; many species of fish and shellfish now considered as unwholesome will, in the years to come, be considered as articles of food.

In early colonial days the scallop' was frequently mentioned by the writers of that period, possibly because the attractive appearance of the fan-like shell rendered it a conspicuous object on the beaches, and possibly because the scallop shell had been from the time of the Crusades of emblematic significance. The first use of the scallop was as fertilizer. When blown ashore in quantities, the farmers occasionally came with their carts and carried the decaying shellfish to spread over their inland farms. The next step in the popularization of the scallop was made by the domestic animals, such as cats, dogs, pigs, etc., as the inhabitants let the swine obtain their living from the flats and shellfish. No records have been found by the writer to show that the Indians taught the colonists the use of the scallop as an article of food, or that they were conversant with its use for that purpose in England. So in all probability the edible qualities of this mollusk gradually became known.

Previous to 1874 the industry was of little importance as the scallops were only gathered by hand or taken from the shallow water with dip nets and rakes. This date marks the introduction of the dredge on Cape Cod, which revolutionized the industry by opening new territory and increasing the ease of capture in the deep water. From this time the fishery steadily increased and the market correspondingly widened.

In Buzzard's Bay the fishery first started at New Bedford in the Acushnet River in 1870, furnishing between 1870 and 1879 a winter living for 15 men. From this locality the fishery spread rapidly in 1879 among the other shore towns on the north side of the bay. In 1879 several boats from New Bedford commenced dredging in Wareham waters, and the townspeople soon followed the example of the invaders. From 1879 to 1899 the fishery became of importance as a winter industry in the upper waters of the bay, and flourished until 1899, when it became commercially extinct except at New Bedford and Fairhaven. The fall of 1907 furnished a revival of the fishery, which has every indication of becoming permanent.

The industry first started on Cape Cod at Hyannis in 1874, where a number of men entered the new business; and for several years the production increased rapidly, with the opening of new territory and improved methods of capture. The other towns on the south side of the Cape entered in the new fishery at the same time and with similar success. From that time on the fishery has been a variable factor in the towns of this section, depending upon the supply.

On the islands the fishery began at Edgartown in 1875 and at Nantucket in 1883, and in both cases the supply has been fairly constant, a poor or successful season depending more on the market price and the abundance in the rest of the State than on the local supply.

While the natural supply has remained the same or has evidenced a decline in certain localities, the value of the industry as a whole, both in regard to the number of men engaged, capital invested and the market returns, has steadily increased. The price of scallops varies from year to year and at different parts of the same season; but in spite of the irregularity of the catch the price per gallon has increased threefold (from 50 cents to $1.50) since 1880, showing the increasing importance of the fishery.

The Decline.

The most important questions which first come to mind when considering the scallop industry of to-day are these: (1) Has there been any decline in the industry? If so, how extensive? (2) What are the causes of the decline?

Extent of the Decline. — There is no question but that the industry as a whole has declined. This decline has made itself manifest, especially in certain localities, *e.g.*, Buzzard's Bay, where until 1907 the entire fishery, except at New Bedford and Fairhaven, had been extinct for seven years. Along the south side of Cape Cod, at Edgartown and Nantucket, the supply has, on the average, remained the same. Of course there is varying abundance each year, but as a whole the industry in these localities can hardly be said to have declined. On the other hand, on the north side of Cape Cod we find a noticeable decline. A scallop fishery no longer exists at Plymouth, Barnstable harbor, Wellfleet and Provincetown, though twenty-five years ago these places possessed a slight industry.

So we have to-day in Massachusetts three localities, two of which show a marked decline in the scallop fishery, while the other shows some improvement. Of the two depleted areas, the one (north of the Cape) may never revive the industry; the other (Buzzard's Bay) gives indications that the industry can once more be put on a profitable footing. The only thing necessary is perpetual precaution on the part of the fishermen in order to prevent this decline.

Causes of the Decline. — The causes of the decline of this industry can be grouped under three heads: (1) natural enemies; (2) overfishing by man; (3) adverse physical conditions. In the last instance the severe winters, storms, anchor frost, etc., bring destruction upon the scallops, especially during early life.

The Fishery.

The Season. — There is considerable diversity of opinion among the scallopers as to when the scallop season should open. Some advocate November 1 as the opening date, instead of October 1, as the present law reads; and many arguments are put forth by both sides.

The class of fishermen who desire November 1 are those who are engaged in other fishing during the month of October, and either have to give it up or lose the first month of scalloping. Naturally, they wish a change, putting forth the additional argument of better prices if the season begins later. The scalloper who is not engaged in other fishing of course desires the law to remain as it is at the present time, claiming that the better weather of October gives easier work, more working days, and allows no chance of loss if the winter is severe.

Under the present law, the town can regulate the opening of its season to suit the demands of the market and the desire of the inhabitants. This does away with the necessity of any State law on this point, which, under the present system of town control, would be inadvisable.

The general opinion of the fishermen is in favor of the present date, October 1. As nearly as could be determined, about 75 per cent. favor October 1 and 25 per cent. November 1. This sentiment is divided by localities, as more men were in favor of November 1 at Nantucket and Edgartown than on Cape Cod and Buzzard's Bay, where very few favored a change.

The Methods. — The methods of scalloping follow the historical rise of the fishery. As the industry grew more and more important, improvements became necessary in the methods of capture, and thus, parallel with the development of the industry, we can trace a corresponding development in the implements used in the capture of the scallop.

(*a*) *Gathering by Hand.* — When the scallop was first used as an article of food, the primitive method of gathering this bivalve by hand was used. This method still exists on the flats of Brewster, and often in other localities after heavy gales wagons can be driven to the beach and loaded with the scallops which have been blown ashore.

(*b*) *Scoop Nets.* — The hand method was not rapid enough for the enterprising scallopers, and the next step in the industry was the use of scoop nets, about 8 inches in diameter, by which the scallops could be picked up in the water. These nets were attached to poles of various lengths, suitable to the depth of water. "This method," writes Ingersoll (8), "was speedily condemned, however, because it could be employed only where scallops are a foot thick and inches in length, as one fisherman expressed it."

(*c*) *The Pusher.* — The next invention was the so-called "pusher." The "pusher" consists of a wooden pole from 8 to 9 feet long, attached to a rectangular iron frame 3 by 1½ feet, upon which is fitted a netting bag 3 feet in depth. The scalloper, wading on the flats at low tide, gathers the scallops by shoving the "pusher" among the eel grass. When the bag is full, the contents are emptied into the dory and the process repeated. The scallopers who use the "pusher" go in dories, which are taken to the various parts of the scalloping ground and moved whenever the immediate locality is exhausted. This method is in use to-day, but is applicable only to shallow flats, and can be worked only at low tide, where dredging is impossible. It is hard work, and not as profitable as the better method of dredging. This method of scalloping is used chiefly at Chatham, Dennis and Yarmouth; occasionally at Nantucket and other towns.

(*d*) *Dredging.* — The greater part of the scallop catch is taken by dredging, which is the most universal as well as the most profitable method. The dredge, commonly pronounced "drudge," consists of an iron framework about 3 by 1½ feet, with a netting bag attached, which will hold from one to two bushels of scallops. Catboats, carrying from 6 to 10 dredges, are used for this method of scalloping. These boats, with several "reefs," cross the scallop grounds pulling the dredges, which hold the boat steady in her course. A single run with all the dredges overboard is called a "drift." The contents of all the dredges is said to be the result or catch of the "drift."

When the dredges are hauled in they are emptied on what is known as a culling board. This board runs the width of the boat, projecting slightly on both sides. It is 3 feet wide, and has a guide 3 inches high along each side, leaving the ends open. The scallops are then separated from the rubbish, such as seaweed, shells, mud, etc., while the refuse and seed scallops are thrown overboard by merely pushing them off the end of the board. Each catch is culled out while the dredges are being pulled along on the back "drift," and the board is again clear for the next catch. The culled scallops are first put in buckets and later transferred either to bushel bags or dumped into the cockpit of the boat.

Two men are usually required to tend from 6 to 8 dredges in a large catboat, but often one man alone does all the work. This seems to be confined to localities, as at Nantucket nearly all the catboats have two men. At Edgartown the reverse is true, one man to the boat, though in power dredging two men are always used.

Several styles of dredges are used in scalloping, as each locality has its own special kind, which is best adapted to the scalloping bottom of that region. Four different styles are used in Massachusetts, two of which permit a subdivision, making in all six different forms. Each of these dredges is said by the scallopers using them to be the best; but for all-round work the "scraper" seems the most popular.

(1) *The Chatham or Box Dredge.* — As this dredge was first used in Chatham, the name of the town was given to it to distinguish it from the other styles. At the present time its use is confined to Chatham and the neighboring towns of the Cape. With the exception of a very few used at Nantucket, it is not found elsewhere in Massachusetts.

The style of the box dredge is peculiar, consisting of a rectangular framework, 27 by 12 inches, of flat iron 1 by ¼ inches, with an oval-shaped iron bar extending back as a support for the netting bag, which is attached to the rectangular frame. To the side of the rectangular frame is attached a heavy iron chain about 4 feet long, to which is fastened the drag rope.

(2) *The Scraper.* — As can be seen by the illustration, this style of dredge consists of a rigid iron frame of triangular shape, which has a curve of nearly 90° at the base, to form the bowl of the dredge. Above, a raised crossbar connects the two arms, while at the bottom of the dredge a strip of iron 2 inches wide extends from arm to arm. This strip acts as a scraping blade, and is set at an angle so as to dig into the bottom. The top of the net is fastened to the raised crossbar and the lower part to the blade.

The usual dimensions of the dredge are: arms, 2½ feet; upper crossbar, 2 feet; blade, 2½ feet. The net varies in size, usually holding about a bushel of scallops, and running from 2 to 3 feet in length. Additional weights can be put on the crossbar when the scalloper desires the dredge to scrape deeper. A wooden bar, 2 feet long, buoys the net.

Two styles of this dredge are in use. At Nantucket the whole net is made of twine, while at Edgartown and in Buzzard's Bay the lower part of the net is formed of a netting of iron rings, the upper half of the net being twine. The iron rings are supposed to stand the wear better than the twine netting. This difference seems to be merely a matter of local choice. The "scraper" is perhaps the dredge most generally used, as, no matter what style is in use, a scalloper generally has a few "scrapers" among his dredges.

(3) *The "Slider."* — The principle of the "slider" is the reverse

of the "scraper," as the blade is set either level or with an upward incline, so the dredge can slide over the bottom. This dredge is used on rough bottom and in places where there is little eel grass. In some dredges the blade is rigid, but in the majority the blade hangs loose.

The "slider" used at Edgartown differs from the "scraper" by having perfectly straight arms and no curved bowl, the blade being fastened to the arms in a hook-and-eye fashion. The dimensions of this dredge are the same as those of the "scraper," although occasionally smaller dredges are found.

(4) *The "Roller" Dredge.* — This style of dredge is used only in the town of Mattapoisett, where the scallopers claim it is the most successful. The dredge is suitable for scalloping over rough ground, as the blade of the dredge is merely a line of leads, which roll over the surface of the ground gathering in the scallops.

The dredge consists of an oval iron frame, 32 by 20 inches, which acts as the arms, and is attached to another iron frame, 32 by 3 inches. The blade of the dredge consists of a thin rope with attached leads. The net is made wholly of twine, and is about 2½ feet long.

Outfit of a Scalloper. — The average invested capital of the scalloper can best be given for two classes, — the boat fisherman and the dory fisherman: —

Boat Fisherman.		*Dory Fisherman.*	
Boat,	$500 00	Dory,	$20 00
Dory,	20 00	Oars,	1 50
Six dredges,	25 00	Pusher,	2 50
Rope and gear,	25 00	Shanty,	25 00
Culling board,	2 00		
Incidentals,	3 00	Total,	$49 00
Shanty,	50 00		
Total,	$625 00		

Scalloping with Power Boats. — The season of 1907 has witnessed in Massachusetts the first use of auxiliary power in the scallop fishery. At Edgartown the main part of the scalloping is now done by power, which, in spite of the additional expense of 5 gallons of gasolene per day, gives a proportionately larger catch of scallops. The Edgartown scallopers claim that their daily catch, using power, is from one-third to one-half better than under the old method of dredging by sail. Not only can they scallop when the wind is too light or too heavy for successful scalloping by sail, but more "drifts" can be made in the same time. A slight disadvantage of scalloping with power is the necessity of having two men, as the steering of the power boat demands much closer attention than the sail boat, which is practically held to a fixed course by the dredges. A power boat for scalloping possesses only the disadvantage of additional cost; but it is only necessary to look forward a few years, when expedition rather than cheapness will be in demand, to a partial revolution in the present methods of scalloping, whereby the auxiliary catboat will take the place of the sail boat in the scallop fishery.

Preparing the Scallop for Market. (*a*) *The "Eye."* — The edible part of the scallop is the large adductor muscle. The rest of the animal is thrown away, though in certain localities it is used as fish bait and in others for fertilizer. Why the whole of the animal is not eaten is hard to say. Undoubtedly all is good, but popular prejudice, which molds opinion, has decreed that it is bad, so it is not used as food. This is perhaps due to the highly pigmented and colored portions of the animal. Nevertheless, there is a decided possibility that in the future we shall eat the entire scallop, as well as the luscious adductor muscle.

The adductor muscle is called by the dealers and fishermen the "eye," a name given perhaps from its important position in the animal, and its appearance. The color of the "eye," which has a cylindrical form, is a yellowish white.

(*b*) *The Shanties.* — The catch of scallops is carried to the shanty of the fisherman, and there opened. These shanties are usually grouped on the dock, so the catch can be readily transferred. Inside of these shanties, usually 20 by 10 feet or larger, we find a large bench 3 to 3½ feet wide, running the length of the shanty, and a little more than waist high. On these benches the scallops are dumped from the baskets or bags, and pass through the hands of the openers. Under the bench are barrels for the shells and refuse.

(*c*) *The Openers.* — The openers are usually men and boys, though occasionally a few women try their hand at the work. Of late years there has been a difficulty in obtaining sufficient openers, and the scallopers often are forced to open their own scallops. The openers are paid from 20 to 30 cents per gallon, according to the size of the scallops. One bushel of average scallops will open 2½ to 3 quarts of "eyes." An opener can often open 8 to 10 gallons in a day, making an excellent day's work. The price now paid is more than double that paid in 1880, which was 12½ cents per gallon. Some openers are especially rapid, and their deft movements cause a continual dropping of shells in the barrel and "eyes" in the gallon measure.

(*d*) *Method of opening the Scallop.* — The opening of a scallop requires three movements. A flat piece of steel with a sharp but rounded end, inserted in a wooden handle, answers for a knife. The scallop is taken by a right-handed opener in the palm of the left hand, the hinge-line farthest away from the body, the scallop in its natural resting position, the right or smooth valve down. The knife is inserted between the valves on the right-hand side. An upward turn with a cutting motion is given, severing the "eye" from the upper valve, while a flirt at the same moment throws back the upper shell. The second motion tears the soft rim and visceral mass of the scallop and casts it into the barrel, leaving the "eye" standing clear. A third movement separates the "eye" from the shell and casts it into a gallon measure. Frequently the last two movements are slightly different. The faster openers at the second motion merely tear off enough of the rim to allow the separation of the "eye" from the shell, and on the third movement cast the "eye" in the measure, while the shell with its adhering soft parts is thrown into the refuse barrel. These last two motions can hardly be separated, so quickly are they accomplished.

(*e*) *Shipment.* — The kegs in which the scallops are shipped cost 30 cents apiece, and contain about 7 gallons. A full keg is known as a "package." The butter tubs are less expensive, but hold only 4 to 5 gallons. Indeed, anything which will hold scallops for shipment is used to send them to market.

When the scallops get to the market they are strained and weighed, 9 pounds being considered the weight of a gallon of meats. In this way about 6 gallons are realized from every 7-gallon keg. With the improved methods of modern times scallops can be shipped far west or be held for months in cold storage, for which purpose unsoaked scallops are required. Certain firms have tried this method of keeping the catch until prices were high, but it has not been especially successful.

(*f*) *Market.* — One of the greatest trials to the scallop fisherman is the uncertainty of market returns when shipping. He does not know the price he is to receive; and, as the price depends on the supply on the market, he may receive high wages or he may get scarcely anything. The wholesale market alone can regulate the price, and the fisherman is powerless. While this is hard on the scalloper, it does not appear that at the present time anything can be done to remedy the uncertainty of return. The scallop returns from the New York market are usually higher than from the Boston market. The result of this has been to give New York each year the greater part of the scallop trade, and practically all the Nantucket and Edgartown scallops are shipped to New York.

Either from a feeling of loyalty, or because the market returns are sooner forwarded, or because the express charges are less, Cape Cod still ships to the Boston market, in spite of the better prices offered in New York. Why so many Cape scallopers should continue to ship to Boston, and resist the attractions of better prices, is impossible to determine, and appears to be only a question of custom.

(*g*) *The Price.* — The price of scallops varies with the supply. The demand is fairly constant, showing a slight but decided increase each year. On the other hand, the supply is irregular, some years scallops being plentiful, in other years scarce.

The Food Value of the Scallop.

The large adductor muscle is the only part of the scallop which is used for food at the present day, as the rest of the soft parts are considered non-edible. The adductor muscle occupies the center of the shell and by reason of its conspicuous position has been given the name of "eye" by the fishermen. Less frequently it is spoken of as the "heart." From the standpoint of the consumer and the retail dealer the "eye" is the object of importance, and the word scallop is applied in such a way that many people believe that the little white cube comprises the whole animal. The "eye" can best be likened to the finished product of manufacture as it passes into the purchaser's hands. Therefore, it is to the advantage of the consumer to know (1) the amount of nutriment of the scallop compared with other articles of food, both shellfish and meats; (2) the effects of "soaking" scallops; (3) the amount of waste and the percentage of actual food in scallops from the different localities in the Commonwealth.

Food Value. — As a food the scallop stands ahead of all the other shellfish, containing much more nourishment than the oyster. The following figures are from the tables of Professor Atwater, rearranged by C. F. Langworthy (14): —

	Refuse Bone, Skin, etc. (Per Cent.).	Salt (Per Cent.).	Water (Per Cent.).	Protein (Per Cent.).	Fat (Per Cent.).	Carbohydrates (Per Cent.).	Mineral Matter (Per Cent.).	Total Nutrients (Per Cent.).	Fuel Value per Pound, (Per Cent.).
Oysters, solids,	-	-	88.3	6.1	1.4	3.3	.9	11.7	235
Oysters, in shell,	82.3	-	15.4	1.1	.2	.6	.4	2.3	40
Oysters, canned,	-	-	85.3	7.4	2.1	3.9	1.3	14.7	300
Scallops,	-	-	80.3	14.7	.2	3.4	1.4	19.7	345
Soft clams, in shell,	43.6	-	48.4	4.8	.6	1.1	1.5	8.0	135
Soft clams, canned,	-	-	84.5	9.0	1.3	2.9	2.3	15.5	275
Quahaugs, removed from shell.	-	-	80.8	10.6	1.1	5.2	2.3	19.2	340
Quahaugs, in shell,	68.3	-	27.3	2.1	.1	1.3	.9	4.4	65
Quahaugs, canned,	-	-	83.0	10.4	.8	3.0	2.8	17.0	285
Mussels,	49.3	-	42.7	4.4	.5	2.1	1.0	8.0	140
General average of mollusks (exclusive of canned).	60.2	-	34.0	3.2	.4	1.3	.9	5.8	100

In the following table the scallop is compared with the chemical analysis of various meats in their food stuffs. The figures for the meats are taken from Howell's "Physiology" (13). The comparative prices were obtained in the Boston markets on Feb. 18, 1910.

	In 100 Parts (Per Cent.).					Wholesale Price per Pound (Cents).
	Water.	Protein.	Fat.	Carbo-hydrate.	Ash.	
Scallop "eyes,"	80.30	14.70	.20	3.40	1.40	19½
Beef, moderately fat,	73.03	20.96	5.41	.46	1.14	8¾
Veal, fat,	72.31	18.88	7.41	.07	1.33	12½
Mutton, moderately fat,	75.99	17.11	5.77	-	1.33	10
Pork, lean,	72.57	20.05	6.81	-	1.10	14½

"Soaking." — The "eye" is frequently put through a process familiarly known as "soaking" before it is sent to market. If not done by the fishermen it is completed by the dealer, in order to tempt the purchaser with a beautiful white, plump "eye" instead of a small yellow-colored specimen. Undoubtedly fishermen and dealers would willingly sell unsoaked scallops at a proportionate price the moment the market demands them; but the consumer, through ignorance, prefers the large, nice-appearing "eyes," and thus unwittingly favors the practice.

From a practical standpoint "soaking" is a very simple affair, the "eyes" being placed in fresh water for several hours until they have absorbed sufficient water to increase their bulk about one-third. It has been noticed that whenever salt-water products are allowed to soak in fresh water an increase of bulk is found. This is due to a complicated change, the most prominent factor being osmosis, which causes a swelling of the tissues. The "eye" can be increased by this change to a gain of more than one-third its natural size; that is, 4½ gallons can be increased to 7 by judicious "feeding" with fresh water.

Two methods of swelling scallops are in use. When the scallops are shipped in kegs which usually contain 7 gallons, the following method is applied: 4½ to 5 gallons of "eyes" are placed in each keg, and are allowed to stand over night in fresh water; in the morning, before shipment, more water is added and the keg closed, and by the time of arrival to the New York or Boston market the scallops have increased to the full amount of 7 gallons. The second method of "soaking" is slightly more elaborate. The "eyes" are spread evenly in shallow wooden sinks, 5 by 3 feet, with just enough fresh water to cover them, and left over night. In the morning a milky fluid is drawn off, and the "soaked" scallops are packed for market in kegs or butter tubs.

The process of "soaking" was not instituted until some years after the start of the scallop industry. In 1886 Ingersoll (8) reports that scallops were not being "soaked" in Rhode Island and Connecticut. Dr. Hugh M. Smith (12) attributes the beginning of soaking to the fact that the small Cape scallops could not compete in the Boston market with the larger Maine scallops (deep sea), and that the fishermen found it necessary to increase the size by swelling. If this were the cause, the fishermen soon found it decidedly to their advantage to continue the process of selling "watered stock."

A change has taken place in the appearance of the scallop a few hours after soaking. The small yellow or pinkish "eye" of the freshly opened scallop has taken on a white, plump appearance, adding greatly to its salable qualities. On the other hand, the fine flavor and freshness have disappeared, "soaked" out, so to speak, and the transformed scallop lacks many of the qualities which endear it to the heart of the epicurean. Considerable loss in nourishment has taken place, although exact figures have not been conclusively obtained by experiment, and the scallop spoils much sooner than the unsoaked. If kept too long the absorbed water is given off and the scallop shrinks back to its original size, a process which is more quickly accomplished on the frying pan, where the "soaked" scallop rapidly shrivels. While too much cannot be said to discourage the "soaking" of scallops and to educate the public to demand the real article, it can be fairly stated that the process, although producing an inferior article of food, is not detrimental to the public health as long as proper sanitary precautions are taken by having the surroundings hygienic and by using pure water.

The practice of "soaking" will only come to an end when the public refuse to buy anything but "dry" scallops, and only till then, unless special legislation is enforced, will "soaked" scallops be taken from the market. At the present time, if the wholesale dealers uniformly demanded "unsoaked" scallops from the fishermen, and increased the price, they would be able to get their shellfish unsoaked.

Food and Waste. — The determination of the amount of food and waste in the scallop was undertaken with scallops from six scalloping towns, comprising the three sections of Buzzard's Bay, Cape Cod and the islands. In this work the "eye" was considered the only edible part of the animal. Four sizes, 55 millimeters, 60 millimeters, 70 millimeters and 75 millimeters were used. Ten scallops of each size were dissected, and the weight of the different parts recorded.

(*a*) *The Food Value of the Average Scallop.* — The "eye" or edible portion constitutes but a small part of the entire scallop. By weight the actual food in a scallop of 65 millimeters (2%16 inches), the average from all the determinations, is only 17.77 per cent. of its weight. Thus, in order to get 18 pounds of "eyes" (2 gallons) it would be necessary to procure 100 pounds of living scallops.

The average scallop (Fig. 82) is made up as follows: total weight, 1.5 ounces, or 100 per cent.; total non-edible part, 1.23 ounces, or 82.23 per cent. (includes both shell and non-edible soft part); non-edible soft parts, .49 of an ounce, or 32.8 per cent.; shell, .74 of an ounce, or 49.43 per cent.; actual food, .27 of an ounce, or 17.77 per cent. Considering merely the soft parts of the scallop, the proportion of food and waste is much closer. The " eye " is by weight 35 per cent. of the soft parts, while the non-edible soft parts constitute the remaining 65 per cent.

(*b*) *The Non-edible Parts.* — The non-edible parts of the scallop can be divided into two classes, (1) the shell or hard portion, which is necessarily waste except for certain uses common to all shellfish, (2) the viscera of the scallop, or all parts except the " eye." The latter is the non-edible part proper; as in other shellfish these parts are utilized for food.

(1) *The Shell.* — The shell impregnated with lime salts necessarily makes up a good portion, about one-half, of the total weight. However, it cannot be considered waste except in a non-edible sense, as the scallop shell is found useful in several ways. (*a*) Oyster planters buy large quantities of shells for cultch to catch the oyster set, as the fragile nature is most serviceable in separating the clusters of young oysters. The average price runs from 3 to 5 cents per bushel. The greater part of the shell heaps are utilized for this purpose. (*b*) On Cape Cod, shell roads and walks are sometimes made with scallop shells. (*c*) Work baskets, pin cushions and various ornaments of the house are decorated with scallop shells. (*d*) Within the last few years scallop shells bound together with ribbon and containing miniature photographic views, for souvenir postal cards, have been put on the market by Boston firms, who purchased the cleaned shells from the scallopers at the rate of $6 per barrel. Only the lower or bright colored valve is used.

(2) *The Soft Parts.* — The non-edible part or body of the scallop forms 32.8 per cent. by weight of the total scallop. While not utilized for food at the present time, although there is no reasonable objection except custom and prejudice, it is made use of for (*a*) fish bait, either fresh or salted; (*b*) fertilizer. The probable reason why this wholesome flesh is not made use of as food is because of the brilliant coloring of the mantle and its tough appearance. Other shellfish, such as the clam, quahaug and oyster, are eaten entire, and there is no good reason why the scallop should not be taken in the same way.

(*c*) *The Size of the " Eye."* — The relative size of the " eye " increases with the size of the scallop, as its percentage by weight is slightly greater in large scallops. The percentage by weight for a 60-millimeter scallop is 17.47 per cent.; for a 65-millimeter, 17.87 per cent.; for a 70-millimeter, 17.97 per cent., while the ratio of shell and body does not seem to change. The actual weight of the " eye " varies in the different localities, some showing as much as one-fourth more weight for the same sized scallop. In percentage the Buzzard's Bay district led, averaging about 18.18 per cent., with 18.70 per cent. high at New Bedford, while Chatham and Nantucket gave only 17.20 per cent. and 16.67 per cent. respectively. This fact does not indicate anything about the food value of the scallops from these localities, but is merely cited to show the variation in the weight of the "eye," and that Buzzard's Bay scallops should yield a greater return per bushel. Beside this variation, two conditions influence the size and weight of the "eye": (1) the season or time of year, as the "eye" is reported by the fishermen "to turn out more to the bushel" when the cold weather comes on; (2) the age of the scallop, as the "eye" of a two-year-old scallop (one that has passed the period of allotted life) is looser in texture and weighs less.

(*d*) *Weight of Shell.* — Differences in the weight of the shell for scallops of the same size occur in different localities. The weight of the shell is determined by two factors, (1) the rapidity of growth; (2) the amount of lime salts in the water. These factors are rarely the same for any two localities, and naturally variations would be expected in the weight of the shell. The average weight of the shell for a 65-millimeter scallop is 21.9 grams, yet in six localities we find the weights ranging anywhere between 20 and 23 grams.

The Laws.

The question of scallop legislation has attained considerable importance during the past four years, particularly in regard to the "seed" scallop. During this period three laws have been passed, with the ostensible purpose of protecting the "seed," but have proved far from satisfactory both from the standpoint of the fishermen and the officials employed by State and towns for their enforcement. The reasons for the unsatisfactory state of affairs resulting from this frequent change in legislation are twofold: (1) it is almost impossible to give a comprehensive legal definition of a "seed" scallop; (2) a general law necessarily cannot suit all localities. The present law of 1910, founded on the legislative experience of past years, should prove satisfactory to the State as a whole.

In the early days the scallop was not considered worthy of legislation, as it had no market value, and was generally considered as a poisonous or non-edible shellfish. With the opening of the market arose the necessity of regulating the fishery, and legislation of a restrictive character was enacted.

Previous to 1874 the scallop came under the general acts included in the term shellfish, with the clam, oyster and quahaug. The general acts were of several kinds, (1) town regulation; (2) permits; (3) seizure in vessels; and (4) protection of the shellfisheries by limiting the catch, place and time of taking.

In 1874 occurs the first mention of the word scallop in a legislative act "to regulate the shellfisheries in the waters of Mount Hope Bay and its tributaries," whereby the selectmen of the towns bordering on Mount Hope Bay were permitted to grant licenses for the cultivation of clams, quahaugs and scallops, and other shellfish to any inhabitant. It seems strange that such an advanced and beneficial act should have been passed at that early period, as it was clearly before its time, and unsatisfactory, as is shown by its repeal the following year. It is only within the last year that similar legislation has been passed for the quahaug. Although it is improbable that the cultivation of scallops will ever become extensive, it is only the question of a short time when the cultivation of all shellfish will be legalized.

The second mention of the word scallop is found in the act of 1880, by which the Commonwealth gave to the towns and cities their present oversight of the shellfisheries and full power "to control and regulate the taking of eels, clams, quahaugs and scallops." This act was later amended by the Acts of 1889, but the general terms of the act were not changed, and the present law is but slightly different. Town control as applied to scallop fishery has its advantages and disadvantages, and the wisdom of State control is a debatable question. The present system is to the advantage of certain towns and a loss to the fishermen of the other towns and to the general consumer, since town restrictions prohibit the taking of shellfish by outsiders. Owing to the short life of the scallop the adults left untaken, occasionally in large numbers at the end of a season, perish before another year. More men could have been given employment and a greater supply furnished the consumer if the large beds had been opened to other fishermen besides townsmen. As matters exist, the majority of fishermen seem satisfied with the present system of town control, and until public opinion is favorable to the best utilization of the scallop fishery, State control is not desirable.

Special legislation for the scallop fishery was first enacted in 1885 by an act which limited the catch to 25 bushels a boat per day, the first restrictive legislation upon the scallop fishery. Since that time, within twenty-six years, eight State and seven special acts for towns, in all fifteen laws, have been enacted, all but one of which have been for the regulation of the fishery as regards permits, season, catch and town supervision. The only exception was an act empowering the Commissioners on Fisheries and Game to make an investigation of the spawning and propagation of the scallop. These laws illustrate the following features: —

Daily Limit to the Catch. — The act of 1885 placed a limit of 25 bushels per day for each boat, making no allowance as to the size of the boat. No record of the repeal of this act has been found, and it remained practically an unknown law until 1910, when a limit of 10 bushels per day for each person was passed.

The Season. — Previous to the act of 1885, which made a closed season between April 15 and September 1, there had been no restriction upon the time of capture. The primary object of this act was due to a desire to protect the scallop during its breeding season, and because the winter months were the best suited for handling and marketing the "eyes." In 1887 and in 1896 the closed season was changed to April 1 to October 1, which proved satisfactory until 1909, when the experiment was tried of shortening it to September 1. In 1910 the act of 1909 was repealed, at the petition of the scallop fishermen of the Commonwealth, and the old limits (April 1 to October 1) resumed. The acts of 1885 and 1887 prohibited the capture, sale and export of scallops during the closed season, while that of 1896 replaced the word export by "have in possession." In 1909 any inhabitant of the Commonwealth was permitted to gather by hand scallops for his own use at any season.

The Penalties. — The acts of 1885 and 1887 gave a maximum penalty of $20, which was increased to $50 by the act of 1896, which likewise established a minimum of $20. The acts of 1907, 1909 and 1910 lowered this penalty to a minimum of $5 and a maximum of $20. Special acts for the towns of Buzzard's Bay, in 1888, 1892, 1893 and 1900, established a penalty of $20 to $100.

"Seed" Scallops. — Legislation for the protection of the "seed" scallop was first enacted in 1887, with maximum penalty of $20 for each offence, which was increased to $50 in 1896. Neither act in any way defined the term "seed" scallop. In 1906 a "seed" scallop was legally defined as a scallop under 2 inches, but a size limit proved unsatisfactory, owing to the great variation in size of young and adult scallops, and was replaced in 1907 by a detailed definition. This definition, although describing thoroughly the "seed" scallop, proved too cumbersome for legal use, and was simplified in 1909 to read merely "a well-defined growth line." The act of 1909 gave a leeway of 15 per cent. for the "seed" unavoidably taken, which made the law difficult to enforce and harmful to the fishery. This percentage was lowered to a nominal 5 per cent. in 1910. "Seed" scallop legislation has been the most troublesome, owing to the difficulty in adequately defining the term so that it will bear legal interpretation. As long as the scallop fishermen refuse to take the immature scallops, there is but little need of the rigid enforcement of the "seed" scallop law.

Town Laws. — Special acts for towns are somewhat different than the general State laws governing the fishery, as they merely apply to local waters and emphasize the powers already given by the general shellfish law of 1880 to the town officials. Special scallop laws apply to Nantucket, Wareham, Bourne, Marion, Rochester, Mattapoisett and Fairhaven, and are of two classes: —

(*a*) *Bait Regulation.* — Nantucket is the only town which is allowed to catch scallops for bait out of season, and here only from April 1 to May 15, according to an act of 1901, previous to which the limit was from April 1 to May 1 by the act of 1888.

(*b*) *Local Regulation by Permits.* — The selectmen of the towns above mentioned, except Nantucket, were empowered by special acts to issue permits for scalloping in whatever way they saw fit, and at whatever charge they deemed proper. A severe penalty of $20 to $100 fine was imposed for taking scallops without permits, except for family use and for bait. At the present time five towns, Fairhaven, Marion, Mattapoisett, Wareham, and Nantucket, issue special scalloping permits, while four others, Bourne, Chatham, Edgartown and Harwich, include the scallops under the general shellfish permits.

The local town laws which benefit the scallop industry are made each year according to the condition of the industry. Edgartown and Nantucket have perhaps the best-governed scallop industries. Laws requiring licenses, regulating the opening of the season and restricting at proper times the catch, so as to get the best market prices instead of overstocking the market when the prices are low, are to be recommended on account of their benefit to the scallopers.

Scallop Legislation.

No.	Date.	Kind.	Penalty.	Provisions.	Remarks.
1	1874	Special town.	$5 to $10 and $1 per bushel.	License to plant scallops in Somerset, Swansea, Fall River.	Repealed 1875; word "scallop" mentioned.
2	1880	State, .	$3 to $50, . .	Towns to regulate shellfisheries.	Word "scallop" mentioned.
3	1885	State, .	$20, . . .	25 bushels limit; closed season April 15 to September 1.	- -
4	1887	State, .	$20, . . .	Seed scallops; closed season April 1 to October 1.	- -
5	1887	Town, .	- -	Nantucket allowed to take scallops for bait from April 1 to May 1.	- -
6	1888	Town, .	$20 to $100, . .	Wareham and Bourne; permits.	- -
7	1889	State, .	- -	Town regulation, . . .	Modification of No. 2.
8	1892	Town, .	$20 to $100, . .	Marion, same as No. 6; permits.	- -
9	1893	Town, .	- -	Marion, Sec. 4 of No. 8, amended; Rochester, Mattapoisett.	Word "waters" added.
10	1893	Town, .	$20 to $100, . .	Fairhaven, same as No. 8, .	- -
11	1896	State, .	$20 to $50, . .	Seed prohibited; season April 1 to October 1.	Repetition of 1887 act, except penalty.
12	1900	Town, .	$20 to $100, . .	Mattapoisett, same as No. 8,	- -
13	1901	Town, .	- -	Nantucket; bait, April 1 to May 15.	- -
14	1901	State, .	$5 to $10 for first offence; $50 to $100.	Capture prohibited in contaminated waters.	General shellfish; Fish and Game Commission powers.
15	1905	State, .	- -	Investigation and report, .	- -
16	1906	State, .	$20 to $50, . .	"Seed" scallop, 2-inch limit,	Repealed, 1907.
17	1907	State, .	$5 to $20, . .	"Seed" scallop, definition, .	Repealed, 1909.
18	1909	State, .	Not exceeding $25.	Definition of "seed" scallop; 15 per cent. "seed"; capture by hand at any time.	Repealed, 1910.
19	1910	State, .	Not exceeding $25.	Definition of "seed" scallop; 5 per cent. "seed"; capture by hand at any time; daily catch 10 bushels.	- -

Method of Improving the Scallop Industry.

At the present age a fishing industry must show a steady development to keep pace with the increasing market, which is continually widening through better transportation facilities. Unfortunately, the tendency in the past has been, particularly in industries directly dependent upon natural resources, to meet the question of progression by increasing the yield through the improvements in implements and methods rather than by attempts to increase the natural supply, with the result that under the increased strain the natural resources have been seriously impaired and oftentimes completely destroyed. In these cases protective legislation has either been absent or based upon wrong principles. Examples of impaired resources are found in the natural oyster beds, the shad, sturgeon and alewife fisheries, the clam, quahaug and lobster industries, etc. In the future, fishing industries should be developed both by improved methods and by the increasing of the natural supply through propagation and protection, a work which is being carried on by federal and State fish commissions, and is gradually widening its scope to include all kinds of fisheries.

The scallop fishery presents peculiarities which differentiate it from other fishing industries, and a knowledge of which is essential in considering its improvement. (1) Protective legislation is principally confined to the "seed" scallop, or scallop less than one year old, although the new law of 1910 has placed a daily limit of 10 bushels for each man's catch. (2) The future welfare lies wholly in the hands of the fishermen and their proper respect for the preservation of the "seed" scallop. (3) Although there is plenty of room there is no great prospect for a wide expansion of the fishery, as there are few ways of artificially increasing the supply; but, on the other hand, if the spirit of protective legislation prevails there is but slight danger of a serious diminution. (4) The scallop fishery is peculiarly fortunate, as, unlike the clam and quahaug industries, it is unaffected by heavy fishing and needs but minimum care on the part of the fishermen to remain in excellent condition for years to come. Thus, while there are few possibilities for its development by increasing the natural supply, there is but slight danger of its permanent extinction.

Methods of Increasing the Natural Supply. — The possibilities of increasing the supply of scallops and thus improving the fishery will first be taken up. Many short-sighted fishermen would be opposed to the increasing of the supply, for they consider that the price would be lowered, and they would prefer a high price and small supply. But this idea is erroneous, as it takes no longer to dredge from thick beds than it does from depleted areas, and in view of the increasing popularity of the scallop the price would soon regain its former level. The consumer would be the gainer by the increased production, which would tend to make scallops no longer a luxury but a part of the common diet. However, the fisherman need have no fears in this direction, as investigation has shown that there can be no great increase in the scallop supply, although many of the poor years can be avoided by proper foresight and by work along the lines here suggested.

The reason that the scallop supply can never be successfully increased is due, (1) to no practical means of artificial culture; (2) it was found by this department that money expended in propagating the embryos and young at the present time would be wasted, for the destructive agencies enumerated in chapter IV. would defeat any increase of the supply through successive years, one bad season undoing the work of several years and entailing a new start. If a severe winter killed all the spawning scallops in one locality, there would be the same scarcity of spawn, no matter how great the number of scallops. If such disasters were of rare occurrence the effect would not be so important, but destruction often occurs upon the shallow flats. Thus, under natural conditions there seems a maximum and minimum point of variation between which the scallop supply is constantly wavering. The supply can be somewhat increased and conditions improved by judicious transplanting from the exposed places, thus eliminating the adverse conditions.

(*a*) *Artificial Propagation.* — Artificial propagation may be of two kinds: (1) raising the young from the eggs; (2) catching the spat. So far our experiments have indicated that it is impossible to raise the young embryos in sufficient numbers for commercial hatching. Undoubtedly some benefit would result from the artificial fertilization of the eggs and the liberation of the young larvæ when they first begin to swim, as in nature there is a great loss through non-fertilization. But such a result is purely theoretical, as there is no way of determining the loss when the spawn is liberated. When kept in hatching tubs the majority die before they attain the shell stage. So far this method has proved unsatisfactory, and it is hardly believed that it can be put on a practical basis.

Spat collecting has already been considered under chapter IV., and it only is necessary here to state that for practical work spat collecting does not pay, as greater quantities of scallops can be obtained when small from the eel-grass flats than could be caught with extensive spat-collecting apparatus. Looking at it in one way the scallop supply would be increased so much by the scallops taken on the collectors, as they probably would not survive to set elsewhere, but such would be a "penny wise and pound foolish" method for the planter. If a scallop culturist found it impossible to obtain "seed" it might pay him to try spat collecting. This would only occur in rare instances, where scallops were not plentiful.

(*b*) *Artificial Culture.* — The question of raising scallops artificially for the market, and thus increasing the general supply, was one of the first points considered in this investigation. Parallel work on the quahaug and clam showed that by individual culture or farming the general supply could be increased, barren area made to yield a harvest, the decline of the natural supply checked, and a profitable industry employing several times the number of men now engaged could be started. Conditions were found to be different with the scallop. There are serious limitations to individual cultivation. Scallops can swim and move for short distances, although they do not make the long migrations commonly credited to that species, and thus require penning. It was found that in a few places in the State the scallop could be cultivated by private persons. In every instance the locality of the prospective grant was in a small bay with a narrow outlet, situations so rarely existing that the idea of private scallop culture must be abandoned. Undoubtedly in the future, when grants are given for oysters, clams and quahaugs, they will be assigned under the broad term of "shellfish grants," and the scallops upon these bottoms will be considered as belonging to the grantee. In such cases the scallop is of secondary consideration, and in reality there will never be many true scallop grants.

(*c*) *Communal Culture.* — The scallop offers better opportunities for communal culture, *i.e.*, by towns. There is but one way now known of artificial propagation for the scallop industry, *i.e.*, by transplanting in the fall the abundant set from the exposed places to the deeper water before the "seed" is killed by the winter. It is merely assisting nature by preventing a natural loss, and in no sense can properly be termed propagation. It is a preventive, and money used in this way to preserve the scallop is well expended. Usually the set is abundant, and can be transferred in large numbers. This is the only practical method now known of increasing our scallop supply, though it is hoped in the future that other methods may be devised.

In connection with the above comes the question, if we can thus preserve scallops doomed to destruction, will it not be profitable to transplant scallops to places where the scalloping has been exterminated by various causes, and by means of these "seeders" furnish succeeding generations which may populate the barren areas? This plan is practical and feasible, and should be given due consideration. Why should not scallops be transplanted to the harbors of Buzzard's Bay to again restock these areas? Often the attempt might fail, but there is bound to be success if there is perseverance. The best time to plant scallops is in the fall, as a double service will be given: (1) preservation from destruction of the seed scallops; (2) furnishing spawn and young in the barren locality. Ingersoll (8) speaks of the restocking of Oyster Bay in 1880: —

In the spring of 1880 eel grass came into the bay, bringing young scallops [the eel grass carries the scallops attached to it by the thread-like byssus]; thus the abundance of that year was accounted for, though there had not been a crop before in that bay since 1874.

If such a restocking can be accomplished by nature, it can be done with more certain effect with man's assistance.

Restocking Barren Areas. — The practicability of restocking barren or depopulated areas is illustrated by the following: As few natural scallops were found in the Powder Hole, Monomoy Point, in 1906, and as it was desired to have the place well stocked for experimental work in 1907, 50 bushels of small scallops about the size of a quarter of a dollar were transplanted from the Common Flats at Inward Point in November, 1906. The result was an enormous set from these "spawners" in 1907, and the sandy bottom along the shores of the Powder Hole during the fall of 1907 and the summer of 1908 was thickly covered with the numerous 1907 set. The fishermen, who had been at Monomoy for years, remarked that it was the largest set that had ever been seen in the Powder Hole. It can be fairly asserted that the remarkable abundance was due to the bringing in of the spawners, and that this case is a striking illustration of the proper methods of assisting nature in increasing the scallop supply in any particular locality.

Our present town laws stand as obstacles to any restocking, as no town will give up the slightest part of its "seed" scallops to another town, thus making any practical tests impossible. Time will smooth away these difficulties, and the welfare of the community as a whole will be placed before the petty rivalry of towns.

Improving the Fishery. — The second means of improving the industry is to increase the efficiency of the fishery as regards methods, marketing, utilization of waste, etc. Perhaps the most important means of developing the fishery is to keep the fishermen well informed as to what is going on in other scalloping districts, what opportunities are being opened for the marketing of shellfish, how the waste products can be utilized, and how the fishery can be preserved. This report contains practically all obtainable information upon the scallop and the industry in Massachusetts at the present time. While the main facts set forth in the preceding pages about the life and habits of the scallop will remain the same, the condition of the industry will change, and in the future the descriptions of methods, implements, marketing, etc., will be of little practical value except from an historical standpoint. It is sincerely hoped that this report will attain its main object, *i.e.*, the presentation of the life history of the scallop and the needs of the industry in such a light to the fisherman that he will realize the great necessity of the preservation of the "seed" scallop for the maintenance of the fishery. At regular intervals, for instance every five years, small pamphlets containing up-to-date information concerning methods of developing the fishery, as regards implements, marketing, utilization of waste, etc., should be distributed among the scallopers.

Besides the utilization of the waste parts, the uses of which at the present time have been enumerated under the food value of the scallop, the market can be improved in three ways: (1) To do away with the marketing of "soaked" scallops by the co-operation of the dealers and the payment of a proportional increase in price per gallon for "dry" scallops from the fisherman. (2) Co-operation between commission merchants and scallopers, which would result in better satisfaction in both goods and prices, and do away to some extent with that great bugbear, "uncertainty of returns," which is so discouraging to the fisherman and makes the fishery a lottery. (3) To increase the popular demand for scallops by wider fields through the transportation facilities and advertising.

The methods of capture will slowly improve. No suggestions can be offered here for improvements in dredges, etc., as each locality has conditions peculiar to itself. The description of the different styles of dredges in the various localities may cause innovations in certain sections which have fallen in that rut of custom so prevalent in our fishing towns. During the last few years the gasolene dredger has gradually replaced the sail, and while dredging with sail will probably remain, it will be in combination with power, as in power catboats, resulting in a partial revolution in scalloping methods.

The question of just and fair laws has been an important factor in the fishery. While in the past all laws have not met this standard, the tendency at the present time and for the future is improvement in simplicity and justice, with the sole aim of preserving the fishery, serving the consumer and protecting the fisherman.

CHAPTER VII — METHODS OF INVESTIGATION

Owing to the different classes of readers, and with a desire to present the material so that it will be intelligible to all, it has seemed best to "cull" from the main portions of the report the various methods, tables, etc., which were used in its preparation, and to incorporate them in a reference chapter, where, though accessible, they will not interfere with the continuity of the narrative. In this way the report is made more interesting to the fishermen and general public, without detracting from its scientific value. Throughout the paper constant reference is made to the contents of this chapter, for the purpose of avoiding repetition and unnecessary description.

The chapter is mainly divided into: (1) methods used in obtaining the early embryology and life history; (2) methods of conducting the growth experiments; (3) tables; (4) glossary; and (5) bibliography.

Embryological Methods.

It is hardly necessary to describe in detail the general method of investigation of the early life history of the scallop. It is sufficient to state that the usual methods of microscopic study, camera lucida drawings, various micrometers, preparations, fixatives, etc., were employed, while the material was obtained in a variety of ways, as is hereafter described. The investigation on the life history was carried on at Monomoy Point during the summers of 1906, 1907, 1908, and 1909, and at Wellfleet in 1908. Only those methods are here described which especially apply to the scallop or show some peculiarity which rendered them of value in this investigation.

Method of measuring the Scallop Egg. — The size of the mature scallop eggs was determined with the aid of camera lucida drawings and a standard stage micrometer. This work was done with oculars 1 and 2 and objectives ⅔ and ⅙, Bausch and Lomb microscope, the camera lucida and stage micrometer also being obtained from the same firm. The average measurements of several batches of eggs, hatched in 1906 at Monomoy Point, just previous to fertilization, gave the long diameter as $1/15.58$ millimeter ($1/396$ of an inch) and the short diameter as $1/16.66$ millimeter ($1/423$ of an inch). These measurements do not correspond with those made by Risser (2), who found the size to be $1/6000$ of an inch, or about one-fifteenth as large as the measurements made in this investigation.

Method of determining the Number of Eggs produced by the Average Scallop in One Season. — How many eggs does a scallop contain at time of spawning? The answer varies with the size of the scallop, a large specimen possessing many times the number in a small one. For the purpose of determining two sizes were used, (1) small, 40 millimeters (1⅗ inches), (2) large, 68 millimeters (2¾ inches). Taking $1/16$ of a millimeter ($1/400$ of an inch) as the average diameter of a scallop egg, the number of eggs in a cubic millimeter can be estimated as 4,096, and as there are 1,000 cubic millimeters to 1 cubic centimeter, there would be 4,096,000 eggs to 1 cubic centimeter. As it is estimated that one-fourth of the volume is taken up by egg capsules and tissue, it can be safely stated that there are at least 3,000,000 eggs to 1 cubic centimeter. The second operation consists in removing the ovaries from a number of scallops of a given size and measuring them in graduates to determine the volume of the average ovary. From this data the average number of eggs that a scallop of any size is capable of producing can be readily calculated. Twenty ovaries of scallops measuring 40.15 millimeters in size made 10 cubic centimeters, one specimen thus averaging ½ cubic centimeter. Therefore, a 40-millimeter scallop can produce about 1,500,000 eggs in a season. The average of seven 68-millimeter scallops made the ovaries of one equal to 1³⁄₇ cubic centimeters. Therefore, a 68-millimeter (2.7 inches) scallop may produce in a season 4,285,700 eggs.

At best this calculation is only an estimate. Exactness would be of little practical value. The errors which arise are as follows: (1) In computing the number of eggs to the cubic millimeter the eggs are considered as spheres with intervening spaces, whereas in reality they are packed together in distorted shapes in the ovary. This perhaps offsets the second error. (2) In the second part of the computation the coils of the digestive tract, left in the ovary, are not allowed for, and with the outer covering are included in the total volume. (3) Another error arises from the fact that all the eggs may not be as large as the mature ones. (4) There is also the room taken by the egg capsules and tissues. Whether these errors offset each other, or whether the one-fourth allowance is correct, it is impossible to state. However, for all practical purposes the method and count are accurate enough.

Method of determining the Number of Spermatozoa produced by the Average Scallop in One Season. — The method of finding the number of spermatozoa in the testes of a scallop is practically the same as in computing the number of eggs in the ovaries. It takes 260 spermatozoa heads placed lengthwise to measure 1 millimeter, and 500 heads placed side by side to measure the same distance. It therefore takes 65,000,000 to make a volume of 1 cubic millimeter. By a generous allowance of 15,000,000,000 for tails and tissue there would still be left 50,000,000,000 spermatozoa to every cubic centimeter. It was found that the size of the testes and the ovaries in the same scallop was practically identical, and that the testes of a 40-millimeter and a 68-millimeter scallop measured ½ cubic centimeter and 1³⁄₇ cubic centimeters respectively. Thus the average 40-millimeter scallop is capable of producing 25,000,000,000 and the 68-millimeter scallop 71,400,000,000 spermatozoa.

Methods of recording Spawning. — A variety of methods were employed in determining the spawning of the scallop. Chief among these were (*a*) general observation at the various scalloping localities of the coast; (*b*) microscopic examination of the eggs from the ovaries at different seasons; (*c*) the plankton net; (*d*) recording the color of the egg sac by color charts; (*e*) appearance of the young set in the different localities and at different years; (*f*) individual spawning.

(*a*) *General Observation.* — This method was chiefly followed in 1905 and 1906. Trips were made to the various localities, such as Edgartown, Nantucket, Buzzard's Bay, Cape Cod, and the condition of the egg sac of a large number of scallops noted both by eye and by microscopical examination. The condition of the sexual products were then classed under three heads, (1) immature, (2) spawning, (3) spawned, according as to whether the eggs had been liberated at that date. By making several trips during the summer a general idea of the duration of the spawning season and its variation in Massachusetts waters was obtained. This method, though naturally inaccurate in the minor details, nevertheless proved extremely useful.

(*b*) *Microscopical Examination.* — This method was used to more or less extent with (*a*), and was only of additional value in following the development of the immature eggs previous to the spawning season, showing at what period other investigations should be started. The eggs and sperm were removed from the ovary, placed on a slide and their size and appearance recorded, the sperm being classed as (1) active or (2) inactive.

(*c*) *The Plankton Net.* — A small net of silk bolting cloth No. 11, with a diameter of 12 inches, and slightly tapering for 24 inches to a rounded bottom, was used for this work. By towing the net through the water the veliger larvæ, which are abundant during spawning season in the water, could be captured. This is an important method of recording the spawning, as the presence of scallop veligers from two to four days old is proof that the spawning season is under way. By making daily towings under the same conditions and for a definite distance, it was possible to count the number of larvæ in the water each day, and thus determine the conditions influencing the spawning season. Although this method has been of greater value in the work on the other shellfish, as the same method is applicable to lamellibranchs in general, a description is here given.

The plankton net, as shown in Fig. 72, is attached in the form of a bag to a copper ring, to which the tow line is fastened in the same manner as a kite string. The outfit is trailed from the stern of a dory or rowboat for a definite distance at a slow, uniform rate, so that no outward current will sweep away the larvæ from the mouth of the net, which acts as a sieve to collect all microscopic organisms too large to pass through the meshes.

When the proper distance is covered, the net is taken from the water and the contents washed into a small pail containing from 4 to 5 inches of clear sea water. The lamellibranch and gasteropod larvæ are now separated from the rest of the tow contents by giving the water a swift circular movement around the edge of the pail with a small stick. The action of the water forces the larvæ to settle to the bottom at the center of the pail, where they can be readily transferred by a pipette to a watch glass for study.

A convenient means of analyzing the towing similar to the Sedgwick-Rafter method of a diatom counting was devised. The larval contents of the towing was spread evenly throughout a cell 50 by 20 by 1 millimeters, covering an area of 1,000 square millimeters, or a cubic volume of 1 cubic centimeter, and ten counts (1/100 of the total area), each covering an area of 1 square millimeter as measured with a square ocular micrometer, were made from different parts of the cell to get a representative average. The approximate number of larvæ for each species of shellfish was obtained by multiplying the sum of these counts by 100.

(*d*) *The Color Chart.* — The color of the ovaries of a scallop is an excellent test of their maturity, as when distended with ripe eggs they generally have a rich orange hue. Before and during the spawning season all grades of color from a flesh pink to a deep orange can be found. While doubtless there is considerable variation in the color at maturity, the general average is sufficiently constant to warrant using it as a basis for recording the spawning season. By the use of Prang's color chart a record of the spawning of scallops in the different sections was made. At Monomoy Point, by examining the color of the ovaries without injuring the scallop (the valves being merely held wide apart), the same lots of scallops were followed during the entire summer, and the color changes indicative of the spawning season charted at weekly intervals, according to the standard grades of color in the chart.

(*e*) *Appearance of Set.* — By observations of the appearance of the set in different localities, and having already a knowledge of the age of the scallop at this period, the date of spawning could be correctly estimated. The sets, taken on the spat boxes at Monomoy Point, were carefully recorded for four years, and in other localities when opportunity was given.

(*f*) *Artificial Spawning.* — In order to obtain accurate data as to the spawning of individual scallops the following method was employed: a large glass aquarium containing fresh sea water was placed on the warm sand in the sunlight. Small glass jars, each containing enough sea water to cover a scallop, were placed near the aquarium. The scallops were gently scrubbed with a brush, rinsed in a pail of clean salt water, and placed one in each of the small jars, under which dark paper was placed to facilitate detection of spawn. The usual number under observation at any one time was 16, which proved the most convenient number to watch. In order to prevent injury to the developing eggs by contact with metal the temperature was taken from a separate jar containing the same amount of water. The temperature of the water was taken at the time the scallops were put in and at the discharge of the first lot of spawn. At each spawning the contents of the small jar was transferred to a bottle labeled with the number of the scallop, number and time of discharge, and examined microscopically to determine whether eggs, spermatozoa or both were liberated. The animal and dish were rinsed in the pail, fresh water of the same temperature was taken from the aquarium, and the scallop returned to its former position.

Artificial Fertilization. — Two methods of artificial fertilization have proved most satisfactory in the study of shellfish larva: (1) removal of the sexual products by cutting; (2) forcing the spawning, although the former is not as successful with the scallop as with the oyster, as there are certain drawbacks, such as the crushing of the eggs, abnormal development, non-fecundation of the numerous immature eggs, and sacrificing the parent. The other method (forced spawning) is accomplished by transferring the scallops from cool to warmer water, which causes the ripe eggs to be extruded in a more natural manner. Spawn could be obtained at any time during the season if the temperature was satisfactory, and the same scallops could be used over and over.

In raising the larvæ for laboratory study the aquaria should be kept clean, a relatively large amount of water for a few larvæ should be allowed, as crowding results in death, and the decomposing eggs, if not separated by siphoning off the surrounding embryos, soon cause the death of all. With every precaution the death rate is very high, owing to the débris, parasitic protozoa, bacteria, etc., which collect in the water, but there is good reason to believe that by careful experiment scallops can be raised in numbers in the laboratory, although during this investigation only a few were successfully carried to the post-embryonic stage.

Artificial Propagation. — The object of artificial propagation is the prevention of the great "infant mortality," as under natural conditions but $\frac{1}{30,000}$ of 1 per cent. of the number of eggs develop into mature scallops. Artificial fertilization and the protection of the young embryos during the first few days of life would to a large extent do away with this great loss; but the practical difficulties in successfully rearing the larvæ over this period are such as to make the undertaking problematic. At the present time liberation of the eggs immediately after artificial fertilization seems to be of most benefit to the fishery.

The Rate of Growth.

Methods of measuring the Scallops. — Three measurements were made of each scallop (Fig. 65): (1) *height,* along the dorso-ventral axis, or from the hinge to the opposite edge of the shell; (2) *width,* along the antero-posterior axis, or from the left to right edge of the shell; (3) *thickness,* along the lateral axis, or the depth through the valves.

The growth of any mollusk can only be accurately stated by determining the gain in volume. As it was obviously impossible to obtain the water displacement of the scallop with its loose shell, the following method of calculating the volume was devised: the three dimensions of the scallop were multiplied together and the result called the *cubic volume,* equivalent to the volume of a solid rectangular prism of those dimensions, in which the scallop is theoretically enclosed. Thus the following proportion can be established: scallop A of cubic volume 1,000 is to scallop B of cubic volume 5,000 as 1,000 is to 5,000 (A:B::1,000:5,000). Thus scallop B is five times, or 500 per cent., larger than scallop A, and the relative per cent. of increase is obtained with the same results as if the water displacement had been taken. By taking several hundred measurements of width and thickness for scallops of the same height a table has been formulated, giving the average width, thickness and cubic volume for every sized scallop. Thus having given the height of any scallop, the cubic volume can be found and any gain in length transformed into gain in volume.

Measuring Instrument. — For speed, exactness and uniformity in measuring large numbers of scallops it was necessary to have a suitable measuring implement. (Fig. 105.) The instrument, designed for this work by the writer, consists of an inverted triangle, formed by two strips of metal welded together at the apex of the triangle, and joined at the base by a short cross piece. The whole instrument is made of brass except the braised joint, and can be made as light as desired, although there is danger of a heavy blow rendering a light measurer inaccurate. Several sizes were used in the work, the most convenient having a base measuring 3 inches. On the sides of the triangle the scale is marked in millimeters. The measure is scaled in a simple manner by taking across the broad end a certain width in millimeters, measuring the length of the instrument, and subdividing it into a certain number of equal parts, each corresponding to 1 millimeter. This gives easier and more accurate readings as it is possible to read to ⅕ of a millimeter with the same accuracy as to 1 millimeter on an ordinary rule, each division on the triangle having actual measurement of nearly 5 millimeters. When measuring, the triangle is held with the base away from the body, and the object is brought down the narrowing sides until it strikes, at which point the measurement is read.

The value of the instrument arises from the rapidity with which measurements can be made, as only one movement is required to record the length of an object. Measurements could be made nearly twice as fast as by using calipers, where two movements are required. A proficient person can measure as high as 400 scallops per hour, three measurements being taken for each scallop, or a total of 1,200. The ordinary person can measure about 300 in the same time, or 5 scallops per minute. This instrument can be used for measuring a variety of objects, and students of variation, where rough measurements are alone required, will find it of great convenience.

Growth Experiments. — The growth experiments were carried on in two ways: (1) by measurements at definite periods of the various sets in the different waters of the Commonwealth; (2) by growth in pens at Monomoy Point, Monument Beach, Marion and Chatham.

In the first case the work chiefly consisted of measurements, taken as described above, of a large number of scallops at each time, so as to obtain a correct average. During the first year three measurements of each scallop were made, until sufficient material was at hand to formulate Table D. Afterwards only one measurement, the height, was taken, as the gain in volume for any locality could be determined from the table. The growth line proved of great assistance, as the increase from May 1 at any date could be determined by making two measurements, (1) the height, and (2) the growth line.

Tagged Scallops. — A method of recording the growth of individual scallops as well as obtaining data upon their migratory habits was obtained by "tagging" each specimen. A small hole was punched through the "ear" close to the hinge line, and a numbered copper tag was attached by a fine wire, as in Fig. 66. The scallops were then liberated in the Powder Hole, after their measurements were taken. Whenever found, the number and size were recorded, thus obtaining the exact growth of the individual specimens. The tag apparently did not interfere with the growth or movements of the animals.

Another method of identification was used in the pens. The scallops were notched with a file across one valve, the number of notches giving the class of the scallop when more than one size were confined in the pen.

The Pens. — Most of the growth experiments were conducted in pens (Fig. 80), as the activity of the scallop rendered confinement necessary. In this way, under what might be termed artificial conditions, the rate of growth of *Pecten irradians* was obtained in several localities. The pens were of two kinds: (1) of 1¼-inch wire chicken netting; (2) of old seines. They were constructed by driving in the soil posts of 2 by 3 inch joist, at sufficient intervals to hold the netting firmly in position. When wire netting was used little difficulty was experienced in making the bottoms of the pens tight to prevent the escape of the scallops, as the netting set firmly on the soil, which had previously been leveled. When seines were used the bottom was secured either by baseboards or by fastening the netting by long wooden pegs, an uncertain method at best. The pens were made either of a sufficient height to rise above the average tide, which was possible at Chatham and Monomoy Point, where there is a comparatively small rise and fall of the tide, or were fitted with netting tops when the tide proved high, as at Marion and Monument Beach. The pens, which ranged from 40 to 400 square feet in size, were situated in water from 1 to 2½ feet in depth at low tide, and under a variety of conditions as regards current, soil, eel grass and tide.

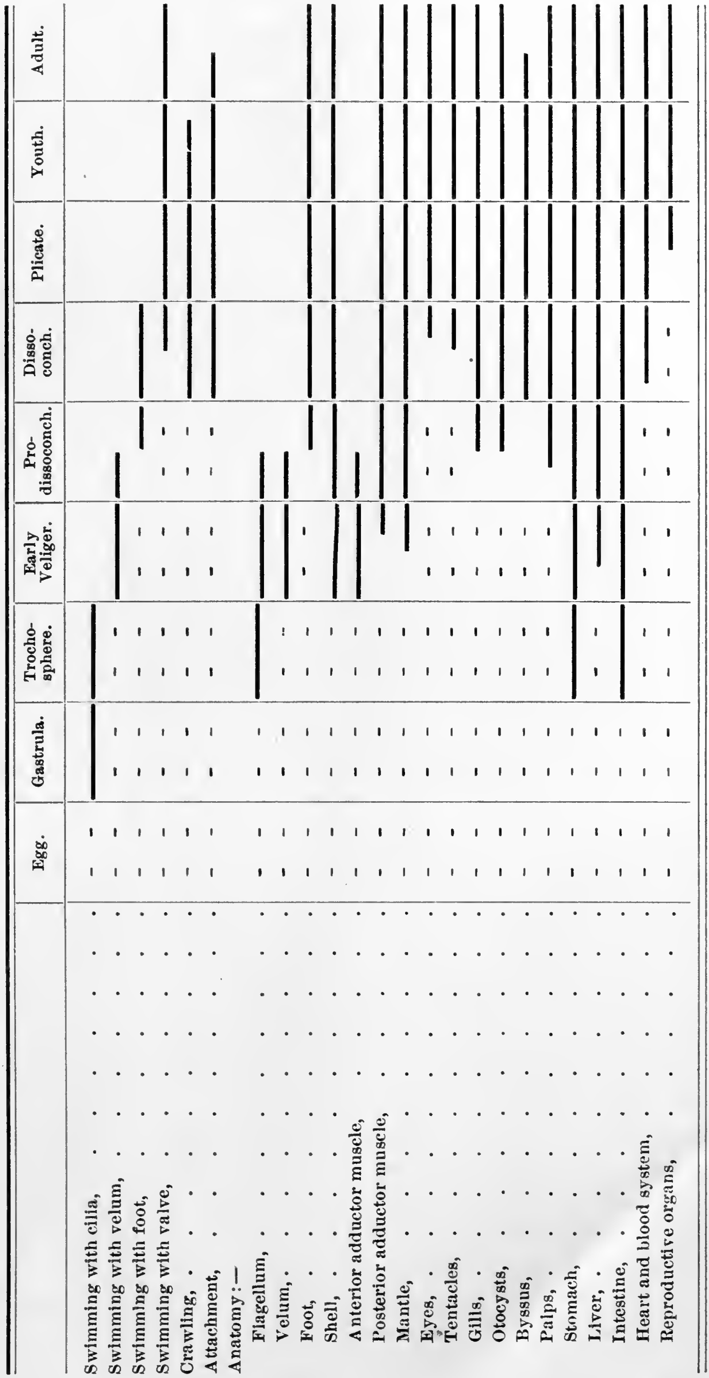
Wire Cages. — Scallops were suspended in wire cages (Fig. 71) from a raft in the Powder Hole, Monomoy Point, in order to obtain the rate of growth, especially of the young "seed," too small to confine in pens. The baskets consisted of a wooden framework, 2½ feet long, 1½ feet wide, 1 foot deep, covered by netting with ¼ to 1¼ inch mesh. Smaller cages were used for the young scallop with galvanized mosquito netting. The objection to the use of a small mesh is due to the restriction of the water circulation by the clogging of the fine meshes by plant growth. This was avoided as much as possible in the growth experiments by frequently cleaning the cages, and transferring the small scallops as soon as their size permitted to the larger cages. In spite of this care the growth of the "seed" inside the cages proved less than those attached outside. Old scallops, as well as young, were confined in the baskets for growth records.

The Biological Raft. — The raft (Fig. 79) from which the wire baskets were suspended proved particularly useful in the study of the post-embryonic life history of the scallop, which "set" in numbers on the boxes, wire cages and ropes, where specimens could be obtained in all stages of development for laboratory examination. From the raft at various depths were suspended wire cages and boxes, in which growth experiments upon the quahaug, clam and scallop were conducted. The raft, 20 feet long by 10 feet wide, was made of two 4 by 6 inch beams, 20 feet long, which were held in place by cross beams, 3 by 4 inches in size. On the framework was a floor, except for a large central "well." Four trapdoors led to smaller "wells" on each side. The raft was buoyed by six oil barrels, two on each end and two on the sides, and was moored in the Powder Hole in 20 feet of water. The scheme of box spat collecting from a raft is recommended to biological students, as the young of many worms, crustaceans, mollusks and other marine forms are caught easily in sand boxes.

A. *Life Table.*

Stage.	Age.	Shape.	Size (Inches).	Movement.
Egg,	–	Spherical,	1/400,	None.
Two cells,	46 minutes,	–	1/400,	None.
Four cells,	67 minutes,	–	1/400,	None.
Eight cells,	81 minutes,	–	1/400,	None.
Sixteen cells,	100 minutes,	–	1/400,	None.
Blastula,	9 hours,	Mulberry,	1/400,	None.
Ciliated gastrula,	10 hours,	–	1/400,	Cilia.
Trochosphere,	12 hours,	Elongate,	1/400,	Cilia and flagellum.
Early veliger,	40 hours,	Flat hinge,	1/275,	Velum.
Late veliger,	5 days,	Umbones,	1/152,	Foot.
Dissoconch,	8 days,	Scallop,	1/152 to 1/20,	Foot.
Plicated,	20 days,	Scallop,	1/20 to 1/5,	Foot and valves.
Youth,	Up to 1 year,	Scallop,	1/5 to 1 3/8,	Valves.
Adult,	Over 1 year,	Scallop,	1 3/8 to 2 1/2,	Valves.

B. Life Table.



Egg.
Gastrula.
Trocho-sphere.
Early Veliger.
Pro-dissoconch.
Disso-conch.
Plicate.
Youth.
Adult.
Swimming with cilia,
Swimming with velum,
Swimming with foot,
Swimming with valve,
Crawling,
Attachment,
Anatomy:—
Flagellum,
Velum,
Foot,
Shell,
Anterior adductor muscle,
Posterior adductor muscle,
Mantle,
Eyes,
Tentacles,
Gills,
Otocysts,
Byssus,
Palps,
Stomach,
Liver,
Intestine,
Heart and blood system,
Reproductive organs,

C. Stages of Development.

In order to give a brief consecutive narrative to the life history of the scallop it was found necessary to confine the detailed descriptions of the period following the time of "set" to the reference portion of the report. For this purpose the life of the young scallop during the dissoconch and the plicated stages has been arbitrarily divided into eight periods. The chief characteristics of each of these periods are described in tabulated form and refer to the drawings of the early stages. In making the divisions the shell has been taken as the standard, and each stage is differentiated by some change in formation.

	1.	2.	3.	4.	5.	6.	7.	8.
Figures,	19, 20.	21, 22, 23.	24.	25, 26, 27, 28.	29, 30.	31, 32.	33, 34.	35, 36, 37.
Character,	No strip across byssal notch.	1 strip across byssal notch.	2 to 3 strips across byssal notch.	No teeth on byssal notch.	1 tooth on byssal notch.	2 teeth on byssal notch.	Plications begin.	Plicated stage.
Age,	1 day after set.	2 days after set.	3 to 4 days after set.	6 to 8 days after set.	9 to 10 days after set.	12 to 14 days after set.	16 to 18 days after set.	20 to 22 days after set.
Size,	.2 by .246 of a millimeter.	.24 by .29 of a millimeter.	.33 by .4 of a millimeter.	.63 by .75 of a millimeter.	.95 by 1.11 millimeters.	1 by 1.15 millimeters.	1.25 by 1.25 millimeters.	1.4 by 1.4 millimeters.
Lines of growth,	None.	1.	2 to 3.	5 to 7.	9 to 12.	10 to 13.	11 to 14.	11 to 14.
Hinge line,	Straight (10 pairs teeth); length, 135.	Straight; length, 156.	Slightly curved.	Straight.	Straight.	Straight.	Straight.	Straight.
Left valve,	More convex than right.	More convex than right.	More convex than right.	More convex than right.	More convex than right.	More convex than right.	More convex than right.	Same curvature as right.
Right valve,	Prismatic structure.	Prismatic structure.	Prismatic structure.	Prismatic structure.	Prismatic structure.	Prismatic structure.	Plicated growth not prismatic.	Plicated growth not prismatic.
Byssal notch,	Just formed.	Present.	Present.	Present.	Present.	Present.	Present.	Present.
Byssal groove,	None.	1 strip.	2–3 stripes.	Present.	Present.	Present.	Present.	Present.
Byssal teeth,	None.	None.	None.	None.	1.	2.	4.	5.
Color,	None.	None.	None.	None.	Beginning.	Present.	Present.	Present.
Mantle,	Simple.	Simple.	Simple.	Complex.	Complex.	Guard flap.	Guard flap.	Guard flap.
Tentacles,	None.	None.	None.	9 primary.	Primary and secondary.	Primary, secondary, tertiary.	Primary, secondary, tertiary.	Primary, secondary, tertiary.
Eyes,	None.	None.	None.	Beginning.	9.	9.	15.	21.
Pseudo-siphon,	None.	None.	None.	None.	Present.	Present.	Present.	Less conspicuous.
Gills,	4 filaments.	4 large, 3 small filaments.	6 large, 3 small filaments.	14.	19 inner, 7 outer.	22 inner, 10 outer.	Numerous inner, 20 outer.	Numerous inner, 25 outer.
Foot,	Ciliated tip.	Ciliated tip.	Ciliated tip.	Ciliated tip.	Ciliated tip.	Ciliated tip.	Ciliated tip.	Ciliated tip.
Byssal gland,	Present.	Present.	Present.	Present.	Present.	Present.	Present.	Present.
Otocyst,	Present.	Present.	Present.	Present.	Present.	Present.	Present.	Present.
Blood system,	No heart beat seen.	No heart beat seen.	No heart beat seen.	Heart conspicuous.	Heart conspicuous.	Heart conspicuous.	Heart conspicuous.	Heart conspicuous.
Adductor muscle.	Posterior.	Posterior.	Posterior.	Posterior.	Posterior.	Posterior.	Posterior.	Posterior.
Digestive tract,	Simple coil of intestine.	Simple coil of intestine.	Simple coil of intestine.	Coiled.	Coiled.	Coiled.	Several coils.	Several coils.

NOTE.—Rate of growth from this time on varies with the conditions under which the scallop is placed, *i.e.*, its environment.

D. Comparative Table of Size and Volume.

In the following table of scallops from 1 to 80 millimeters for each size (height), the average width and thickness are taken from the measurements of many specimens. *Height* is the measurement along the dorso-ventral axis, or from the hinge to the opposite edge of the shell; *width,* along antero-posterior axis, or from the left to right edge of the shell; *thickness,* along the lateral axis, or the depth through the valves. The cubic volume is expressed in cubic millimeters as *height* times *width* times *thickness.* For each size the number per quart is given in the fifth column. This table proved very useful in determining the gain in volume in the planted beds and in the localities under observation, as by merely having the original size and increase in *height,* the gain in volume could be readily calculated.

Height.	Width.	Thickness.	Cubic Volume.	Number per Quart.	Height.	Width.	Thickness.	Cubic Volume.	Number per Quart.
1	1.0	.2	.2	7,927,275.00	25	25.0	8.9	5,563.0	285.00
2	1.8	.5	1.8	880,820.00	26	26.0	9.3	6,287.0	252.20
3	2.7	.8	6.5	243,960.00	27	27.0	9.7	7,071.0	224.20
4	2.6	1.1	11.4	138,596.00	28	28.1	10.1	7,947.0	199.50
5	4.5	1.5	33.8	45,898.00	29	29.2	10.5	8,891.0	178.30
6	5.4	1.8	58.3	27,195.00	30	30.3	11.0	9,999.0	158.30
7	6.3	2.1	92.6	17,123.00	31	31.4	11.5	11,194.0	141.60
8	7.3	2.5	146.0	10,859.00	32	32.5	11.9	12,376.0	128.10
9	8.3	2.8	209.0	7,583.00	33	33.6	12.4	13,749.0	115.30
10	9.3	3.1	288.0	5,506.00	34	34.7	12.9	15,219.0	104.20
11	10.2	3.4	382.0	4,150.00	35	35.8	13.3	16,665.0	95.00
12	11.2	3.8	511.0	3,103.00	36	36.9	13.7	18,199.0	87.10
13	12.2	4.1	650.0	2,439.00	37	38.0	14.1	19,825.0	80.00
14	13.2	4.4	813.0	1,950.00	38	39.2	14.5	21,599.0	73.40
15	14.2	4.8	1,022.0	1,551.00	39	40.4	15.0	23,634.0	67.10
16	15.3	5.2	1,273.0	1,245.00	40	41.6	15.5	25,792.0	61.40
17	16.4	5.6	1,561.0	1,016.00	41	42.8	16.0	28,077.0	56.50
18	17.5	6.0	1,890.0	838.80	42	43.9	16.5	30,423.0	52.10
19	18.6	6.4	2,262.0	700.90	43	45.0	17.0	32,895.0	48.20
20	19.6	6.8	2,666.0	595.60	44	46.2	17.5	35,574.0	44.60
21	20.7	7.2	3,130.0	506.40	45	47.4	18.0	38,394.0	41.30
22	21.8	7.6	3,645.0	434.90	46	48.6	18.5	41,359.0	38.50
23	22.9	8.0	4,214.0	376.20	47	49.8	19.0	44,471.0	35.65
24	23.9	8.5	4,876.0	325.20	48	50.9	19.5	47,642.0	33.30

Height.	Width.	Thickness.	Cubic Volume.	Number per Quart.	Height.	Width.	Thickness.	Cubic Volume.	Number per Quart.
49	52.1	20.0	51,058.0	31.00	65	70.3	29.6	135,257.0	11.72
50	53.2	20.5	54,530.0	29.10	66	71.4	30.2	142,314.0	11.14
51	54.4	21.1	58,540.0	27.20	67	72.6	30.8	149,817.0	10.58
52	55.5	21.7	62,626.0	25.30	68	73.8	31.5	158,080.0	10.03
53	56.7	22.3	67,014.0	23.65	69	75.0	32.2	166,635.0	9.51
54	57.9	22.9	71,599.0	22.15	70	76.2	32.9	175,489.0	9.03
55	59.1	23.5	76,387.0	20.75	71	77.4	33.7	185,195.0	8.56
56	60.3	24.1	81,381.0	19.50	72	78.6	34.5	195,242.0	8.12
57	61.4	24.7	86,445.0	18.34	73	79.8	35.2	205,054.0	7.73
58	62.5	25.3	91,713.0	17.30	74	81.0	35.9	215,184.0	7.37
59	63.6	25.9	97,187.0	16.30	75	82.1	36.6	225,364.0	7.03
60	64.7	26.5	102,873.0	15.40	76	83.2	37.3	233,855.0	6.72
61	65.8	27.1	108,774.0	14.58	77	84.4	38.1	247,604.0	6.40
62	67.0	27.7	115,066.0	13.78	78	85.6	38.9	259,728.0	6.14
63	68.1	28.3	121,415.0	13.06	79	86.8	39.7	272,231.0	5.82
64	69.2	29.0	128,435.0	12.34	80	88.0	40.3	285,120.0	5.56

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GLOSSARY.

Adductor muscle,	Muscle which draws the two valves (shells) together.
Anterior,	Front.
Archenteron,	Primitive or original digestive tract.
Asymmetrical,	Not symmetrical.
Auricle,	A chamber of the heart.
Bathymetrical,	Relating to the depth in the sea.
Blastopore,	The opening into the archenteron.
Blastula,	An early stage in the development of the embryo, in which the outer cells form a definite layer.
Byssus,	Thread-like fibers secreted by the foot for attachment.
Cell,	The unit structure of life.
Cilia,	Filamentous protoplasmic processes.
Cleavage,	Natural division of the egg cells.
Cloacal chamber,	Space into which waste material is discharged before passing out the excurrent siphon.
Crystalline style,	A transparent gelatinous rod which lies along the upper part of the intestine.
Cytoplasm,	That part of the protoplasm outside of the nucleus.
Diatoms,	Microscopic plants, which constitute the food of the shellfish.
Dimyarian,	Having two adductor muscles, as the quahaug.
Dissoconch,	Literally, two shelled; babyhood shell with no plications.
Dorsal,	Referring to the back of the animal but not necessarily the upper side.
Ectoderm,	The external outer layer of cells.
Egg,	The female germ cell — ovum.
Egg capsule,	Case in which the egg is inclosed.
Embryo,	The first rudiments of an organism.
Endoderm,	The inner cell layer.
Equilateral,	Having all sides equal.
Equivalvular,	When two valves are alike in size and shape.
Exoskeleton,	Outside framework or support, differing from a true skeleton or endoskeleton, which is inside the body.

Fecundation, . .	Impregnation of the ovum by the spermatozoön.
Fertilization, . .	Fecundation.
Flagellum, . . .	A long, whip-like cilium.
Follicle, . . .	A small cavity.
Formative cells, . .	Cells which form the animal in contrast with cells which furnish them with food.
Ganglion, . . .	A mass of grey nervous substance, which serves as a center of nervous influence.
Gastrula, . . .	An embryonic stage which has the form of a double-walled sac with an opening leading into a cavity, the archenteron.
Genus, . . .	Group of species.
Geotropic, . . .	Showing a disposition to incline toward the earth.
Germ cell, . . .	That which is to develop a new individual.
Gills, ...	Respiratory organs in water, comparable to the lungs in air.
Gland, . . .	A cell or collection of cells having the power of secreting.
Hermaphrodite, .	An animal having both male and female generative organs.
Invagination, . .	One of the methods by which the various germinal layers of the ovum are differentiated.
Lamella, . . .	A thin plate or scale.
Lamellibranchiata, .	Animals of the mollusk family that have the gills arranged in leaf-like layers.
Larva, . . .	The animal during its development until it reaches adult size.
Lumen, . . .	An opening, space or cavity.
Macromere, . .	One of the larger cells, resulting from segmentation of the egg.
Micromere, . . .	One of the smaller cells, resulting from segmentation of the egg.
Mantle, . . .	The fleshy, membraneous covering, lining inside of the shell.
Mantle cavity, . .	The space between the mantles.
Maturation, . .	The process of ripening or coming to maturity of the egg.
Migration, . . .	Act of traveling from one region to another.
Monomyarian, . .	Having one adductor muscle, as with the scallop and oyster.
Nacreous structure, .	Pearly layer of shell, generally on the inside.
Nucleoli, . . .	Smaller divisions or parts of the nucleus.
Nucleus, . . .	Germinative spot.
Otocysts, . . .	Organs of equilibration.
Ovary, . . .	The organ of a female in which the eggs are formed.
Ovum, . . .	The egg.
Pecten, . . .	Scientific name of the scallop.
Pericardium, . .	Membrane inclosing the heart.
Posterior, . . .	Opposite to anterior.

Prismatic structure, .	Shell made up of prisms.
Prodissoconch, . .	Small embryonic shell of a mollusk.
Protandric, . .	Having male sexual organs while young, and female organs later in life.
Protoplasm, . .	Cell contents — life substance.
"Seed" scallop, . .	A scallop less than one year old.
Set, ...	Attaching of scallop by byssus.
Spawning, . . .	To set free the eggs or spermatozoa.
Spermatozoön, . .	The male sex cell.
Tentacle, . . .	A more or less elongated process, usually an organ of sense or motion.
Testis, . . .	The male gland which produces the spermatozoa.
Trochosphere, . .	Stage in embryonic development, in which the embryo is spherical and rotates rapidly.
Umbo, . . .	The beak or "shoulder" of the bivalve shell.
Valves, . . .	Two valves, the right and left, compose the shell of a lamellibranch mollusk.
Veliger, . . .	Stage in embryonic development in which velum is used as an organ of locomotion.
Velum, . . .	A circular pad covered with cilia and used as an organ of locomotion in the early embryonic stages.
Ventral surface, . .	The side opposite the dorsal surface.
Ventricle, . . .	A chamber of the heart.
Visceral mass, . .	That part of body containing digestive, generative and part of circulatory and nervous systems.

INDEX.

INDEX.

ABBREVIATIONS.

a. — anus.
aa. — anterior adductor muscle.
b. — byssus.
bg. — byssal gland.
bgr. — byssal groove.
bn. — byssal notch.
d. — dissoconch.
di. — distal end.
er. — "ear."
f. — foot.
fc. — foot cleft.
fg. — foot groove.
fl. — flagellum.
fr. — foot retractor muscle.
g. — gills.
h. — hinge line.
ht. — heart.
i. — intestine.
ig. — inner gills.
l. — liver.
lp. — labial palps.
m. — mantle.
mf — mantle flap.
mt. — mouth.
o. — otocyst.
og. — outer gills.
ov. — ovary.
pa. — posterior adductor muscle.
pc. — polar cells.
pd. — prodissoconch.
pl. — plicated growth.
pm. — primitive mouth.
pr. — proximal end.
ps. — pseudo-siphon.
r. — retractors of velum.
s. — stomach.
sg. — shell gland.
t. — tentacles.
te. — teeth.
ts. — testis.
v. — velum.
vm. — visceral mass.
yl. — yolk lobe.

Fig. 1. — Mature egg ready for union with male cell. Magnified 600 diameters.

Fig. 2. — Spermatozoa (male cells). Note length of tail and variation in shape of head. The spermatozoön on the left is the most common form. No attempts were made to study the minute anatomy. Magnified 600 diameters.

Fig. 3. — Compressed egg. Shape due to pressure of eggs within ovary. Shortly after extrusion it becomes spherical. Magnified 600 diameters.

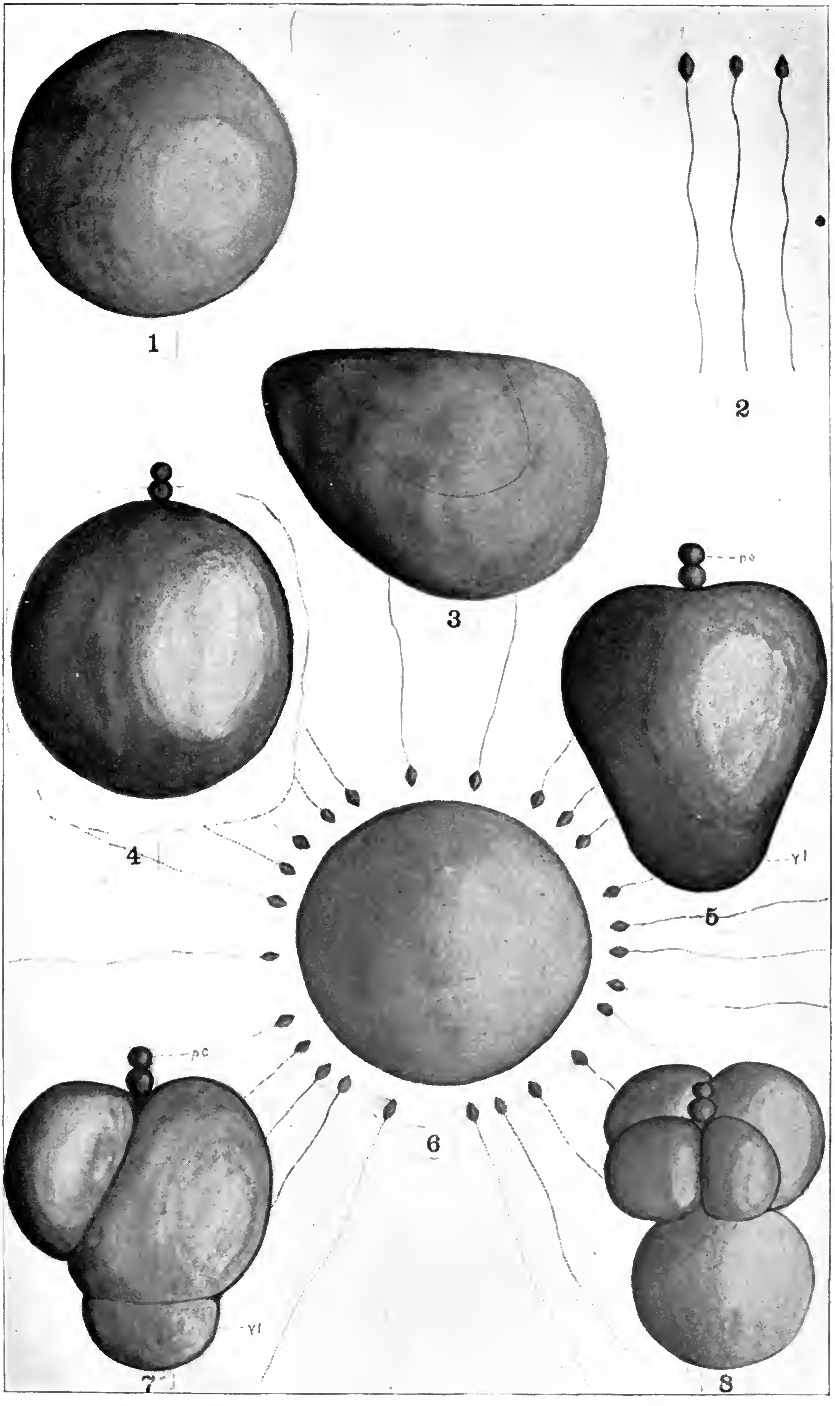
Fig. 4. — Egg enclosed in membranous case. Magnified 600 diameters.

Fig. 5. — Egg, forty-three minutes after fecundation, showing the yolk lobe (yl) and two polar cells (pc). The formation of the yolk lobe has given to the egg a pear-shaped appearance. Magnified 600 diameters.

Fig. 6. — Ring of spermatozoa with radiating tails held away from the egg by a membrane. The entire surface of the membrane is covered by the spermatozoa, but only those in one plane are here shown. Magnified 600 diameters.

Fig. 7. — Two-celled stage, forty-six minutes after fecundation, showing unequal division. The larger cell contains the yolk lobe (yl). Magnified 600 diameters.

Fig. 8. — Four-celled stage, sixty-seven minutes after fecundation. Magnified 600 diameters.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pc
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Yl
6
pc
Yl
7
8

Fig. 9. — Eight-celled stage, side view, eighty-one minutes after fecundation. Magnified 600 diameters.

Fig. 10. — Sixteen-celled stage, viewed from below, one hundred minutes after fecundation. Note large yolk cell. Magnified 600 diameters.

Fig. 11. — Blastula stage, viewed from below, about nine hours after fecundation. The original egg has developed, by repeated divisions, into a mass of cells, giving it a mulberry-like appearance. The large yolk cell has divided into four macromeres, the rest of the cells constituting the micromeres. Magnified 600 diameters.

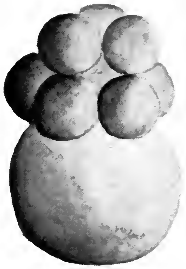
Fig. 12. — Ciliated gastrula, ten hours after fecundation. The embryo can now swim through the water by means of the hair-like cilia. The larger cells have become invaginated. Magnified 600 diameters.

Fig. 13. — Optical section of ciliated gastrula. Magnified 600 diameters.

Fig. 14. — Trochosphere stage, twelve to fourteen hours after fecundation. The body has elongated and the cilia are now confined to the front end. Note the long feeler or flagellum, which serves to guide the animal. The opening of the primitive mouth can be seen on the lower side, while above is a slight indentation corresponding to the beginning of the shell gland. Magnified 600 diameters.

Fig. 15. — Formation of the shell, which arises at two symmetrical points of calcification, right and left of the median line, and gradually envelops the animal. Magnified 600 diameters.

Fig. 16. — Early veliger larva, viewed from the side. The animal arrives at this stage from seventeen to forty hours after fertilization, according to external conditions. The duration of this stage is probably from five to six days, during which the animal leads a free swimming life. Magnified 600 diameters.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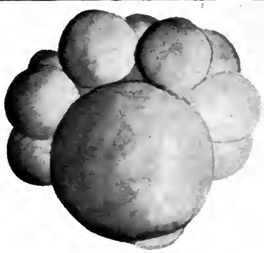
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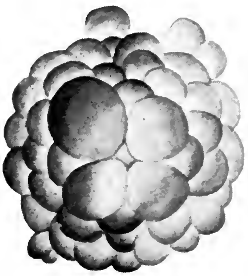
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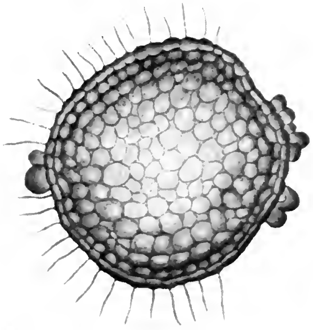
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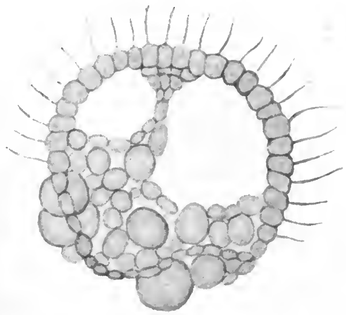
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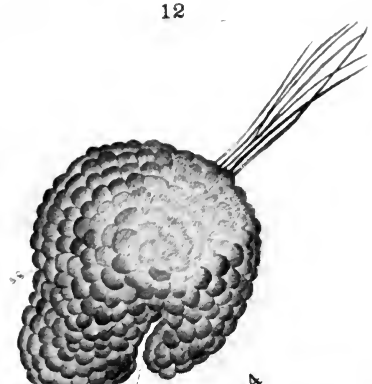
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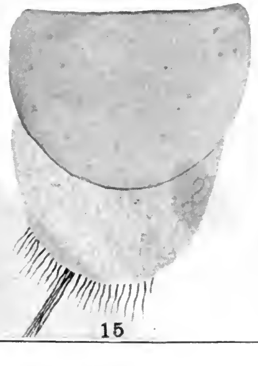
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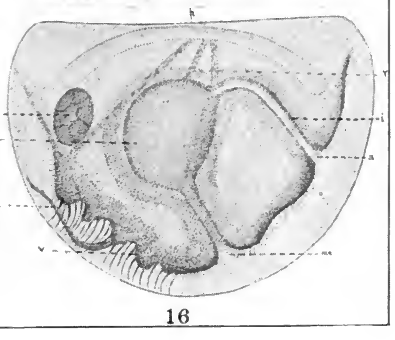
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Fig. 17. — Early veliger swimming with velum extended. Viewed from side. Magnified 150 diameters.

Fig. 18. — Late veliger or prodissoconch. Note change in form of shell, as compared with Fig. 17. This stage marks the end of the embryonic period, as the scallop now forsakes its free swimming life and attaches itself to objects by means of its byssus or "anchor strands." Magnified 150 diameters.

Figs. 19 to 32, inclusive, cover the next distinct stage of development. This form is called "dissoconch," *i.e.*, double shell.

Fig. 19. — Dissoconch Phase 1. Early dissoconch growth after scallop has "set." View of right or lower valve. Note beginning of byssal or foot notch (bn). Scallop is now capable of byssal attachment. Right valve is slightly smaller than left. Magnified 150 diameters.

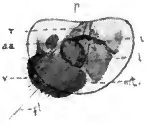
Fig. 20. — View of left valve of same scallop as in Fig. 19. Anatomy shown through transparent shell. Note increased number of gill filaments. Magnified 150 diameters.

Fig. 21. — Dissoconch Phase 2. About two days after "set." View of transparent right valve through which the organs are seen. The right valve is less convex than the left, for aid in crawling. The heart (ht) is observed for the first time during this stage. Note the slower growth of the byssal or foot notch, which is one period behind the growth of the rest of the shell. Note also the increase in the number of gill filaments. Magnified 150 diameters.

Fig. 22. — Internal view of shell of scallop of same age as in Fig. 21, showing ten pairs of small teeth (te), which interlock to form a firm hinge. The shell is inequivalved, *i.e.*, the right valve (upper in illustration) is less concave than the left. Magnified 150 diameters.

Fig. 23. — Internal view of same scallop as in Fig. 21, showing the adductor muscle and foot, the rest of the soft parts having been removed. Scallops of this age often open the shell to an angle of 90°, thus illustrating the flexibility of the adductor muscle. Magnified 150 diameters.

Fig. 24. — Dissoconch Phase 3. View of right valve of scallop about four days after "set," showing anatomy. The left valve projects slightly beyond the right, and the hinge line is inclined slightly upward. Note increased number of gill bars. Magnified 150 diameters.



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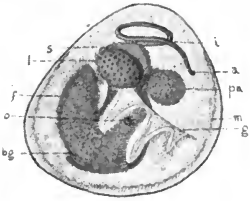

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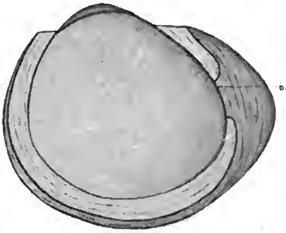

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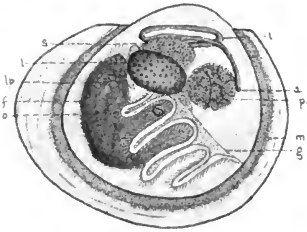

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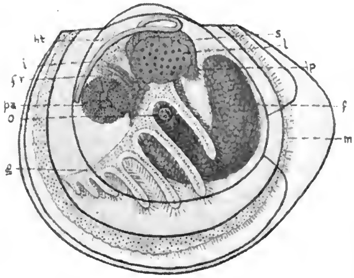

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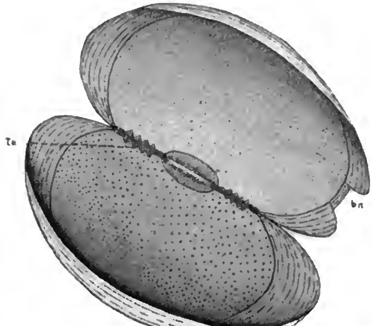

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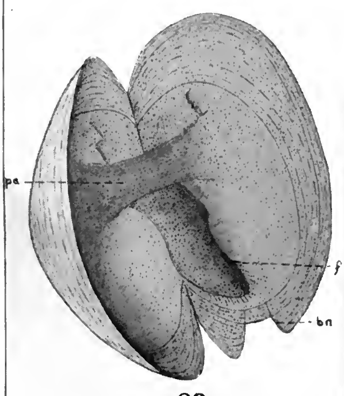

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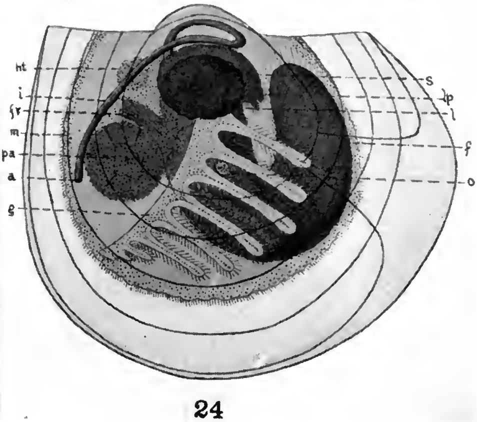

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Fig. 25. — Dissoconch Phase 4. View of right valve of scallop about one week after "set." Note contrast between the prodissoconch (pd) or embryonic shell and the succeeding dissoconch growth (d). A groove has been formed by the growth of the byssal or foot notch (bn), which is increasing in size to correspond with the development of the foot. The right valve is smaller than the left. Magnified 37½ diameters.

Fig. 26. — View of left valve of same scallop as in Fig. 25, showing the lines of growth and the formation of the pseudo-ear, which corresponds to the location of the byssal notch. Magnified 37½ diameters.

Fig. 27. — Same scallop as in Fig. 25, with foot extended. Anatomy shown through transparent left valve. Note increased number of gill filaments (ig) and the well-defined heart (ht). The byssal gland (bg) and cleft have become prominent on foot. The knob-like projections on the mantle are the beginnings of the tentacles (t). Magnified 37½ diameters.

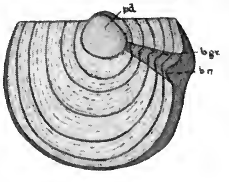
Fig. 28. — View of soft parts of slightly older scallop of Phase 4. Note the nine small tentacles (t), the two eyes (e) and the fourteen gill filaments (ig). Magnified 37½ diameters.

Fig. 29. — Dissoconch Phase 5. Anatomy shown through transparent right valve. This stage is characterized by one tooth in the byssal notch. The scallop is represented as lying in a resting position, with mantle and foot retracted. Note the formation of eight secondary tentacles between the primary, the relative position of the eyes (e) and the tenatcles (t), and the beginning of the outer gills (og). Magnified 37½ diameters.

Fig. 30. — View of same scallop as shown in Fig. 29, as seen through left valve, with mantle (m) expanded and foot (f) extended. The edges of the mantle have joined posteriorly to form a pseudo-siphon (ps), through which water is expelled from the shell. The byssal gland (bg) has a prominent position on the long foot (f). Magnified 37½ diameters.

Fig. 31. — Dissoconch Phase 6. Characterized by two teeth on the byssal notch. View of anatomy through right valve. Tertiary tentacles are developing on the edge of the mantle, which is partially extended. At this age the scallop has about twenty-two inner (ig) and ten outer (og) gill filaments. Magnified 37½ diameters.

Fig. 32. — Scallop of same phase as in Fig. 31, lying on left valve in an unnatural position. The animal has extended his foot (f) for the purpose of turning over. The eyes (e), tentacles (t) and guard flap (mf) can be seen on the edge of the mantle. Magnified 37½ diameters.



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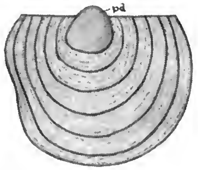

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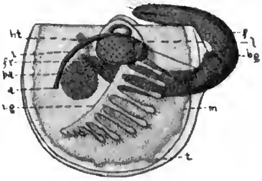

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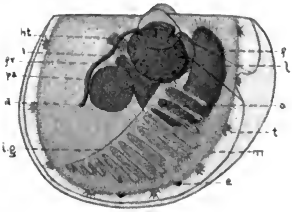

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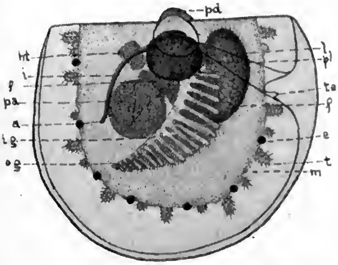

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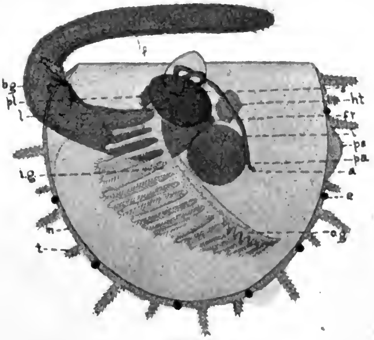

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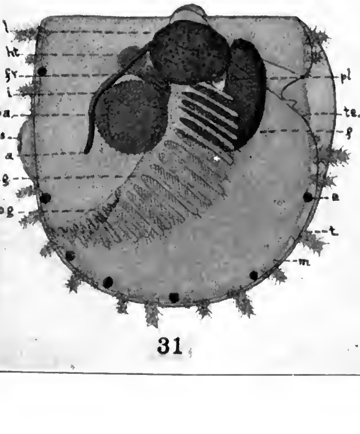

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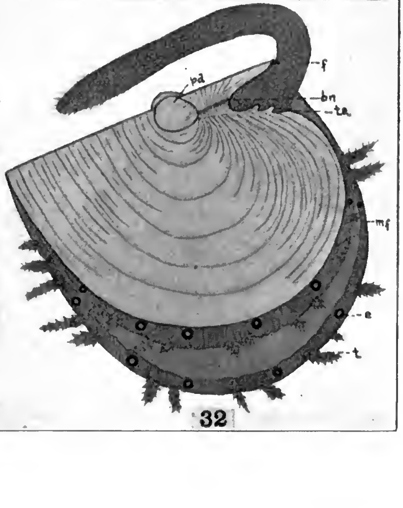

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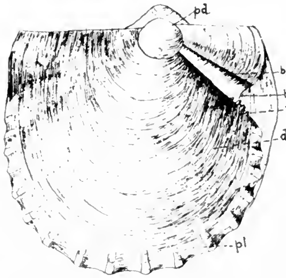
Fig. 33. — Early plicated stage. View of the right or lower valve. Note the smooth prodissoconch (pd) and dissoconch (d) areas, with the beginning of the sixteen plications (pl) of the adult. There are four teeth (te) on the byssal notch. Actual size, 1.25 millimeters ($\frac{1}{20}$ of an inch).

Fig. 34. — Same scallop as in Fig. 33, viewed from left or upper valve. Actual size, 1.25 millimeters ($\frac{1}{20}$ of an inch).

Fig. 35. — View of the anatomy of a slightly older scallop, size, 1.4 millimeters ($\frac{1}{18}$ of an inch), as seen through the right valve. Note primary, secondary and tertiary eyes (e) and tentacles (t). The outer gill (og) has about twenty-five filaments, and begins to resemble the inner gill (ig).

Fig. 36. — View of right or lower valve of same scallop as in Fig. 35. Note the five teeth (te) on the byssal notch (bn) and the beginning of the "ears" (er). The two teeth back of the external border of the byssal groove are older, and have rounded rather than the pointed ends of the last formed teeth. The valves have become nearly equal, the hinge line straight, and the byssal groove (bg) can be traced back to the asymmetrical prodissoconch. Actual size, 1.4 millimeters ($\frac{1}{18}$ of an inch).

Fig. 37. — View of upper left valve of same scallop as in Figs. 35 and 36. Actual size, 1.4 millimeters ($\frac{1}{18}$ of an inch).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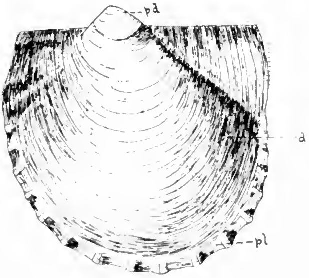
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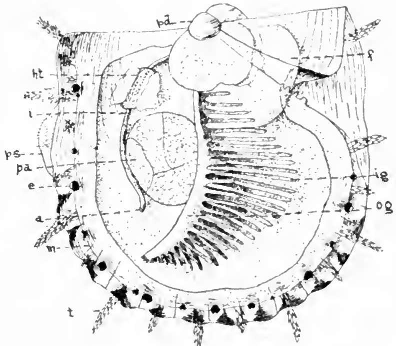
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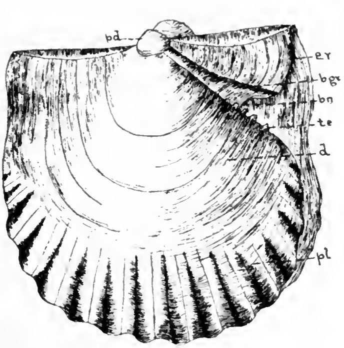
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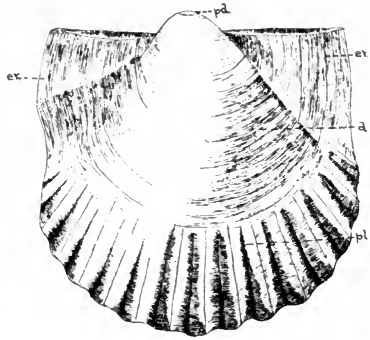
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Fig. 38. — Dorsal view of Pecten in plicated stage, showing umbones and hinge line. The left valve is deeper than the right. The prodissoconch (pd) is sharply marked off, the amount of separation between its two valves being well shown. Magnified 32 diameters.

Fig. 39. — Plicated stage. A 2.15-millimeter scallop magnified 32 diameters. View of corner of right valve, showing groove and notch. Nine teeth (te) can be seen in the byssal area, six of which are within the external border of the groove. There is a second furrow dorsal to the byssal groove, and a serrated structure near the hinge line of seven sharply pointed teeth, which possibly may be an individual variation.

Fig. 40. — Posterior view of scallop in the plicated stage, showing that the shell has become more nearly equivalvular. The plicated (pl) and dissoconch (d) areas are sharply differentiated. Magnified 32 diameters.

Fig. 41. — Prismatic structure of right valve of dissoconch shell highly magnified. This structure is not found on the left valve, or on either valve of the adult. Magnified 340 diameters.

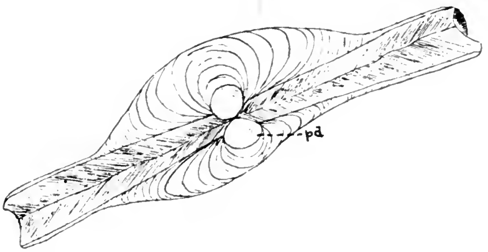
Fig. 42. — Foot of 25-millimeter (about 1 inch) scallop, showing cleft (fc), disc-like tip, byssal gland (bg) and groove (fg). Magnified 7 diameters.

Fig. 43. — Byssus of scallop of dissoconch stage after having been cast off by the animal; distal (di) or attached end; proximal (pr) or gland end. Magnified 5 diameters.

Figs. 44-46. — Stages showing the development of the tenacle. Fig. 44 represents the first appearance, Fig. 45 further development, and Fig. 46 the tip of a completely formed tenacle. The tenacles on the edge of the mantle are used as sensory, clinging and crawling organs. Magnified 110 diameters.

Fig. 47. — Scallop (4 to 5 millimeters in size) drifting just below the surface of water in aquarium (see page 60). Note the extended tentacles (t), open shell and the reverse position, with right valve uppermost. Magnified 5 diameters.

Fig. 48. — Scallop (1.5 millimeters in size) attached to eel grass by a two-stranded byssus (b), formed during the night. Magnified 7 diameters.



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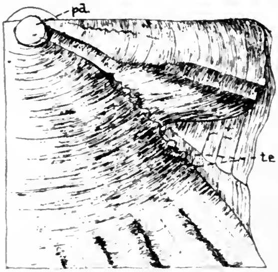

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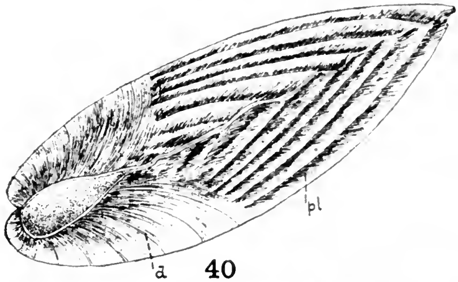

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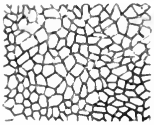

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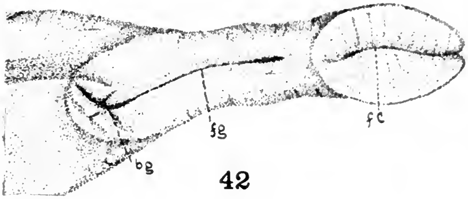

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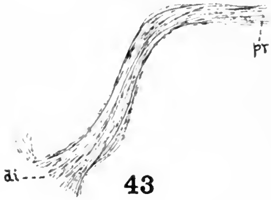

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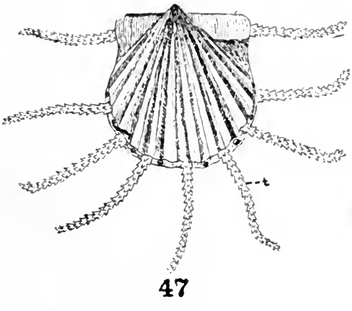

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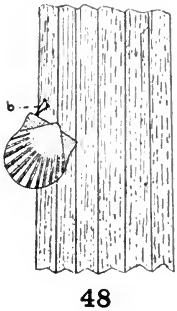

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Figs. 49-51. — Turning Over. — When lying on the left valve, as in Fig. 49, the small scallop appears uneasy, as its normal position is on the right. After a few minutes it thrusts out its foot, waves it around, as if seeking a foothold, and finally applies the cleft tip to the bottom of the glass dish with a twisting motion. By this movement the shell is so pulled that the hinge line rests upon the bottom (Fig. 50), and the scallop pries itself over, naturally falling into its normal position on the right valve.

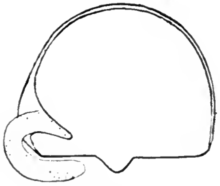
Figs. 52-54. — These figures illustrate the strength of the byssal thread, which permits the revolving of a young scallop at least 360° without breaking the strands. The scallop is shown as it is turned around on its attachment by a pencil.

Figs. 55-57. — Crawling. — In Fig. 55 the young scallop, lying on its right valve, has extended its foot, the tip of which is firmly set on the bottom. Fig. 56 shows the tipping of the shell forward by the contraction of the foot. Fig. 57 shows the completion of the movement, by which the animal has traveled three-quarters of its length, and the extension of the foot for a second pull. The action of the foot is strengthened by the clapping of the valves, which sends out a current of water from the posterior side of the shell.

Figs. 58-60. — Spinning the Byssus. — In Fig. 58 the foot is extended, with tip and byssal gland touching the bottom of the glass dish, in order to attach the byssal thread. Fig. 59 represents the spinning or drawing out of the byssal thread by the retraction of the foot toward the shell, and Fig. 60 shows the young scallop attached by one thread, while the foot is in the act of extension for the purpose of attaching a second strand at a point slightly removed from the fixation of the first. The spinning of a single thread occupies about two minutes.

Figs. 61, 62. — Swimming. — Swimming is accomplished by the alternate expulsion of water first from one "ear," as B, and then from the other, as D, which forces the scallop ahead by a series of zigzag jerks or tacks in the directions C and E respectively. (These two figures are from the illustrations of Prof. R. T. Jackson, Figs. 8, 8*a*, Plate XXVIII., Memoirs Boston Society Natural History, Vol. IV.)

Figs. 63, 64. — These figures illustrate a manner of avoiding enemies. In Fig. 63 the scallop, when approached by a pencil at the free edge, darts quickly away in the direction of the arrow by violently expelling water from its ventral border. Darts can be likewise made in either a forward or backward direction, as shown in Fig. 64.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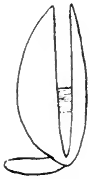
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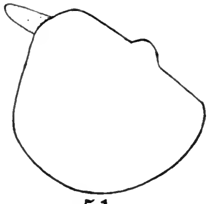
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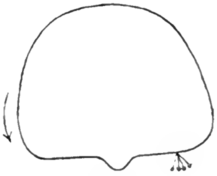
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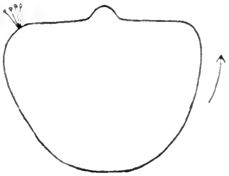
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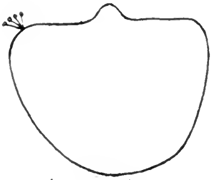
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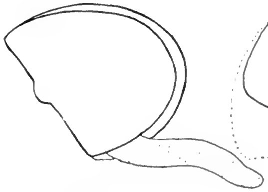
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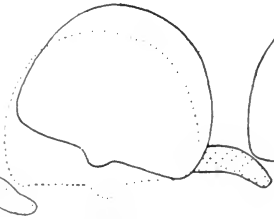
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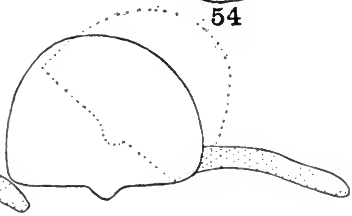
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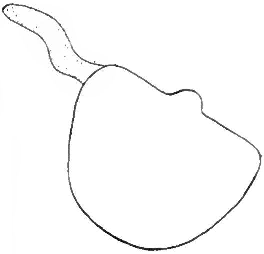
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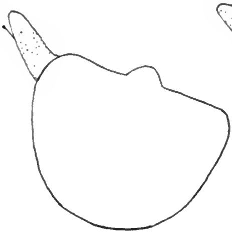
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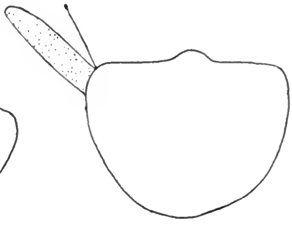
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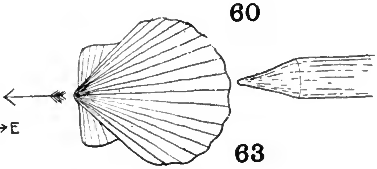
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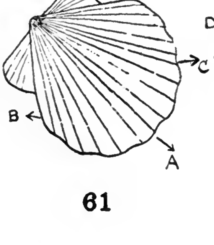

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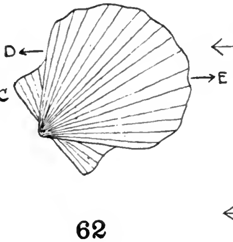

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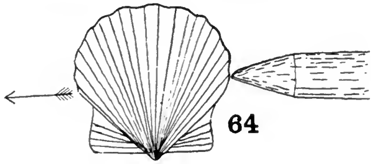
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Fig. 65. — External view of the two valves of the scallop. Left valve: A, anterior border; P, posterior border; D, dorsal border; V, ventral border (free edge); HH, hinge line; AP, width; DV, height. Right valve: U, umbo; B, byssal notch; E, ears; R, ridge; F, furrow.

Fig. 66. — Shows the method of recording the growth of individual specimens and of obtaining data upon the migratory habits of the scallop. A small hole was bored through the "ear" close to the hinge line with an awl. A numbered copper tag was attached by a fine wire.

Fig. 67. — Generative gland: ov, ovary; t, testis; ep, ciliated epithelium on surface of visceral mass; glc, gland cells; bm, basement membrane; ct, tissue of irregular cells beneath epithelium; fep, follicular epithelium; d, ciliated ducts, the one in the testis containing spermatozoa, and on its walls a gland cell being shown; bv, blood vessel. (This illustration is a copy of a drawing by James L. Kellogg, produced as Fig. 71, Plate LXXXIX., Bulletin, United States Fisheries Commission, 1890, and is published with the consent of Dr. Kellogg. Unfortunately, in the reduction much of the fine detail of the original has been lost.)

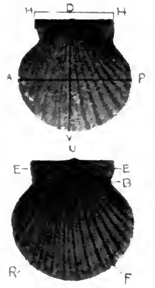
Fig. 68. — The oyster drill (*Urosalpinx cinerea*). An enemy of the scallop, which bores a fine hole through the shell and feasts upon the soft parts. Cases containing the eggs of this mollusk are shown on the right. Life size.

Fig. 69. — **Scallop Food.** — Typical diatoms found in Massachusetts waters. (a, b, c) *Navicula*, (d, e) *Pleurosigma*, (f) *Nitzschia*, (g) *Melosira*, (h) *Chætoceras*, (i) *Cyclotella*, (j) *Licmophora*. Magnified 200 diameters.

Fig. 70. — A starfish opening a scallop by slowly dragging the valves apart by means of small, sucker-like feet on the lower side of each of the five rays or "arms." When the valves are forced apart the starfish rolls out its stomach, which envelops the soft body of the scallop. Digestive juices are poured forth and the food is digested outside the body of the starfish. This creature is the most destructive natural enemy of the scallop, and in certain localities has made serious inroads. It is best killed by steaming or bringing ashore.

Fig. 71. — Diagram of the wire cages in which scallops were suspended from the raft at Monomoy Point. The cage consists of a framework of wood covered with 1½-inch mesh wire netting.

Fig. 72. — Plankton net, made of silk bolting cloth, used to catch the swimming shellfish larvæ. The net is towed through the water behind a rowboat.



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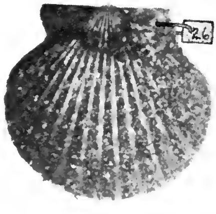

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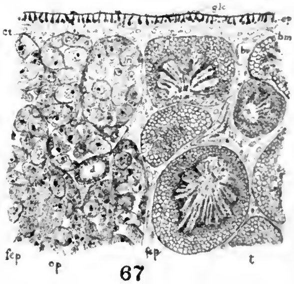

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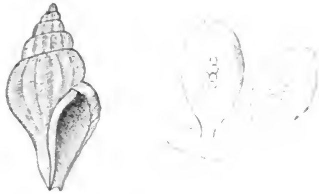

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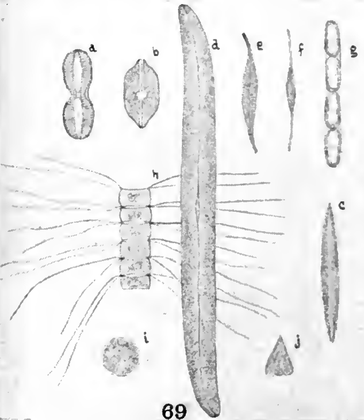

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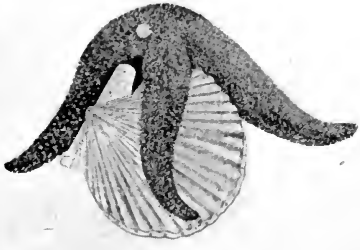

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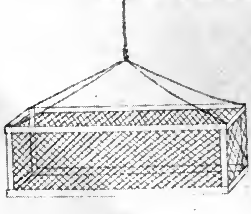

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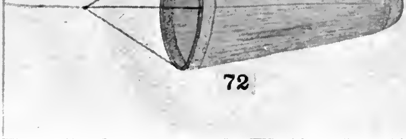

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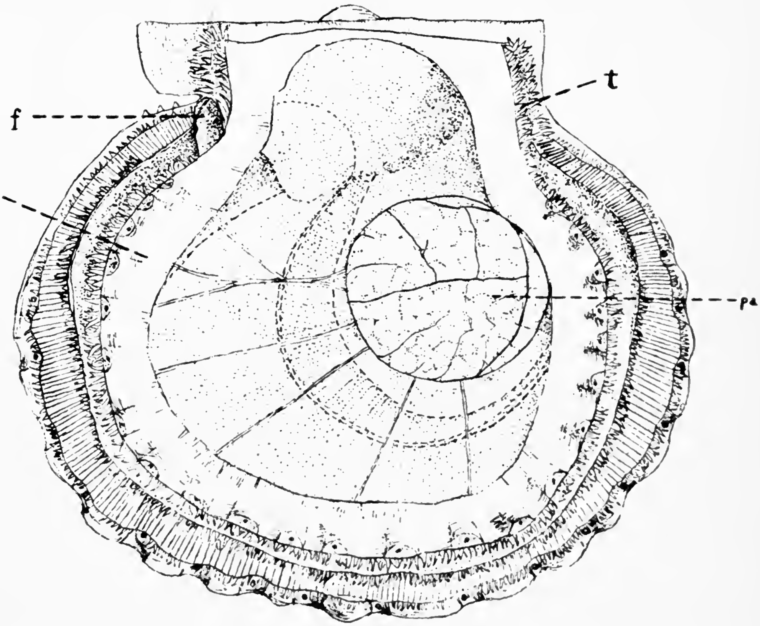
In general, the organs of Pecten lie at three different layers, viz., valve, mantle and gills. Figs. 73, 74 and 75, which are one and one-quarter times the natural size, represent the views disclosed as each of these layers is successively cut away.

Fig. 73. — View of Pecten with left valve removed. The gills (g), liver (l) and palps (lp) are represented in dotted lines as they are seen through the transparent mantle. As the left lobe of mantle (m) has been detached from the shell, it has contracted. The right mantle (m) lobe is shown fully extended.

Fig. 74. — View of Pecten with left valve and mantle removed, showing gills (g), palps (lp), foot (f) and liver (l).



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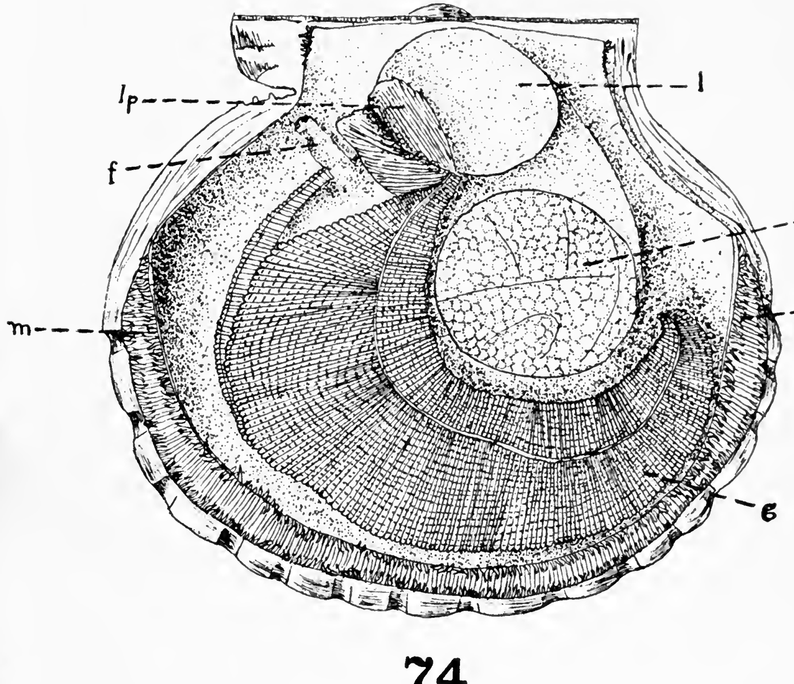

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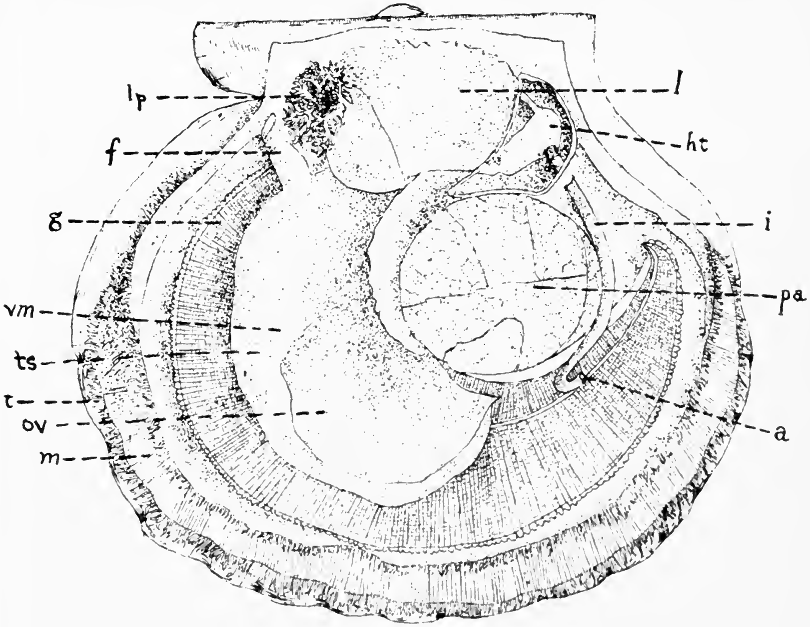
Fig. 75. — View of Pecten with left valve, mantle (m) and gills (g) removed, showing the heart (ht), visceral mass (vm) and reproductive organs.

Fig. 76. — View of Pecten, showing the digestive system.



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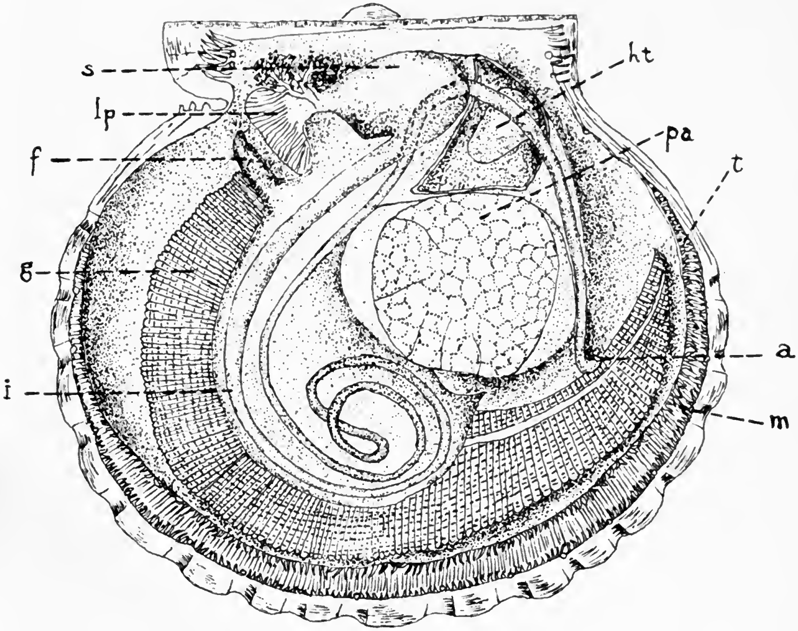

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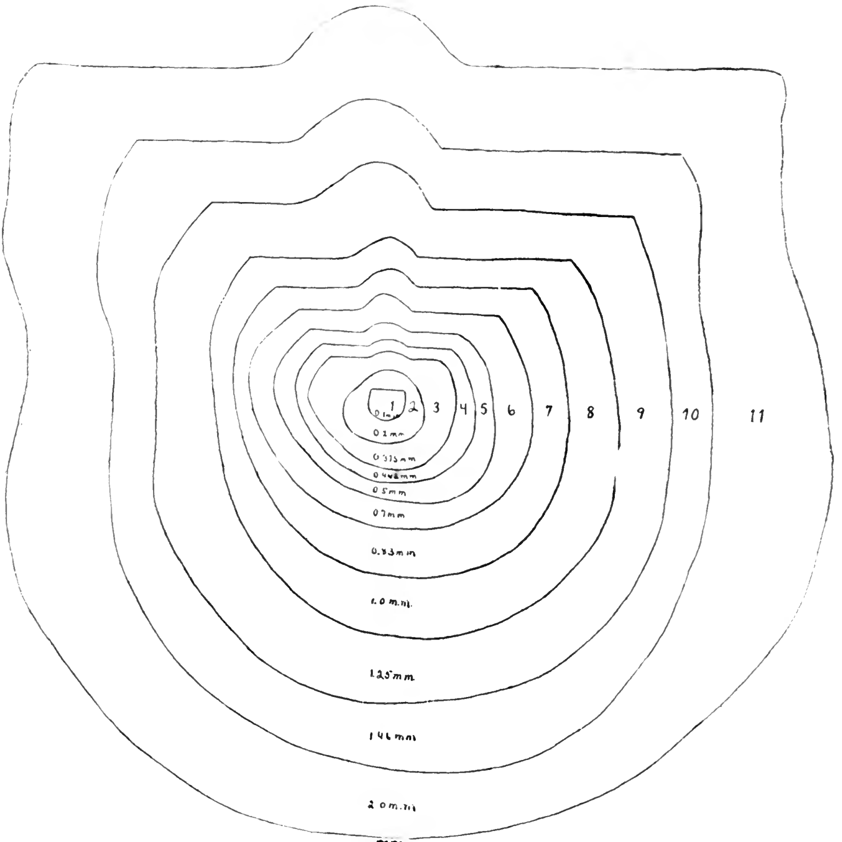
Fig. 77. — Changes in form of shell. A series of drawings illustrating the changes from the early veliger (the first shell), which is $1/10$ of a millimeter in size, to a 2-millimeter scallop. Note (*a*) change from flat-hinged veliger (1) to the prodissoconch (2), with prominent umbones; (*b*) return to a straight hinge (3), width greater than height; (*c*) width and height become equal (8); (*d*) formation of "ears" (10).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2
3
4
5
6
7
8
9
10
11
0 2mm
0 315mm
0 5mm
0 7mm
0.83mm
1.0mm
1.25mm
1.46mm
2.0mm

77

Fig. 78. — Map of the Massachusetts coast, showing the distribution of the shallow-water scallop (*Pecten irradians*). The scalloping grounds are indicated by the black areas.


NEWBURYPORT
GLOUCESTER
SALEM
LYNN
BOSTON
COHASSET
PLYMOUTH
PROVINCETOWN
WELLFLEET
ORLEANS
BREWSTER
WAREHAM
MARION
NEW BEDFORD
BOURNE
BARNSTABLE
HARWICH
CHATHAM
FALL RIVER
FALMOUTH
WEST PORT
MARTHA'S VINEYARD
NANTUCKET

Fig. 79. — Plan of biological raft used at Monomoy Point for growth experiments and spat collecting. The raft, 20 feet long by 10 feet wide, provided with a central well and four trap-doors, was anchored in the Powder Hole in 20 feet of water. Wire cages and wooden boxes were suspended at various depths from the raft. Many kinds of mollusks were caught and raised in these spat boxes. The raft proved particularly useful in the study of the post-embryonic life history, as the scallops "set" in large numbers on the boxes, cages and ropes, where specimens could be obtained in all stages of development for laboratory examination. Also, many interesting growth experiments upon the quahaug, scallop and clam were conducted in the sand boxes.

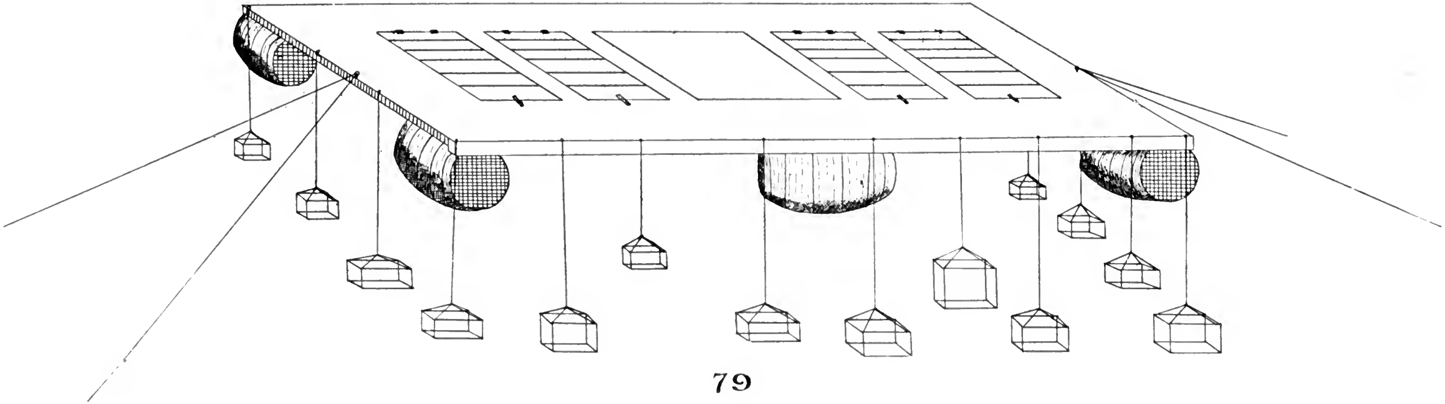

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Fig. 80. — Type of pen used in determining the rate of growth of the scallop. The sizes ranged from 40 to 400 square feet. The posts were made of 2 by 3 foot joists, fixed in the soil and placed at sufficient intervals to hold the netting firmly in position. Wire netting ($1\frac{1}{4}$-inch mesh) and old seines of a suitable height were stretched around the posts.

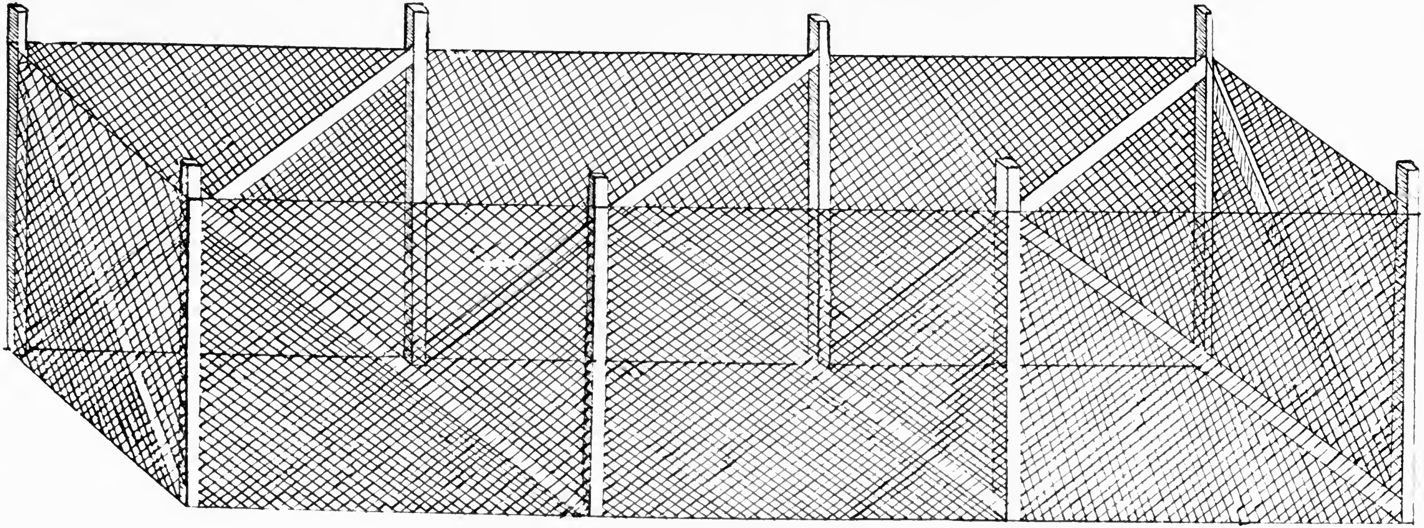

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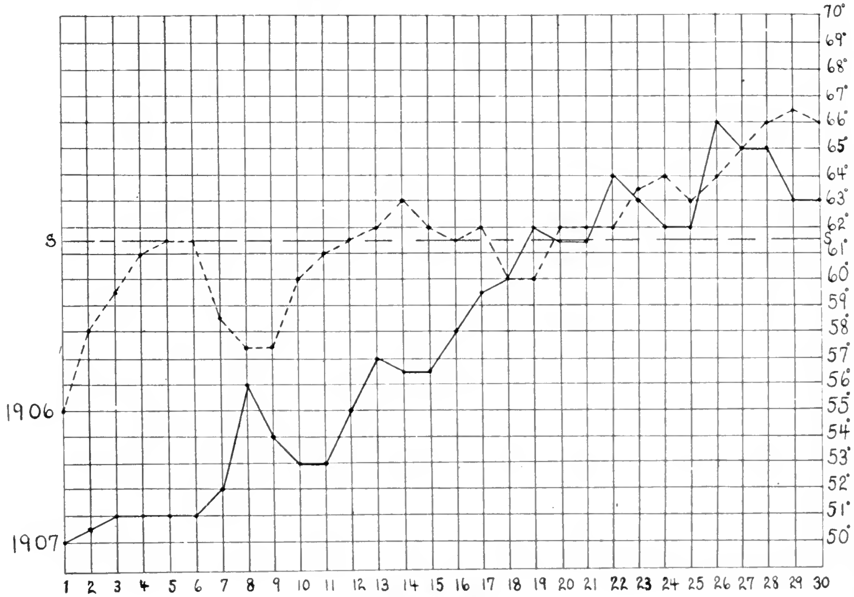
Fig. 81. — Chart of the daily temperatures for the month of June, taken at the Powder Hole at Monomoy Point in 1906 and 1907. The average of the daily temperatures at 1, 10 and 20 feet, taken at 6 A.M., 12 M. and 6 P.M., is given. The great irregularity of the curve is due to the fluctuation of this small body of water with changes in the temperature of the air. The season of 1907 was nearly two weeks behind that of 1906, as during the early part of June the temperature was from 8° to 10° colder, but by June 19 the two became approximately the same as is shown by the intersection of the curves on the chart. The principal fact shown by the plot is the location of the "spawning" temperature, or the temperature necessary for spawning. In 1906 the scallops first spawned on June 12, in 1907 on June 21. In each case spawning did not occur until the water reached the temperature of 61½°, although there was nine days' variation between the two years.

Fig. 82. — **The Food Value of the Scallop.** — The relative proportion, by weight, of the various parts of the average scallop is graphically represented by a series of rectangles, corresponding to (1) the total weight, 1.5 ounces, or 100 per cent.; (2) total non-edible part, 1.23 ounces, or 82.23 per cent., which includes both shell and non-edible soft part; (3) shell, .74 of an ounce, or 49.43 per cent.; (4) non-edible soft part, .49 of an ounce, or 32.8 per cent.; (5) actual food, .27 of an ounce, or 17.77 per cent.



JUNE

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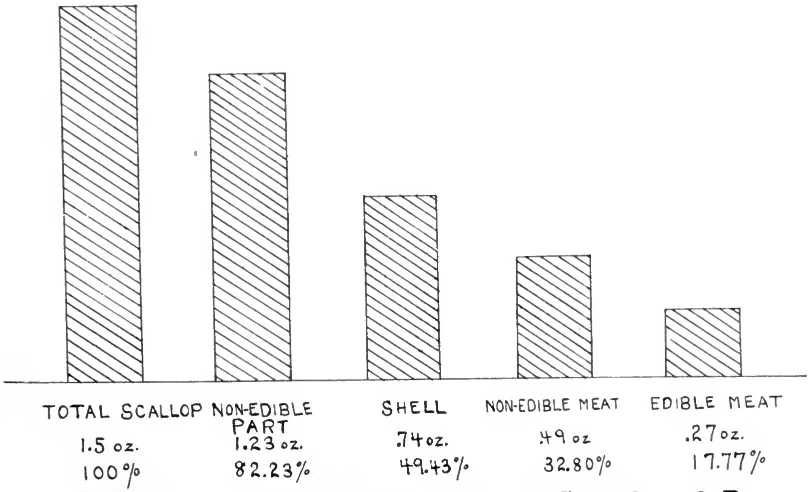


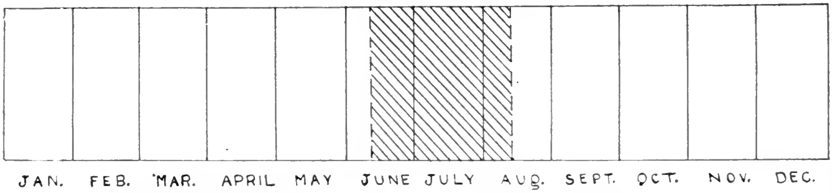
FOOD VALUE OF SCALLOP

82

Fig. 83. — **The Spawning Months.** — The spawning season lasts from the second week in June to the middle of August. This period is represented by the shaded portion.

Fig. 84. — **The Growing Months.** — The scallop increases in size of shell only during the summer months, as during the winter growth ceases. The shaded portion represents the period of growth.

Fig. 85. — **The Relative Value of the Growing Months.** — The scallop does not increase with equal rapidity during the seven months of growth. The relative value of these months is graphically represented in terms of the increase in volume during each month for a standard scallop. The slow growth during June and July, as represented by the short columns, roughly corresponds to the spawning season, and the decrease in growth is probably due to that cause.



SPAWNING MONTHS

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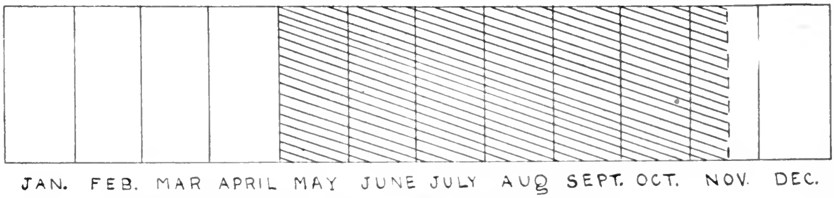

GROWING MONTHS

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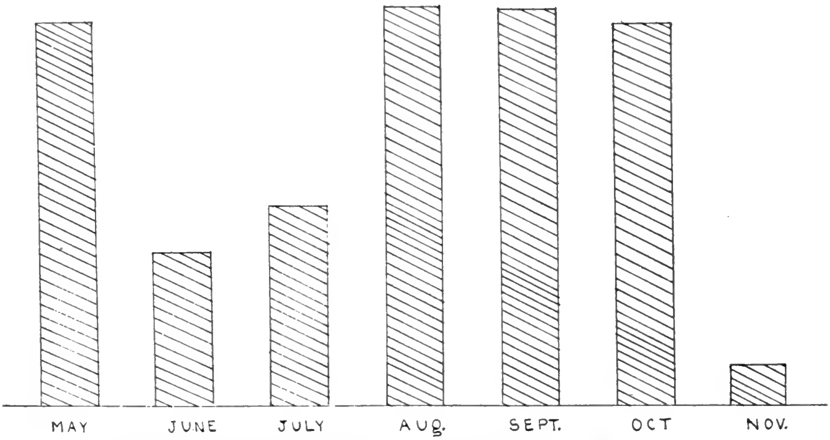


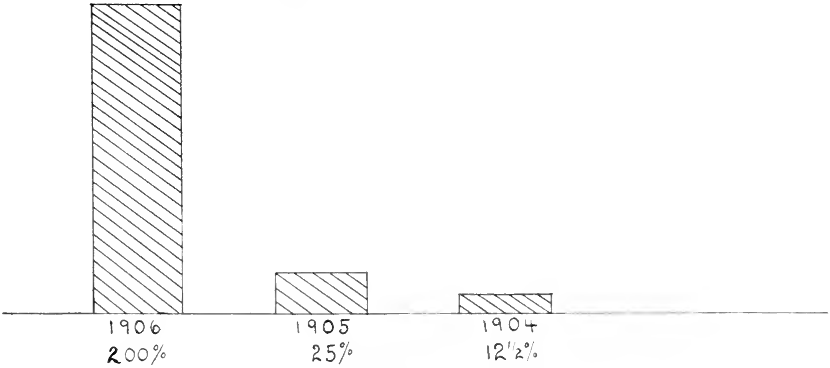
RELATIVE VALUE OF GROWING MONTHS

85

Fig. 86. — Age and Growth. — As the scallop becomes larger the rate of growth, both in actual increase and gain in volume, becomes less. The three columns represent the comparative gain in volume of (1) "seed" scallops (¾ of an inch) of the 1906 set, 200 per cent.; (2) fourteen-month scallops of the 1905 set, 25 per cent.; (3) twenty-six month scallops of the 1904 set, 12 per cent., under the same conditions.

Fig. 87. — Current and Growth. — The three columns represent the volumetric growth, for a definite period, of scallops in good, medium and poor currents, and are formulated from measurements made at Stage harbor, Chatham, in 1906–07. At the mouth of the harbor is a large eel-grass flat, extending from the shore to the channel. The flat was arbitrarily divided into three areas, according to the circulation of water: (1) near the channel (good current); (2) half-way to shore (medium current); (3) near shore (poor current); and the rate of growth of the 1906 set was followed in each division. These figures demonstrate the great importance of current in scallop growth.

Fig. 88. — Current and Growth. — The influence of current is again illustrated by comparing the volumetric growth of "seed" scallops of the same size at (1) the raft, Monomoy Point (good current), 662 per cent.; (2) Stage harbor, Chatham (medium current), 475 per cent.; (3) south side of Powder Hole, Monomoy Point (poor current), 293 per cent.; (4) east side of Powder Hole (no current), 98 per cent. The comparative volumetric growth for a period of seventy-six days during the summer of 1906 is represented for each of these localities by the shaded columns. A knowledge of the relation of current to growth should prove valuable to the prospective scallop culturist.



AGE AND GROWTH

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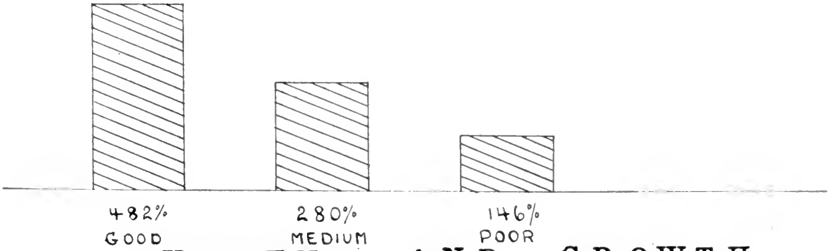
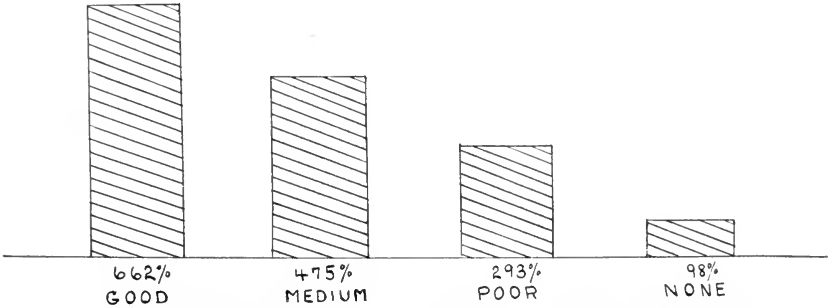


CURRENT AND GROWTH

87



CURRENT AND GROWTH

88

Fig. 89. — Temperature and Growth. — The broken line represents the curve of the average monthly temperature of the water during the year 1906 at the Powder Hole, Monomoy Point, and the numbers on the sides indicate the degrees. The other curve represents the growth of the 1905 scallop set during the year 1906, and the same figures which corresponded to the degrees in temperature now stand for the size of the scallop in millimeters (25.4 millimeters equal 1 inch). Tracing the growth of the scallop, size 34 millimeters, January 1, no growth is noticed until May 1, when the water assumes a temperature of about 49° F. During the month of May there is a rapid growth, which slackens during June and July, the spawning months, as is shown by the drop in the curve, and is again resumed during August, September and October. The growth perceptibly slackens during November, and probably ceases altogether after the middle of the month, when the water is about 43° F. To all practical purposes the growth ceases November 1, at a temperature of 49° F., which is directly comparable to temperature of the water when growth began, May 1. Therefore, it is apparent that the growth of the scallop, as typified by shell formation, depends upon the temperature of the water, at least 45° F. being necessary for growth. The cessation of growth is not due to any decided fall in the food supply but rather to the inactivity of the scallop, which becomes sluggish in cold water.

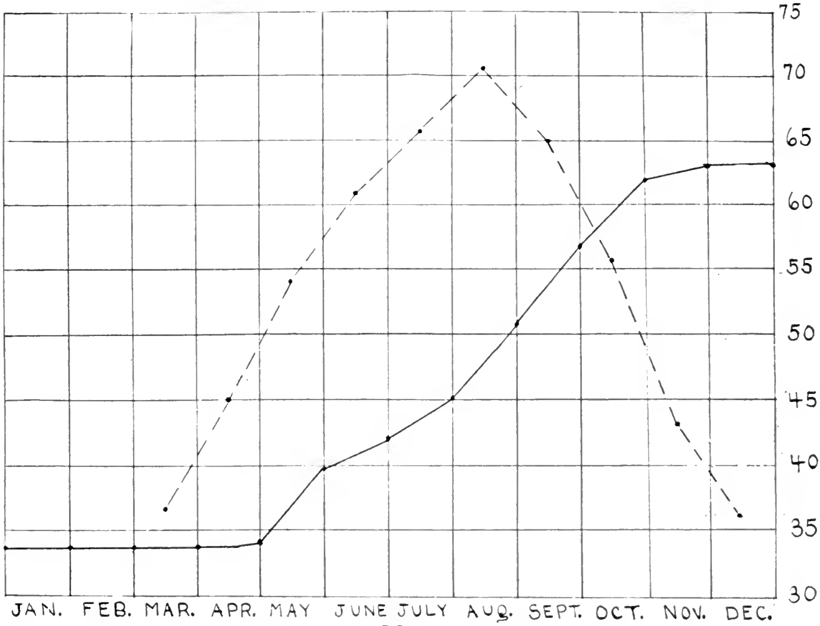
Growth (Millimeters).

May 1,	34.00	September 1,	51.00
June 1,	39.71	October 1,	56.80
July 1,	42.12	November 1,	62.28
August 1,	45.10	December 1,	62.90

Fig. 90. — The plotting shows the comparative growth of large and small scallops of the same age during their second summer. Division B (38.50 millimeters) by the end of the season has gained the greater part of the difference at the start between it and Division A (49.50 millimeters), reducing the margin from 11 to 3.27 millimeters. These scallops were confined in the same pen, and numbered Division A 125, Division B 200. This tendency perhaps accounts for the uniformity in size of scallops in any particular locality at the end of the second summer's growth, when the scallop is ready for market.

Growth (Millimeters).

	A.	B.		A.	B.
May 1,	49.50	38.50	September 5,	56.72	51.90
June 1,	52.25	43.25	September 25,	59.79	55.67
July 10,	53.55	46.25	November 3,	62.88	59.46
August 1,	54.60	47.85	November 22,	63.00	59.73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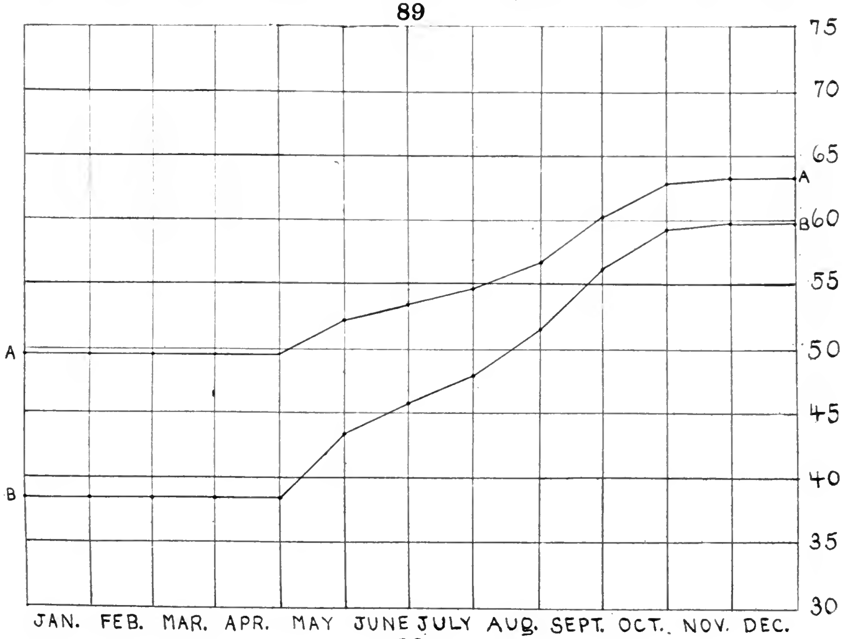
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

89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A
B
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

90

Fig. 91. — The curve represents the growth of the average Massachusetts scallop from 1905 to 1907. Notice the rapid growth from July to December in 1905, and the complete cessation during the winter months. During the second summer comes another period of rapid growth, which ceases about Dec. 1, 1906. The normal life of these scallops ends some time in March or April, 1907, but a few often pass the two years' mark. The growth of these old scallops is represented by the broken line in the diagram, summer growth starting about May 1. The figures on the right represent the size of the scallops in millimeters (25.4 millimeters equal 1 inch).

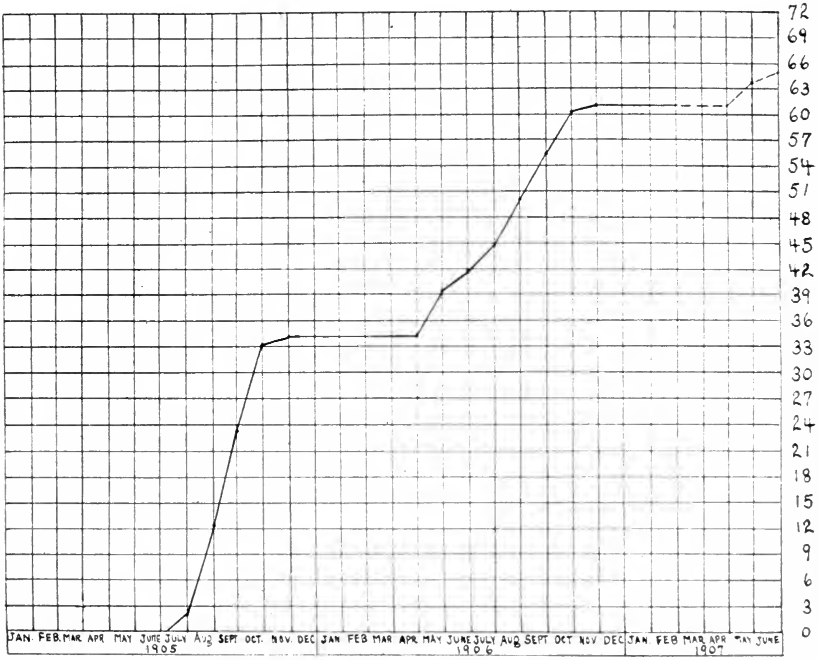
Average Scallop (Millimeters).

Aug. 1, 1905,	2.00	Aug. 1, 1906,	44.57
Sept. 1, 1905,	12.66	Sept. 1, 1906,	50.08
Oct 1 1905,	23.20	Oct. 1, 1906,	55.51
Nov. 1, 1905,	33.11	Nov. 1, 1906,	60.68
Dec. 1, 1905,	34.24	Dec. 1, 1906,	61.27
May 1, 1906,	34.24	May 1, 1907,	61.27
June 1, 1906,	39.51	June 1, 1907,	63.93
July 1, 1906,	41.77	July 1, 1907,	65.07

Fig. 92. — The three curves, A, B and C, represent the growth of the average scallop in the three localities of Buzzard's Bay, Cape Cod and the islands of Martha's Vineyard and Nantucket, respectively. For convenience, the start is considered as uniform, although there is several days' difference in the spawning season. The difference in growth at the various dates can be determined by referring to the figures on the right, which represent the size of the scallop in millimeters (25.4 millimeters equal 1 inch).

Growth (Millimeters).

Date.	C. The Islands.	B. The Cape.	A. Buzzard's Bay.
August 1,	2.00	2.00	2.00
September 1,	10.48	12.52	15.03
October 1,	18.93	22.88	27.86
November 1,	26.71	32.65	39.97
December 1,	27.60	33.76	41.35
May 1,	27.60	33.76	41.35
June 1,	33.44	39.03	46.27
July 1,	35.90	41.25	48.34
August 1,	38.95	44.00	50.92
September 1,	45.98	49.43	56.01
October 1,	50.91	54.28	61.03
November 1,	56.50	59.83	65.73
December 1,	57.13	60.40	66.27
May 1,	57.13	60.40	66.27
June 1,	60.01	63.04	68.73
July 1,	61.28	64.15	69.77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JAN. FEB. MAR APR MAY JUNE JULY AUG SEPT OCT. NOV. DEC
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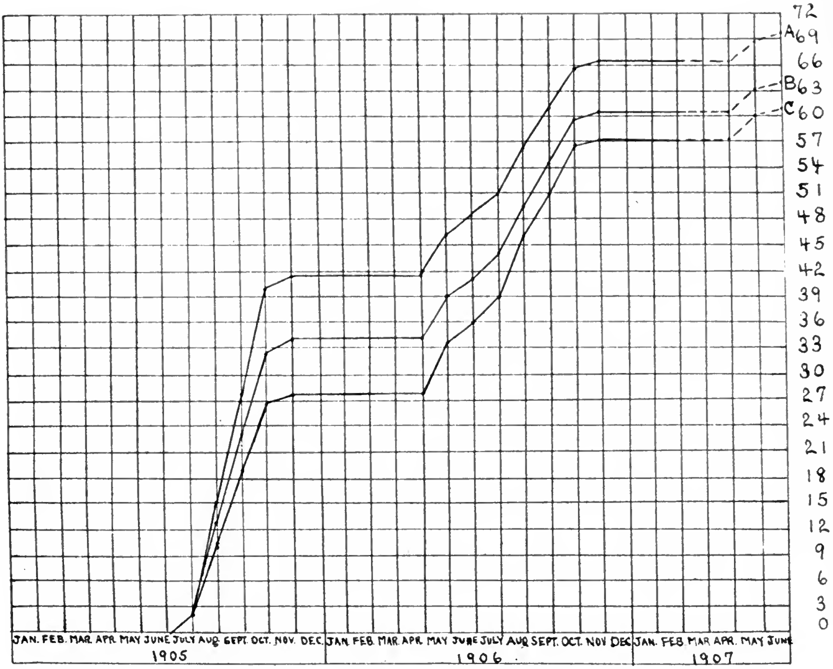
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
1906
JAN. FEB MAR APR MAY JUNE
1907

91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JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1905
JAN FEB MAR APR MAY JUNE JULY AUG SEPT. OCT. NOV DEC
1906
JAN. FEB MAR APR. MAY JUNE
1907

92

Fig. 93. — Graphic representation of the growth of the average scallop and its gain in volume. Starting September 1 with 1 bushel of ½-inch scallops, the increase in volume is represented on the right in terms of bushels, corresponding to the different sized scallops on the left: (1) two-month scallop, .5 of an inch, 1 bushel; (2) three-month scallop, .91 of an inch, 7.3 bushels; (3) five-month scallop, 1.34 inches, 26.5 bushels; (4) thirteen-month scallop, 1.75 inches, 62 bushels; (5) seventeen-month scallop, 2.41 inches, 185.6 bushels. The scallops are drawn one-half actual size. This rapid increase shows the benefit of preserving the "seed" scallop, as the yield in large scallops will more than repay the fisherman for his foresight.

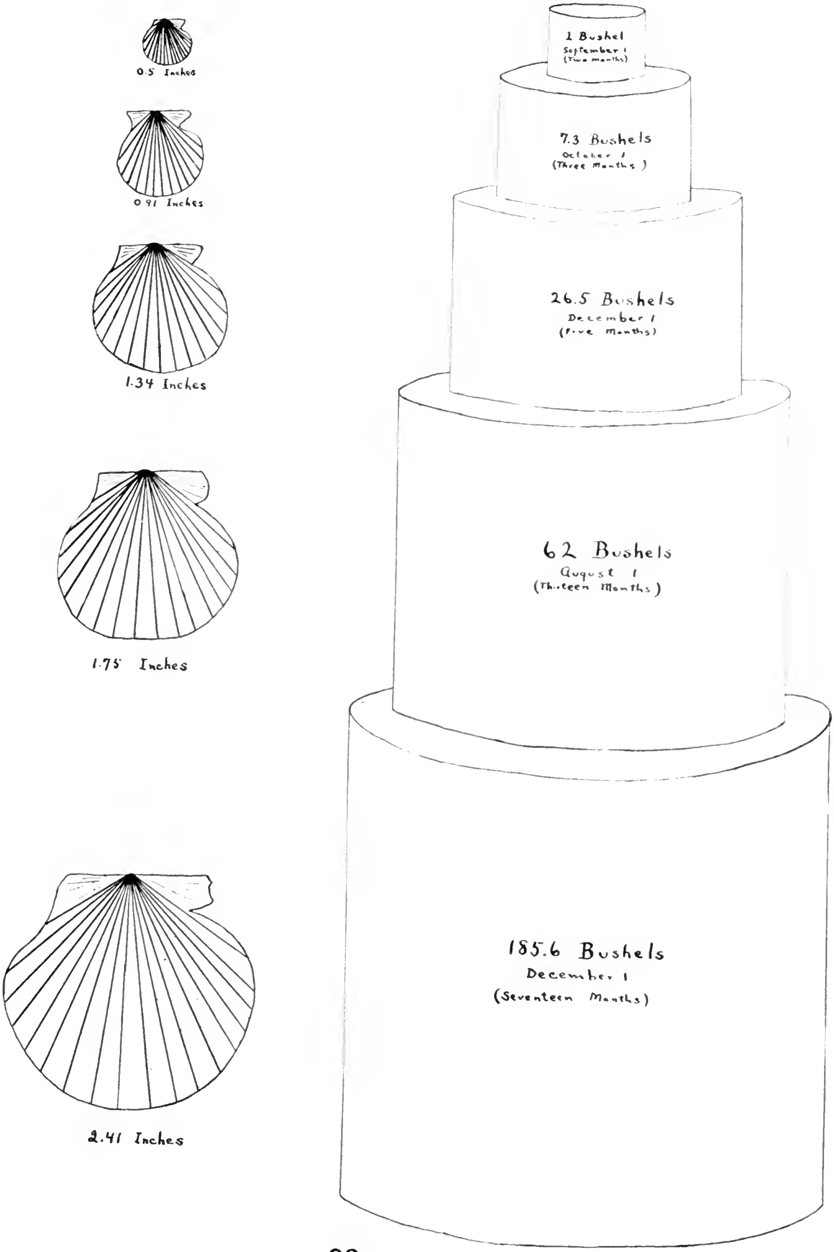
0.5 Inches
0.91 Inches
1.34 Inches
1.75 Inches
2.41 Inches
1 Bushel
September 1
(Two months)
7.3 Bushels
October 1
(Three Months)
26.5 Bushels
December 1
(Five Months)
62 Bushels
August 1
(Thirteen Months)
185.6 Bushels
December 1
(Seventeen Months)

Fig. 94. — *Nassa obsoleta* (the little black winkle of the tide flats) devouring a scallop. These little scavengers swarm over the scallop. Occasionally one is active enough to get between the valves, forming a wedge which permits the entrance of others, which quickly consume the scallop. Owing to the alertness of the scallop and its different habitat (Nassa usually being found on the tide flats) little damage is done.

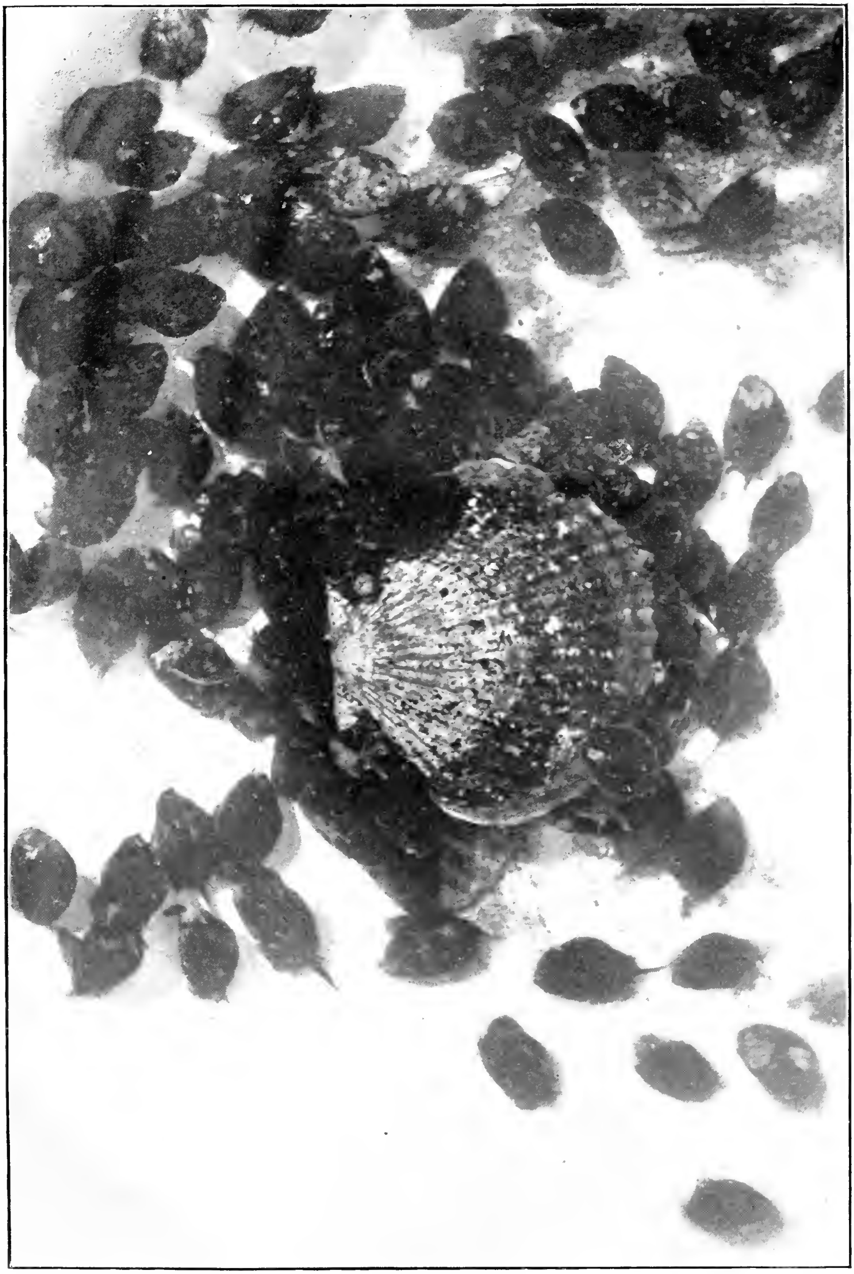

Fig. 95. — The oyster drill (*Urosalpinx cinerea*) boring the shell of a scallop. Five drills were found on this specimen, but one rolled off when the photograph was taken. The drill bores a fine hole through the shell by means of a ribbon-like tongue lined with saw-like teeth, and then sucks out the contents.

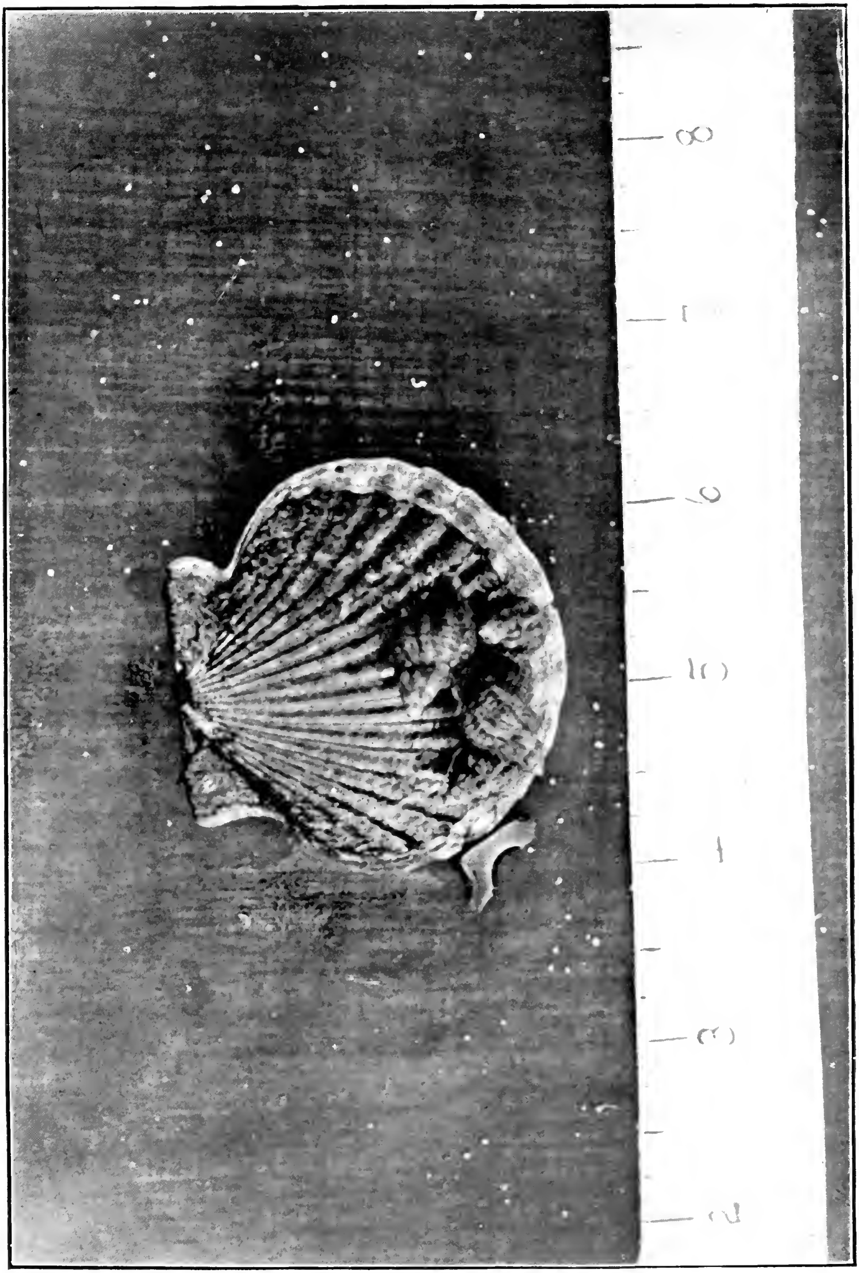

Fig. 96. — Spat boxes, lowered from the raft at Monomoy Point, after having been down for the summer. Notice the quantity of barnacles and silver shells (*Anomia*) which have collected on the outside. Inside these boxes heavy sets of clams and quahaugs were obtained, while on the outside were found numbers of young scallops, which were removed before the photograph was taken.

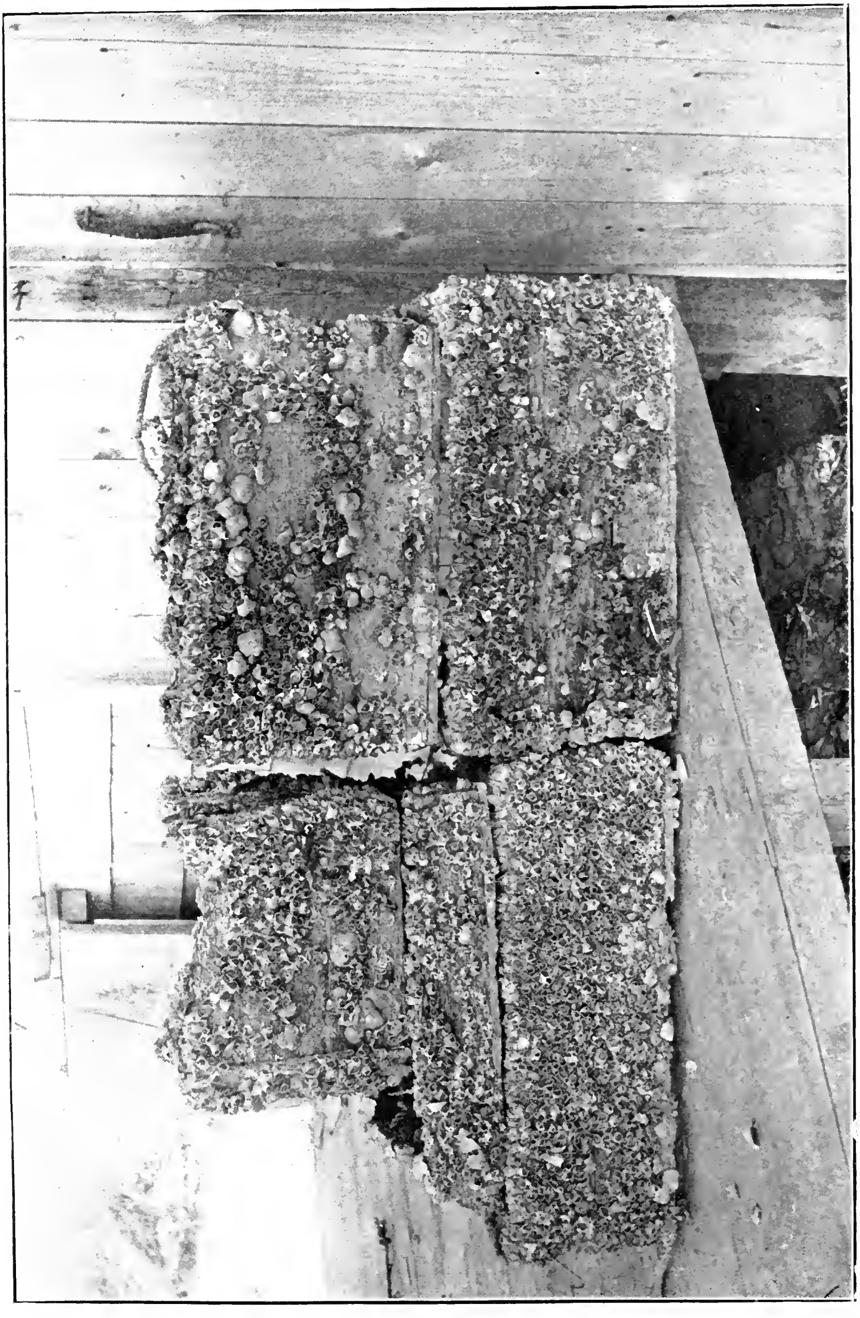

Fig. 97. — Method of recording the spawning of the scallop. W. G. Vinal, following the spawning of individual scallops, placed them in separate glass dishes. In this artificial way the time and manner of spawning could be determined, and the eggs obtained for artificial fertilization. Spawning was accomplished by raising the temperature of the water.

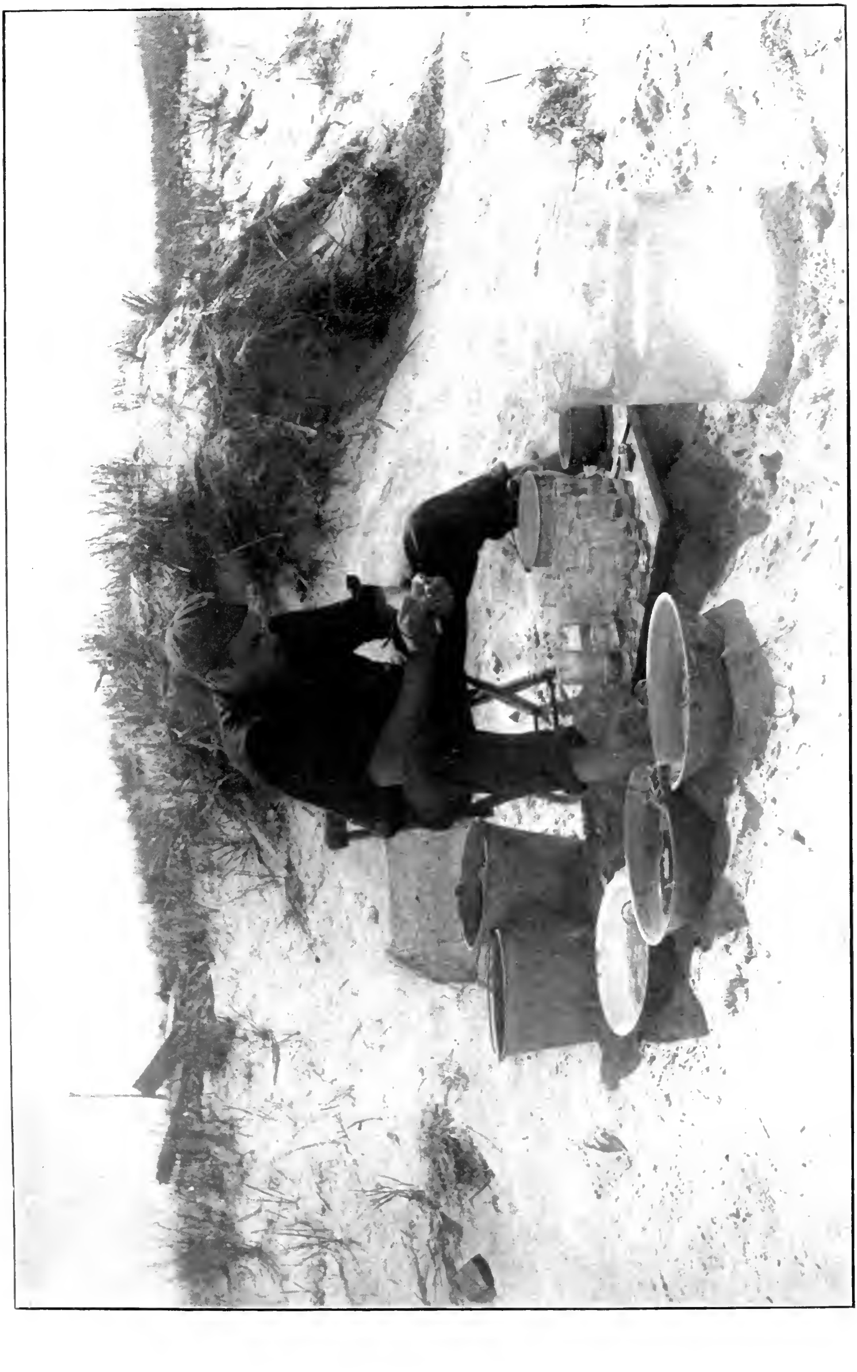

Fig. 98. — Young oysters, about three months old, attached to the upper valve of living scallops, taken at Wellfleet in October, 1908. As these oysters increase in size they prove detrimental to the welfare of the scallops, and finally may cause their death.

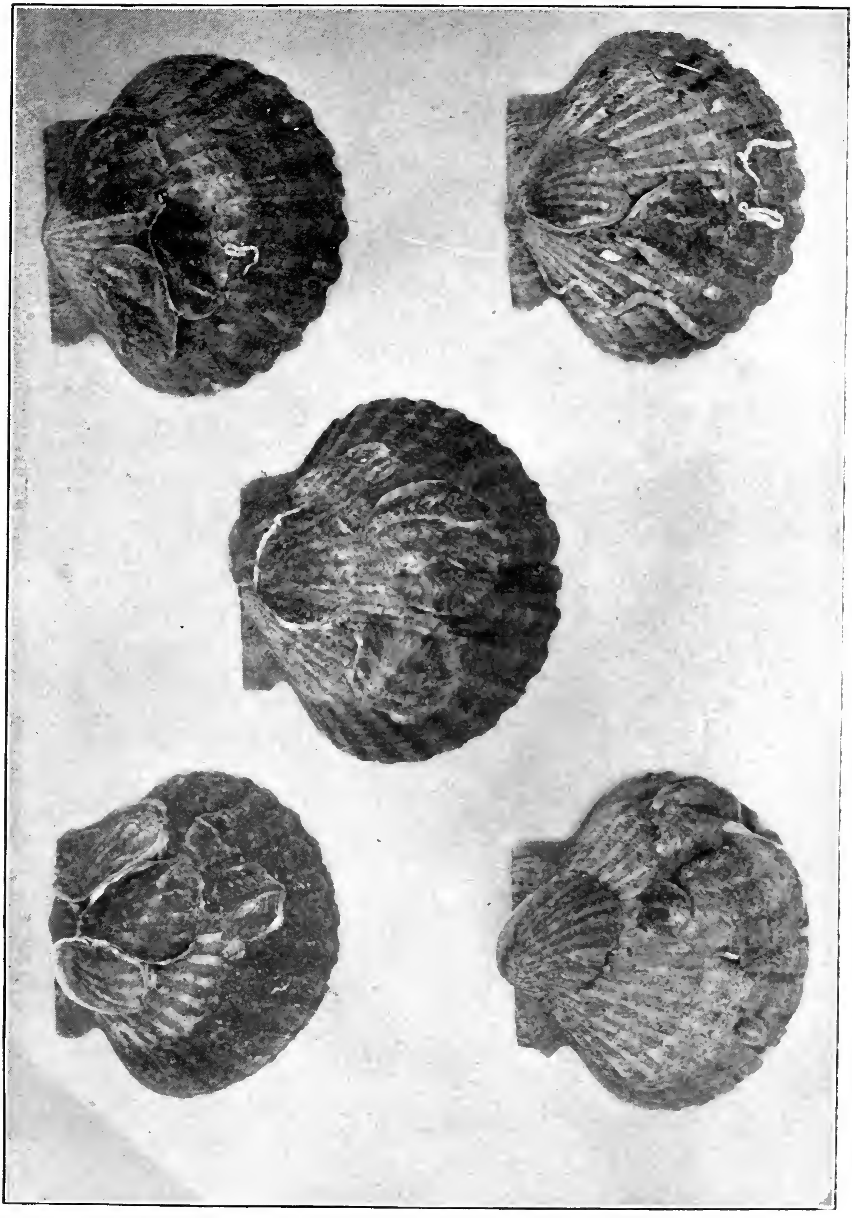

Fig. 99. — Scallops over one year old, as shown by the formation of the annual growth line, which is caused by cessation of growth during the winter months. Any scallop which does not possess this annual growth line is less than one year old, and is a "seed" scallop. The present legal definition of a "seed" scallop is based on the annual growth line, as its absence indicates that the animal has not as yet reached its spawning season, and is, therefore, an immature animal.

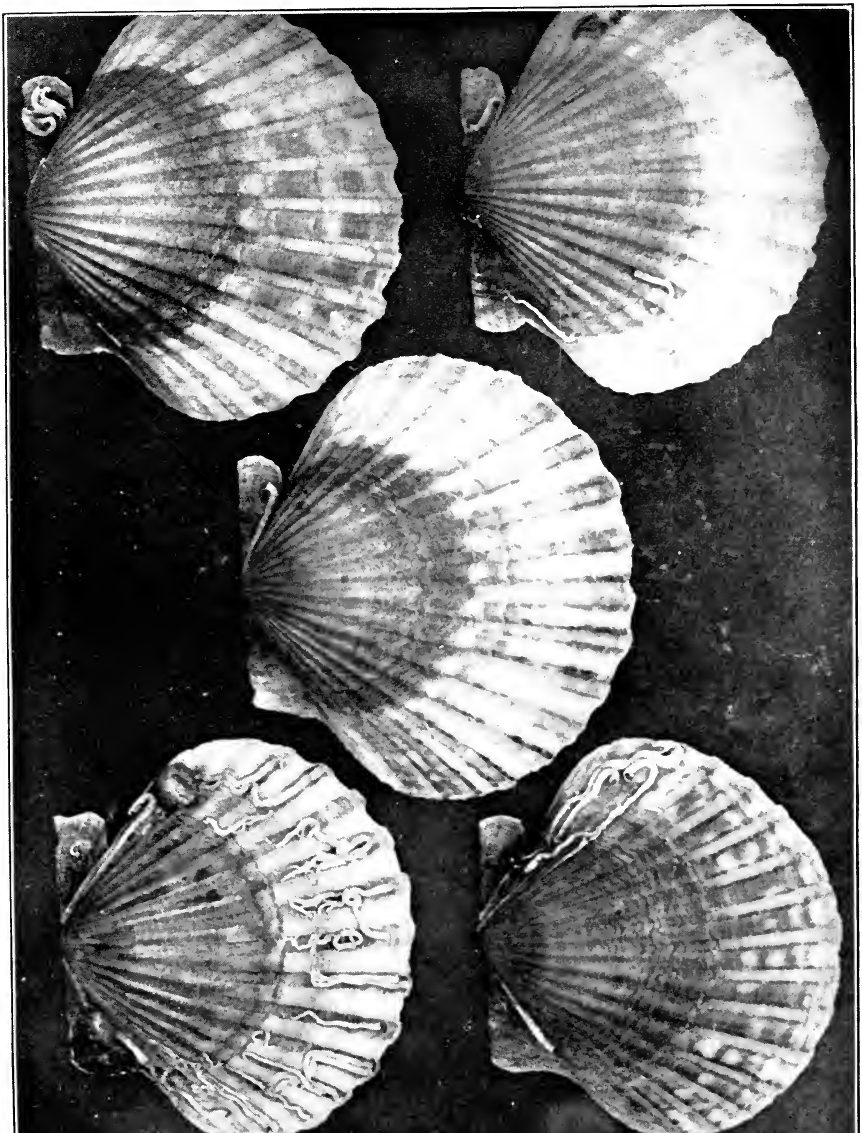

Fig. 100. — "Seed" scallops, with a small amount of white worm tube (*Serpula*) attached to the shell. These scallops have not yet spawned, and, for the future welfare of the scallop fishery, should be protected until they have passed the spawning period, which occurs when the scallop is one year old. The capture of these immature scallops is a decided menace to the fishery, and is forbidden by law.

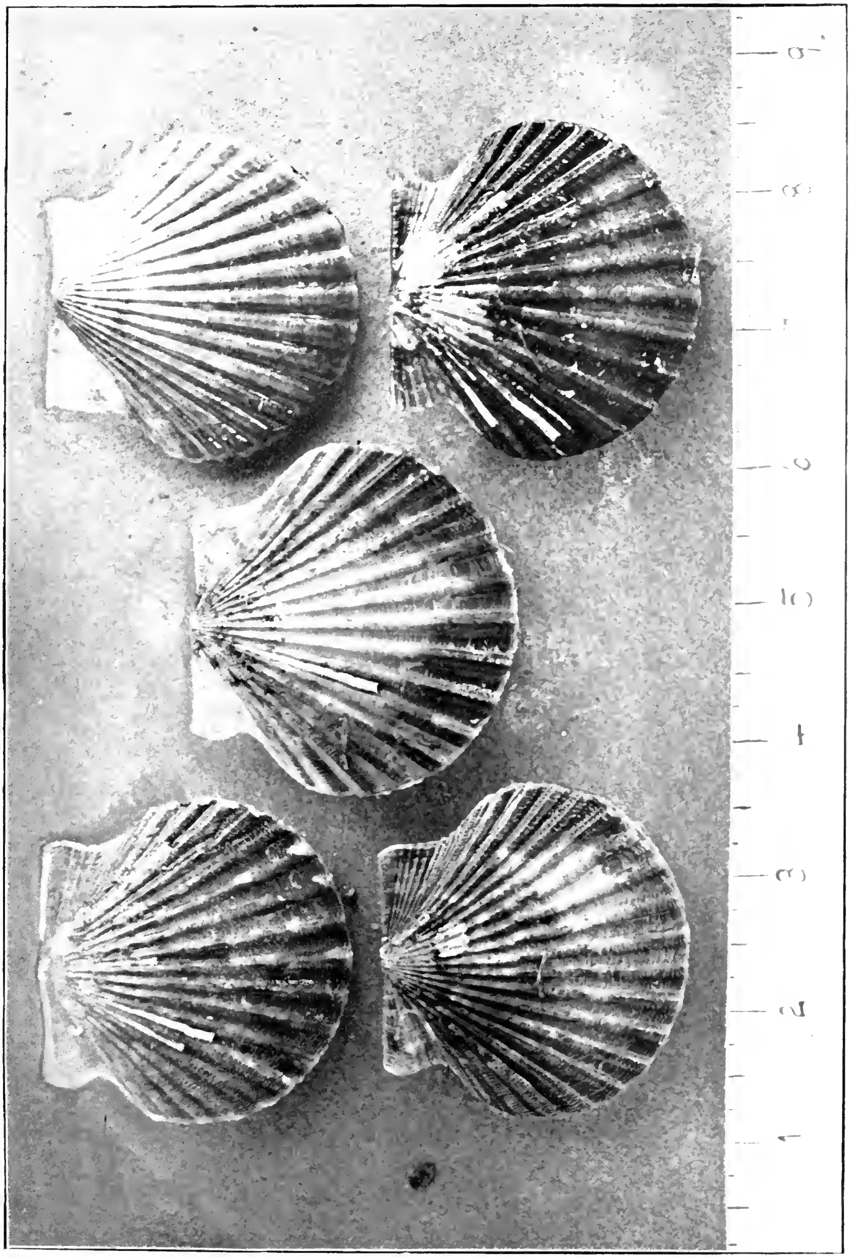

Fig. 101. — Variation in size of scallops. The two on the left are fifteen months old, while the two on the right are "seed" scallops three months old. The difference in size in scallops of the same age, especially in different localities, renders impossible the definition of a "seed" scallop by means of a size limit.

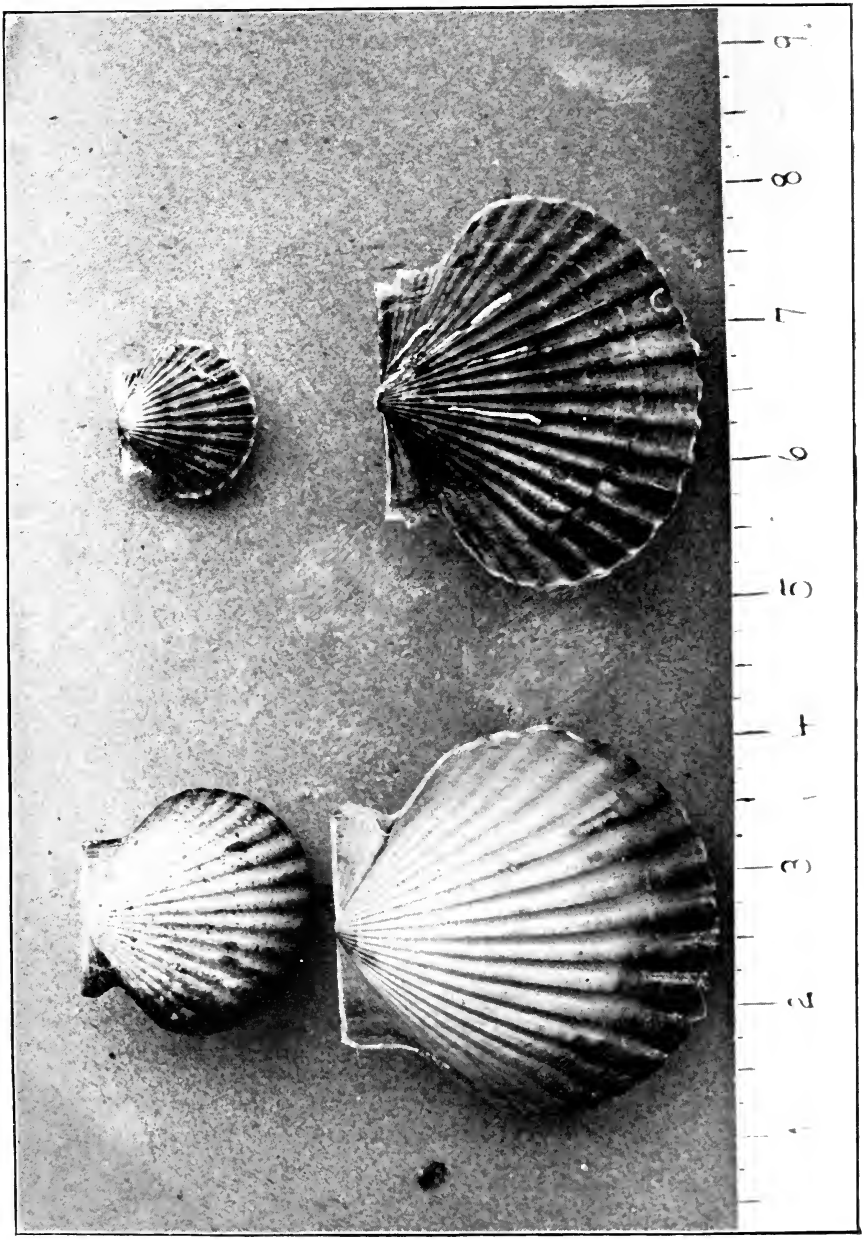

Fig. 102. — Young, yearling and two-year-old scallops. The small scallops on the left are three months old "seed;" those in the center are eleven months old, and have a growth line near the edge of the shell; while the large scallops on the right are twenty-three months old, and have two growth lines, the second being close to the edge of the shell. About one-half life size.

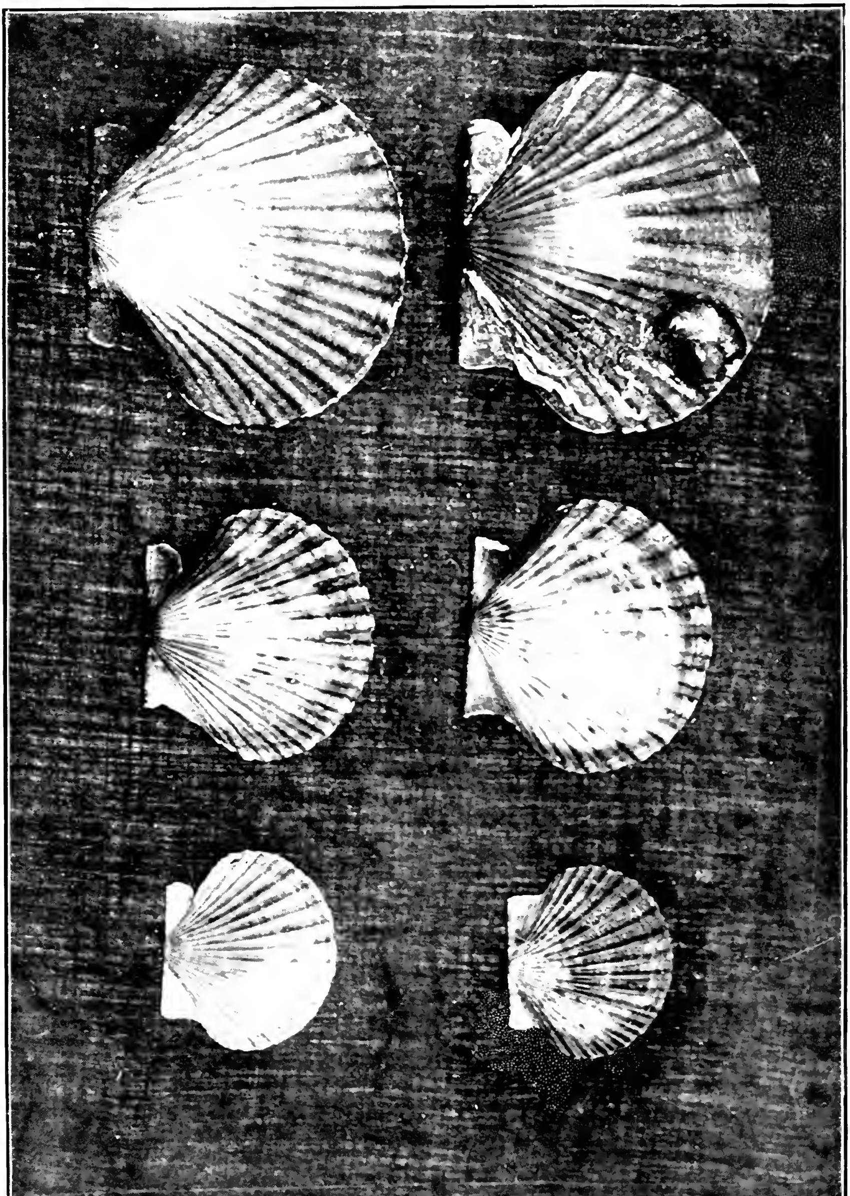

Fig. 103. — The scallop on the left, as indicated by the arrow, has been killed by the oyster drill, which has pierced the shell with a fine hole. A year-old oyster is attached to the scallop in the center, while a *Crepidula* (quarterdecker) has fastened on the scallop on the right.

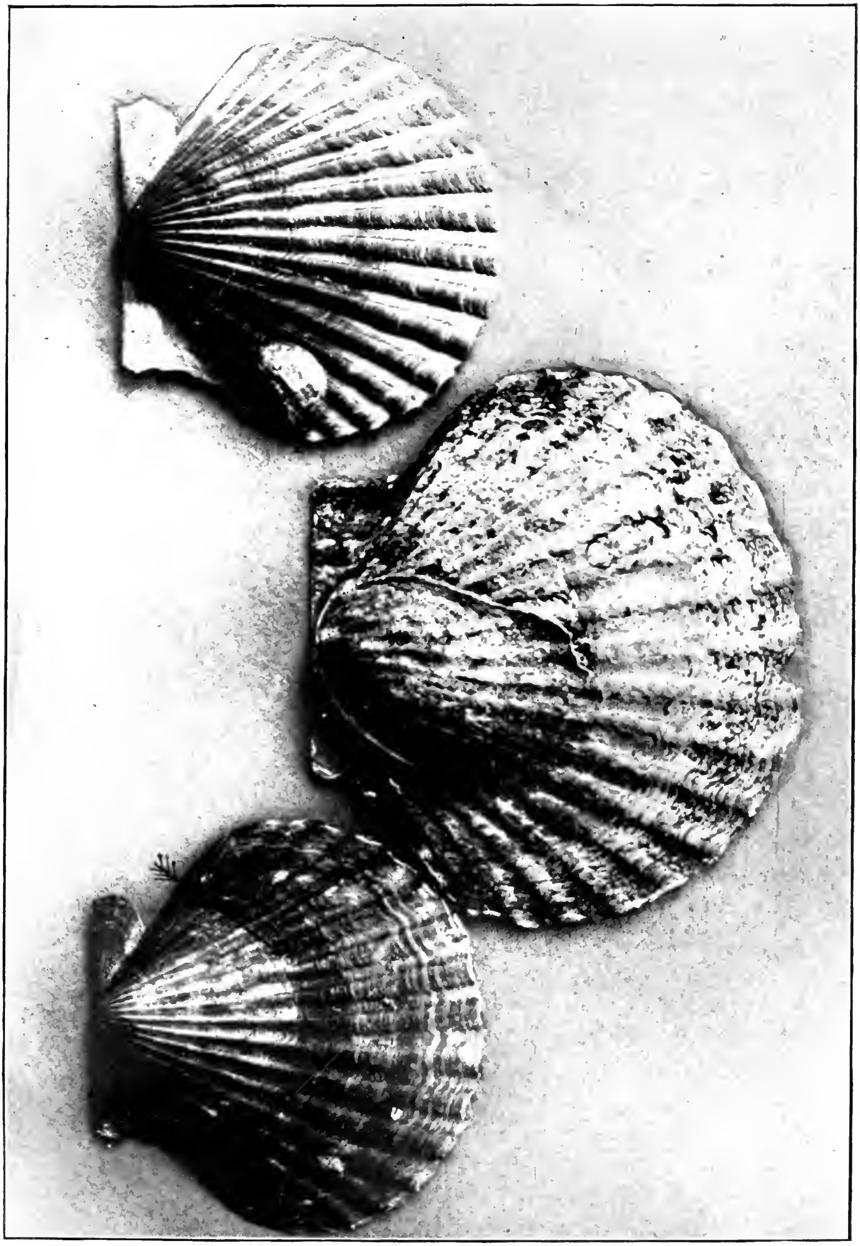

Fig. 104. — These scallops show two or three lines which indicate temporarily arrested growth. A careful distinction should be made between such lines and the annual growth line, which is caused by the non-growth of the scallop during the winter months, appearing about May 1.

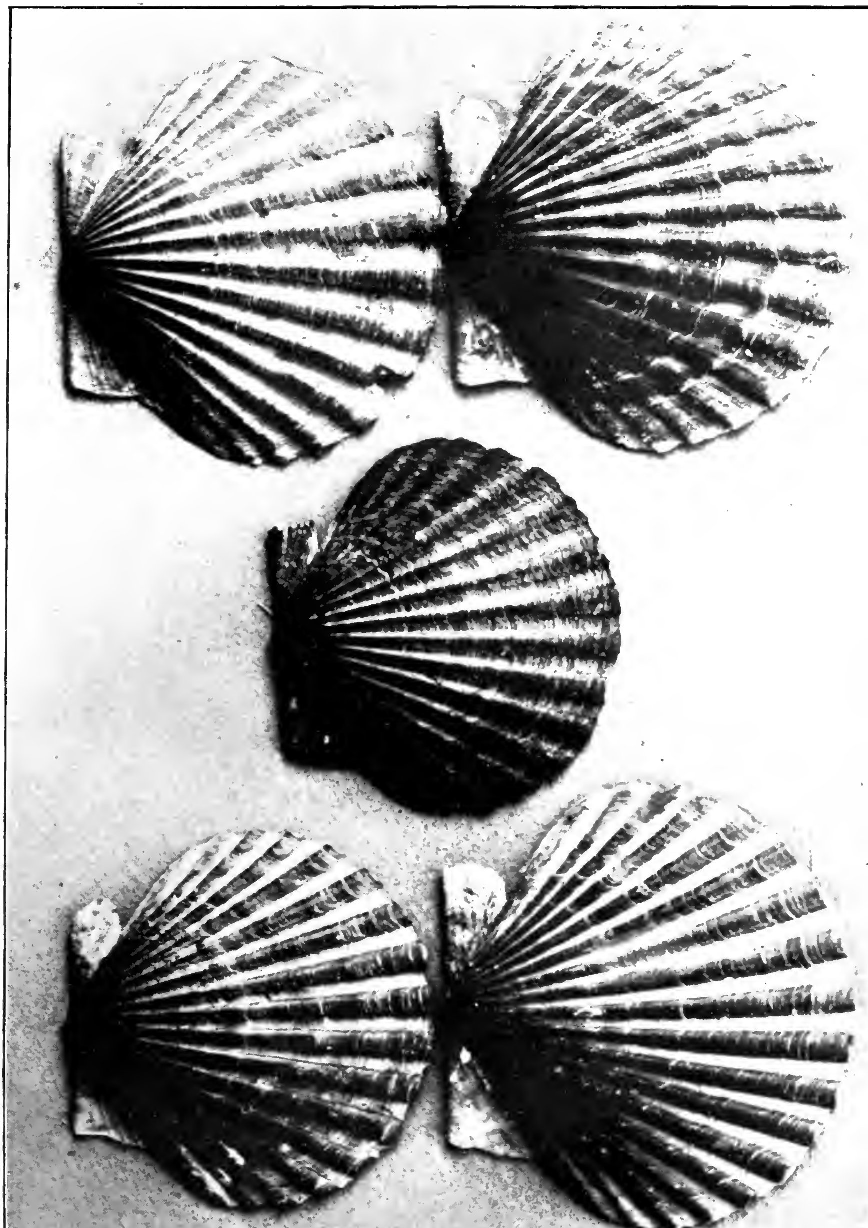

Fig. 105. — Instrument used for measuring the scallops. The scallop is passed down the triangle until it touches on both sides, where the figures indicate its length in millimeters (25.4 millimeters to an inch). The instrument possesses the advantage of speed and accuracy for quick measuring, as many as 1,200 measurements being possible in an hour.

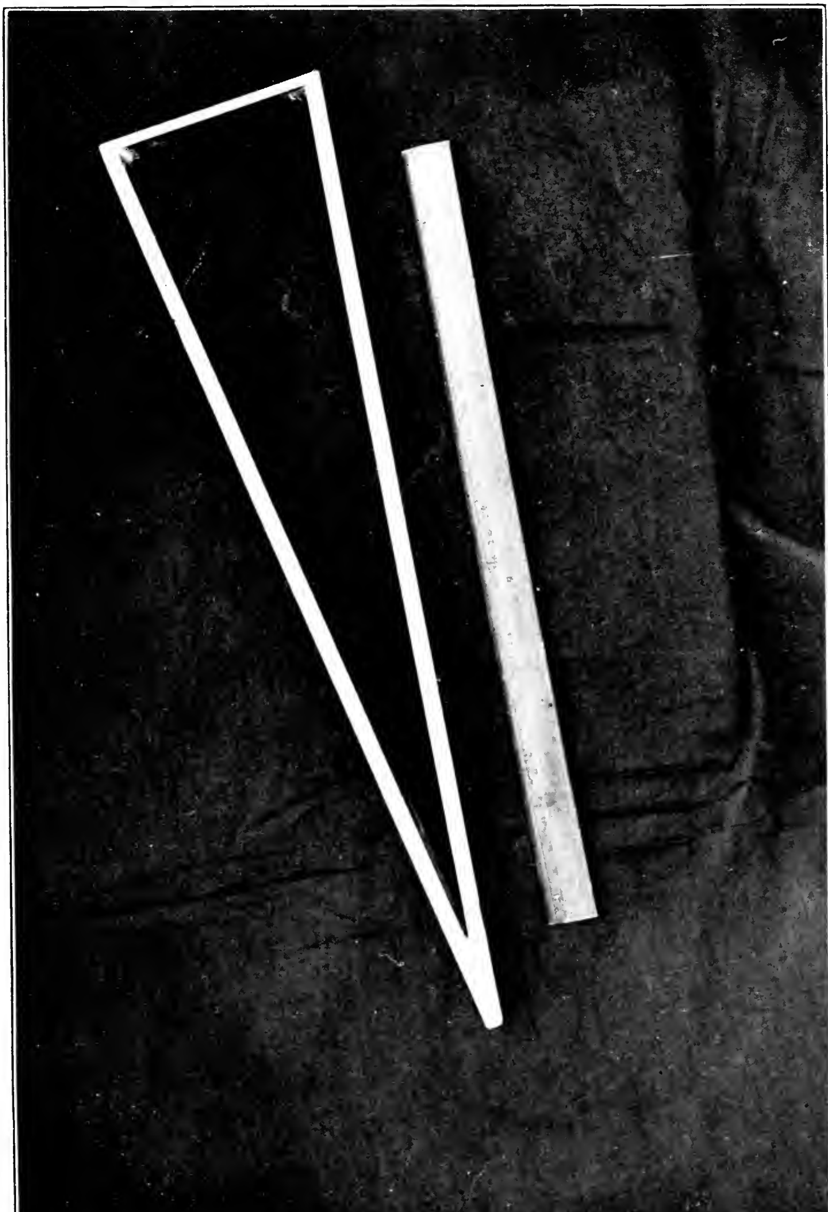

Fig. 106. — The two scallops, each fourteen months old, illustrate the difference in growth between localities with good and poor circulation of water. The scallops situated in the "current" receive more food than in the still water, and naturally have a faster growth, as is shown by the greater size of the "current" scallop.

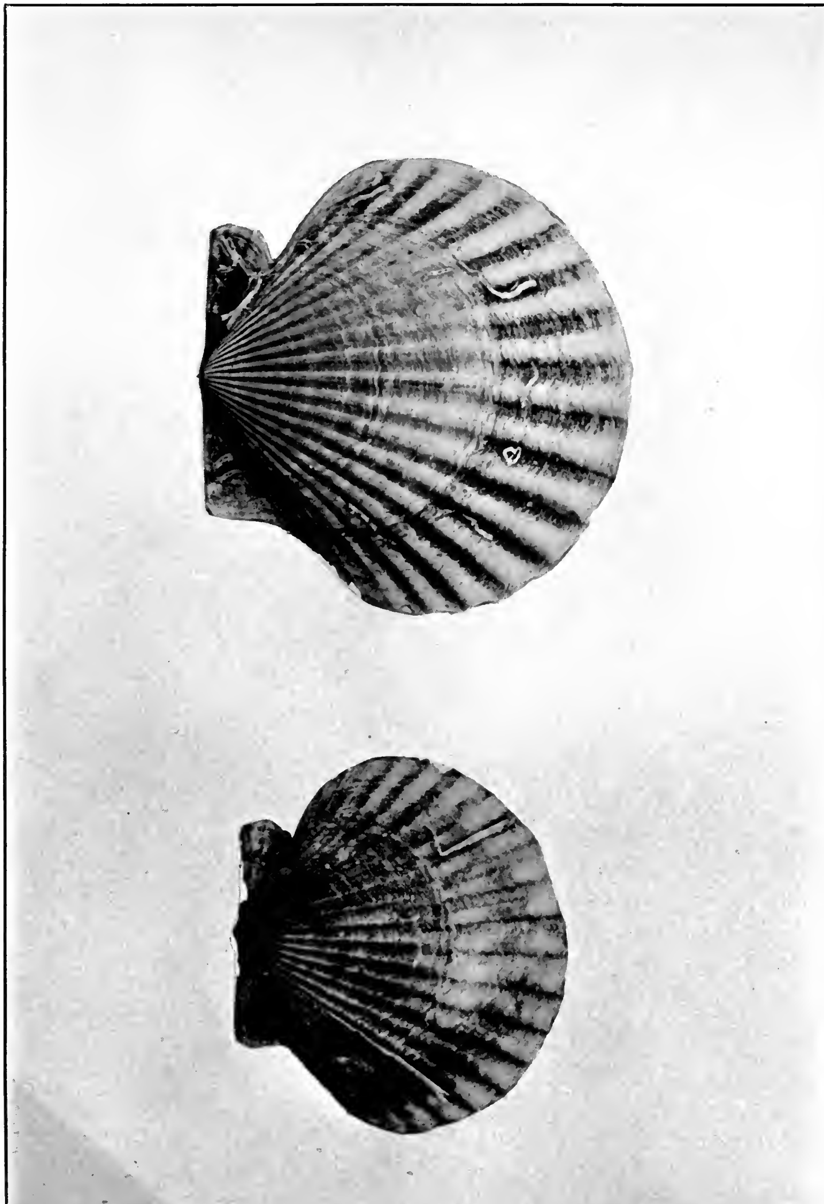

Fig. 107. — The Scallop Pusher. — This implement consists of a wooden pole, from 8 to 9 feet long, attached to a rectangular iron framework, 3 by 1½ feet, fitted with a netting bag 3 feet in depth. The scalloper, wading in the shallow water, gathers the scallops from the flats by shoving the pusher among the eel grass. The photograph shows the correct position of the pusher in operation. Only a small part of the pole is shown.

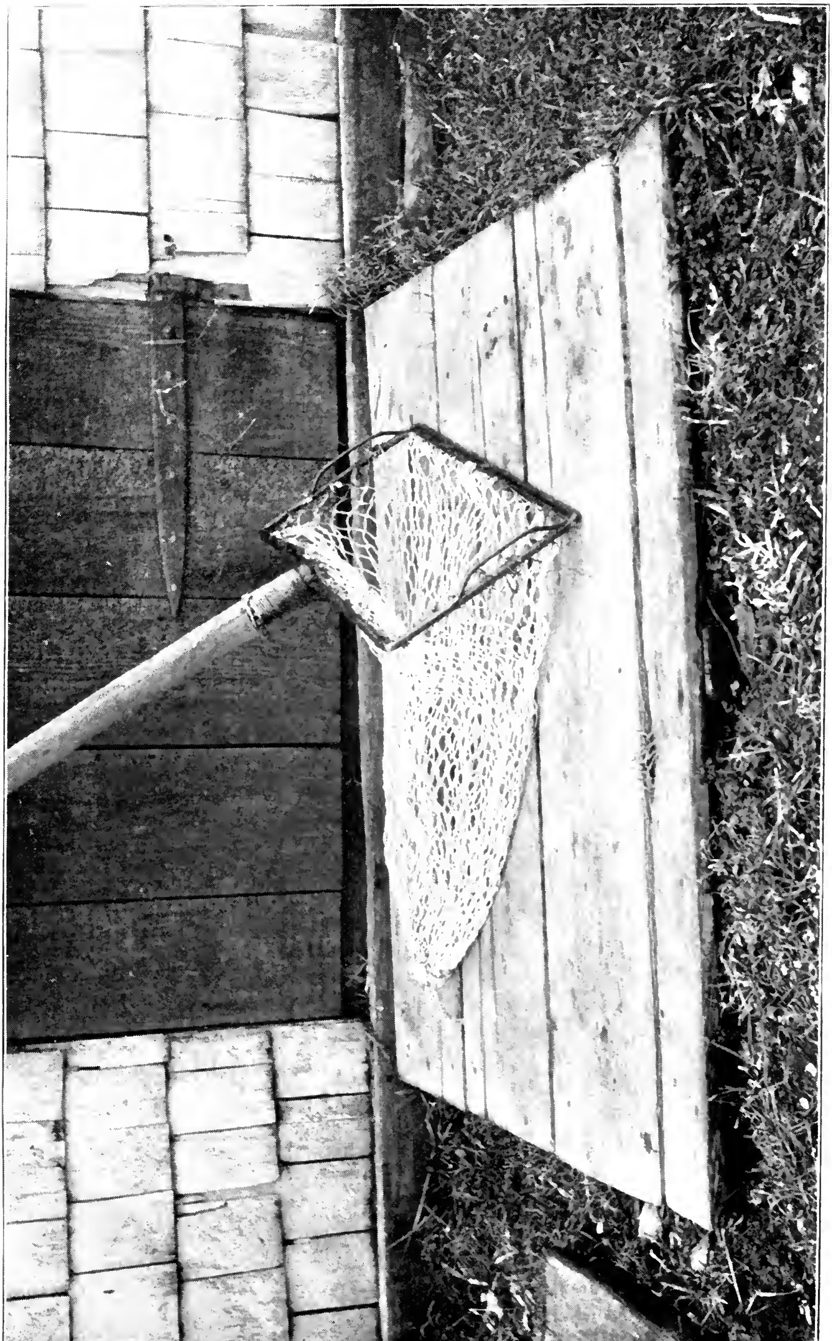

Fig. 108. — Scallop Dredge, — "The Scraper." — This implement has the form of a triangular iron framework, with a curve of nearly 90° at the base, to form the bowl of the dredge. On the upper side a raised crossbar connects the two arms, while at the bottom a strip of iron 2 inches wide extends across the dredge. This narrow strip acts as a scraping blade, and is set at an angle so as to dig into the soil. The top of the net is fastened to the crossbar and the lower part to the blade. The usual dimensions of the dredge are: arms, 2½ feet; upper crossbar, 2 feet; blade, 2½ feet. The net varies in size, usually running from 2 to 3 feet in length and holding between 1 and 2 bushels. Additional weights can be put on the crossbar when the scalloper desires the dredge to "scrape" deeper. A wooden bar 2 feet long buoys the net. The scraper used at Nantucket has the entire net made of twine, whereas in other localities the lower part consists of interwoven iron rings.

Fig. 109. — Scalloping boats between the wharves at Nantucket. The cat-boats are moored in this fashion after the day's dredging.

Fig. 110. — The start. Leaving for the scalloping grounds.

Fig. 111. — The scalloping fleet at work on the beds.
Fig. 112. — "Dredging."

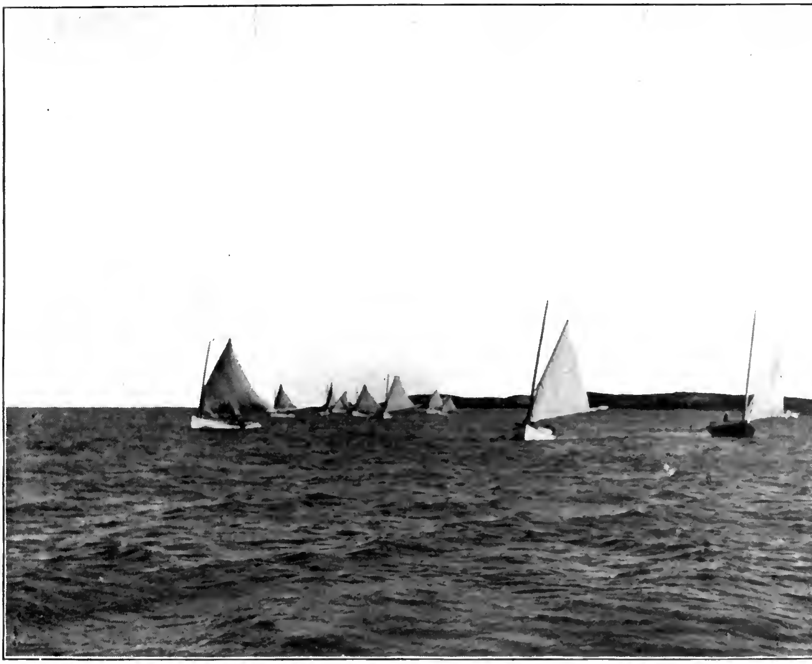


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Fig. 113. — Emptying the contents of the dredge on the "culling" board, where the scallops are separated from the eel grass and other débris.
Fig. 114. — "Culling."

Fig. 115. — Landing the catch on the wharf.
Fig. 116. — Carrying the scallops to the shanties, where they are opened.

Fig. 117. — Shell heap outside the shanties at the end of the season.
Fig. 118. — The finished product, packed in kegs, ready for shipment to market.

NOTE. — Figs. 109–118 are from an excellent series of photographs furnished by Mary H. Northend, Salem, Mass.