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University of the State of New York

BULLETIN

OF THE

New York State Museum

FREDERICK J. H. MERRILL *Director*

No. 43 Vol. 8

April 1901

CLAM AND SCALLOP INDUSTRIES

OF

NEW YORK STATE

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BY

JAMES L. KELLOGG Ph.D.

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INTRODUCTION

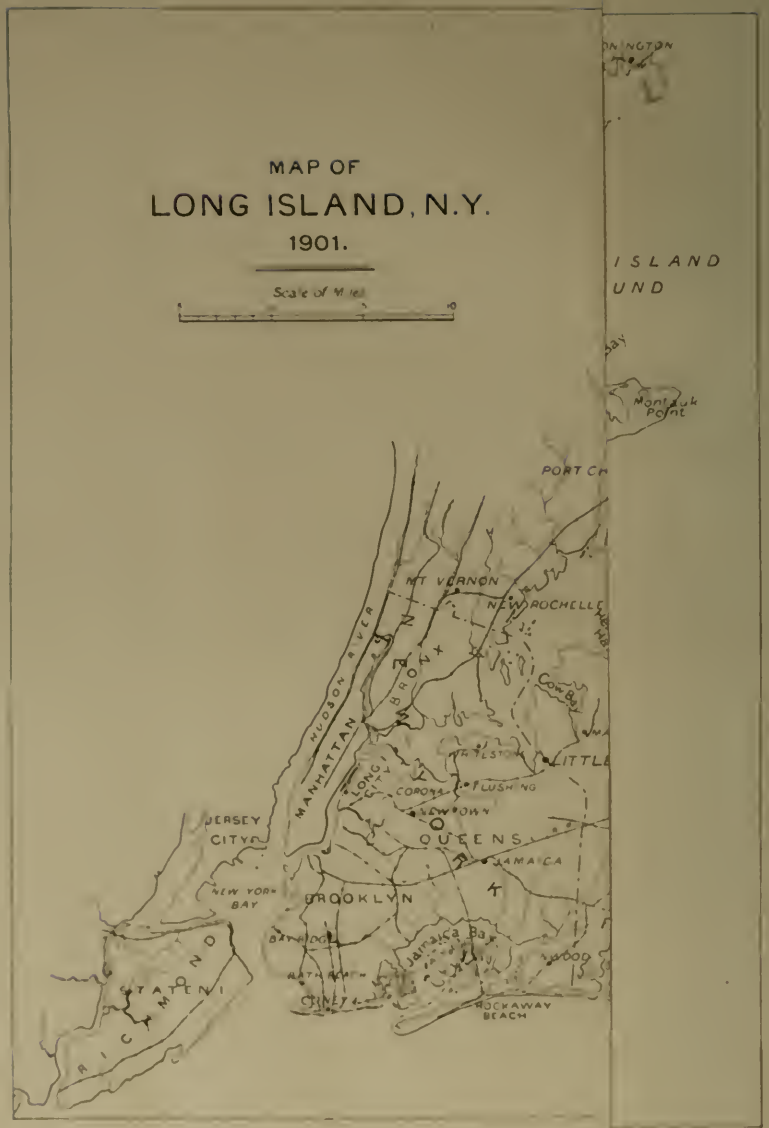
The growth of commercial interest in the natural resources of our country and the public appreciation of the importance of scientific knowledge in husbanding and developing these resources, have made it necessary for the state museum, in its relation to the public of New York, to give attention to all parts of the animal, vegetable and mineral kingdoms which contribute to the needs and comforts of our citizens. There being comparatively little accurate knowledge accessible to the public on the subject of the life history of the clams and scallops and the possibility of their cultivation, the director has been led to engage the services of Prof. James L. Kellogg, of Williams college, to study and report on the subject in which he is the acknowledged master.

While, in the brief space of one field season, it has not been possible to exhaust the subject, the following report is issued in the belief that it will meet the wants of many persons throughout the state.

FREDERICK J. H. MERRILL

Director

Albany N. Y. Dec. 1900


MAP OF
LONG ISLAND, N.Y.
1901.
Scale of Miles
MT VERNON
NEW ROCHELLE
HUDSON RIVER
MANHATTAN
BRONX
LONG ISLAND
CORONA
FLUSHING
LITTLE
JERSEY CITY
QUEENS
JAMAICA
NEW YORK BAY
BROOKLYN
STATEN ISLAND
ROCKAWAY BEACH
Montauk Point

CLAM AND SCALLOP INDUSTRIES OF NEW YORK STATE

DEPLETION AND RESTORATION OF SUPPLY

The comparisons so frequently made btween the social conditions and habits of European peoples and our own, for many reasons are worthy of careful consideration. In Europe the ignorance of the masses in most regions is greater than in America. The greater part of the population is poor. Intercommunication amounts to almost nothing, and the simple needs and desires of a people remain what they have been for many decades.

In America everything is different. The aggressive methods of commercial enterprises, the form of government by the people, the migration into new territory, and popular excursions and expositions, have tempted even the most humble to more or less extended travel. The idea of a diversified life has become national. A knowledge of the social habits of one community has added to the desires of another. The entire country has become the most homogeneous of the nations of the earth, though made of the most diversified units. One portion has stimulated another till the whole has advanced rapidly. The art of living better has been practised by all, and the high-priced luxuries of yesterday have steadily become the low-priced necessities of today. The demand for a rare commodity increases its production, lowers its price, and again enlarges its demand till a certain balance of supply and demand has been reached, which usually brings it within the means of all.

There have been some cases, however, in which the demand has been met with such reckless indifference to future supply, that established industries have been threatened with destruction. In no

MAP OF
LONG ISLAND, N.Y.
1901.

Scale of Miles
5 0 5 10

LONG ISLAND SOUND
BLOCK ISLAND SOUND
ATLANTIC OCEAN
NEW LONDON
STONINGTON
FISHERS I.
Connecticut River
NEW HAVEN
GUILFORD
MILFORD
BRIDGEPORT
Housatonic River
NORWALK
STAMFORD
PORT CHESTER
PLUM I.
Orient Pt.
GREENPORT
GARDINERS I.
Gardiners Bay
SOUTHOLD
SHELTER I.
Fort Pond Bay
Montauk Point
Napeague Harbor
Little Peconic Bay
SAG HARBOR
AMAGANSETT
EAST HAMPTON
BRIDGEHAMPTON
Great Peconic Bay
AQUEBOGUE
RIVERHEAD
WADING RIVER
Smithtown Bay
SETAUKET
PORT JEFFERSON
Huntington Bay
Oyster Bay
NORTHPORT
Cold Spring
HUNTINGTON
SMITHTOWN
MANORVILLE
SHINNECOCK HILLS
Shinnecock Bay
CENTER MORICHES
Moriches Bay
SOUTH OF
MT VERNON
NEW ROCHELLE
Hempstead Harbor
GLEN COVE
OYSTER BAY
SEA CLIFF
MANHASSET
WHITESTONE
LITTLE NECK
FLUSHING
CORONA
NEW TOWN
HICKSVILLE
OLD I PARK
OAKDALE
ISLIP
PATCHOGUE
BAYPORT
SAYVILLE
BAY SHORE
BABYLON
LINDENHURST
AMITYVILLE
Great South Bay
FIRE ISLAND OR GREAT SOUTH BEACH
Fire I Inlet
NASSAU
QUEENS
GARDEN CITY
HEMPSTEAD
MASSAPEQUA
SEAFORD
FREEPORT
JAMAICA
JERSEY CITY
NEW YORK BAY
BROOKLYN
BAY RIDGE
Jamaica Bay
INWOOD
ROCKAWAY BEACH
LONG BEACH
RICHMOND
STATEN I.
MANHATTAN
BRONX
HUDSON RIVER
LONG I.

case has this been better exemplified, perhaps, than in the taking of marine food. The demand for salt-water fish and mollusks has increased at a great rate during the last few years. In all the smaller, as well as in the larger cities and towns of the interior, the demand for fresh mackerel has been added to that for the salted fish. Rich and poor alike have formed a liking for fresh halibut, cod, herring, smelt and shad. Even in a more marked degree has the public demanded the oyster, first in the can, then in "bulk", and finally in the shell. The secret of successful canning, put into practice soon after the civil war, led to the distribution of such food all over the Union. Salmon, oysters, lobsters and clams found a great market in this way, and the production assumed enormous proportions. But in most of these cases, the natural supply soon showed signs of failing.

In Chesapeake bay, probably the most favorable locality in the world for the growth of oysters, the natural beds gradually failed from excessive dredging. The simple method of transferring small oysters to bottoms where oyster food was abundant, though the conditions were not favorable for reproduction, were resorted to with great success about Long Island, and along the southern New England coast. The industry is still growing. In parts of Long Island sound, the "spat", or swimming embryos, "set" or attach themselves naturally, and oyster life in these regions has become much what it is on natural beds. Even the small oysters used in transplanting, are now taken from these beds, and the whole industry has become largely independent of the southern supply. While the conditions of growth are much more favorable in the Chesapeake, the laws of Maryland and Virginia offer little protection to the oyster "farmer", and a very great revenue is lost to those states. While the supply of oysters was at one time seriously menaced, intelligent methods of artificial propagation have permanently established the industry on the northern coast.

With some other forms of marine food this restoration will be much more difficult. It is never attempted in any case till extermination has become almost complete. Even with abundant material for his work, the culturist often finds it hard, or even impos-

sible, to control the young during its precarious early life till it reaches that stage of development where it is able to care for itself.

Everyone is familiar with the extensive and remarkably successful work of the United States and the various state fish commissions in the propagation of marine and fresh-water market fish. In many cases, the continued supply is probably directly and entirely due to the artificial hatching and judicious distribution of the young fish. These institutions have made it very clear that public moneys could not be better expended for the benefit of all classes of people than in their support. Their field is constantly enlarging, also, as one after another of aquatic food animals diminishes in number, and begins to disappear. If the fact were only recognized, that this threatened extinction of forms really is occurring, these commissions and similar institutions would receive much greater support in the form of legislative appropriations. More money for carrying on the work already attempted is urgently needed, and more still will be required as the field of labor enlarges. At the same time, it is money most profitably invested for rich and poor alike.

The reestablishment of a destroyed industry which depended on organisms living and reproducing in a natural state, is usually slow. No one would expect a community depending on wild cattle for its beef to consider the future seriously till the supply was nearly exhausted. Men seldom look far ahead in such matters. When the extinction is practically accomplished, they cast about for a remedy. The close season suggests itself. But, while waiting for the few remaining animals to increase to the necessary number, man is necessarily deprived of food. Even if the flocks quickly recover their numbers, because natural conditions for their growth are favorable, the same decrease and destruction is very likely to recur.

The point is that, when an organism—animal or plant—is largely used as food by man, nature is most often unable to keep up the supply indefinitely, and man must breed and cultivate the desired form under controlled, and more or less artificial conditions.

In our illustration, the habits and needs of the animal—specially the need of food—must be determined, in order that, under confinement, a maximum rate of reproduction may be obtained. In ad-

dition, an increase in the quantity and an improvement of the quality of flesh are aimed at, though this is brought about in higher animals by a careful selection, in many successive generations, of breeding individuals. The whole industry must be built up on an artificial basis, and the first step is to discover in detail the habits and needs of the animals in the natural state.

The same is true of marine food animals. The history of the re-establishment of their supply shows that in every case almost complete destruction has been threatened before any move has been made to improve matters. While a more or less extensive close season operates favorably in some cases, it usually fails permanently to correct the evil condition. While in operation, it suspends the supply altogether. At times it seems to be a necessity in order to prevent complete annihilation; but, if artificial methods were developed early enough, it would not be necessary.

Food supply and proper environment are obviously more obscure in the case of marine than of terrestrial forms, and in many instances are almost entirely unknown. It is surprising to find how true this is even with food animals with which we have long been familiar. But before artificial methods of culture can be developed, it is of course necessary to know the animal's habits and its relations to its surroundings, and to understand all the necessary conditions thoroughly. It is the necessity for this preliminary scientific work that is probably least understood by the public. This work is sometimes slow, and not always productive of economic results, but it is always the necessary first step in developing culture methods.

MYA ARENARIA

Soft clam, or long-neck

It has been, and still is assumed that nature is so lavish in her supply of certain animals that man is unable greatly to diminish their number, much less to cause actual extinction. This is a dangerous belief, but still very common. The lesson of the buffalo and wild pigeon, whose countless multitudes have been known to men of this generation, is not heeded. Scores of similar cases apparently have not lessened man's presumption.

For many hundreds of miles along the north Atlantic coast, it has always been possible to find our common long-neck, or soft clam. It has long been used extensively in the market, and has been dug for so long a time that the supply was apparently limitless. 10 years ago it perhaps would have been impossible to find anyone who believed that a time would ever come when this area should become practically barren. Even at that time, clams were not so abundant as formerly, but the area was great; clams could be taken almost anywhere. They were not everywhere numerous, but in some localities the supply seemed to be without limit. But suddenly the unexpected happened. During the last three or four years, the supply rapidly diminished, and the industry became almost completely paralyzed, excepting in Maine and certain parts of Long Island. Immense flats, long productive, now bear practically nothing. The few remaining regions where clams are dug of course are taxed to such an extent that they can not long maintain themselves. The state of Maine has recently (1899) recognized this fact, and has made the busy summer months (June 1 to Sep. 15), a close season, in which clams may not be canned, exported or sold. While the soft clam has disappeared from many parts of Long Island, there are still two or three localities where they are fairly abundant. These regions, however, not only are called on to yield an increasing number, but they are confronted by a new and peculiar problem in the relation of the clam and the oyster interests which will be described presently. There can be no question that this ruin of the clam industry on our Atlantic coast has been accomplished by excessive digging without corresponding efforts to increase the supply by culture methods. The falling off has been noticed for more than 20 years, but the final disappearance came suddenly.

It must be remembered that the record of market sales does not necessarily indicate the real abundance of the forms considered. A greater demand means a greater production till the limit is reached. An increasing demand, with its higher prices, means that more men are collecting the supply, and with increased energy. It is very evident, then, that the final exhaustion will come suddenly, and

that the record of the market does not indicate in advance just when that evil day shall appear.

It is true, however, that the demand for clams and scallops has been increasing steadily for many years. To our personal knowledge, several towns and smaller cities in the Mississippi valley which formerly consumed a small number of canned clams, have more recently demanded, during the winter months, larger and larger quantities, not only in cans, but also in the shell. The demand has grown rapidly in recent years with the knowledge of their value as a food. Even scallops, sold fresh in bulk, are finding a market farther and farther from the shore.

From the fact, then, that the soft clam has been steadily demanded in increasing numbers for some time past, the following tables will be instructive. They indicate the market supply to 1892, and are taken from the report of the United States fish commissioner for 1894. The item referring to the supply from Rhode Island in 1898 is taken from a paper by Dr A. D. Mead in the 13th annual report of the commissioners of inland fisheries of Rhode Island. The interesting figures covering the Maine supply for 1898 were recently received from the able commissioner of sea and shore fisheries, Mr A. R. Nickerson. They show an enormous increase in the supply over any previous year of which we have any record, and thus show that the previous figures gave no adequate idea of the actual supply. Many factors enter into the explanation of this increase in the number of clams marketed, the most important of which is the fact that the sudden decrease in the supply from other New England states left Maine alone to answer the demands of the general market. That her clam beds are already suffering from the enormous drain is shown by the fact above mentioned, that in 1899 her legislature passed an act prohibiting the sale of clams in any form from June 1 to Sep. 15 in each year.

Emphasis must be laid on the fact that these figures do not really indicate the abundance of clams on the beds at any time. Without the figures of the Maine supply for 1898, we should get an entirely erroneous idea of the conditions in that state. The sales in Massachusetts and Connecticut since 1892 would undoubtedly show

a great decrease. We were not able to get the figures covering these last eight years, or for any one of them, in these states.

Soft clam supply by states

Maine

	Bushels	Value
1880	318 383	$101 808
1887	608 780	228 490
1888	600 675	227 665
1889	595 105	200 761
1892	416 806	157 431
1898	1 109 936	393 577

New Hampshire

	Bushels	Value
1880	17 960	$8 980
1887	280	140
1888	300	150
1889	300	150
1892	1 050	975

Massachusetts

	Bushels	Value
1880	158 626	$76 195
1887	230 659	121 202
1888	243 777	127 838
1889	240 831	137 711
1892	191 923	133 529

Rhode Island

	Bushels	Value
1880	53 960	$48 564
1887	25 825	25 030
1888	30 825	30 030
1889	33 375	32 475
1892	33 950	45 222
1898	15 015	20 569

Connecticut

	Bushels	Value
1880	75 000	$38 000
1887	26 735	25 370
1888	26 575	24 270
1889	26 360	24 900
1892	23 780	25 320

It will be noticed that, with two exceptions, we have in these tables no reference to sales during the last eight years. No serious attempt has been made to collect data showing market sales in New York, for, as explained, such a record does not show conclusively the productive capabilities of the beds. The only way to obtain a knowledge of this is by visiting the clam flats and beaches. Since the summer of 1898, a large part of the shore from the state of New Hampshire to the city of Brooklyn has been personally explored, and while Maine, for clearly understood reasons, has increased her market supply—not her resources—at almost every other point on the coast, the soft clam industry has been practically ruined.

Soft clam supply in New York

The industry in this state has been extensive. It became apparent that the supply of hard and soft clams, and of scallops, was decreasing, and at the invitation of Dr F. J. H. Merrill, director of the New York state museum, a personal inspection of the entire coast of Long Island was attempted during the month of September in the present year (1900), with the view of determining the present condition of the beds. Though it was necessary that this examination should be a hurried one, its results show conclusively that, except in one or two localities, the accomplished depletion of the New England coast is being repeated here.

A reference to the appended map of Long Island will show at its eastern end very extensive bodies of water in Peconic and Gardiners bays. The surrounding shores of both seem to be wonderfully adapted to the growth of the soft clam. According to the reports of clam-diggers in that region, even so far inland as at Riverhead, thousands of bushels dug at the west end of Peconic bay are marketed there every winter. It is maintained that recently there has been a noticeable diminution in the supply, but that it has not as yet become alarming. The shores of Shelter island, except on its northern side, have produced many clams. The supply here also is said to be falling off rapidly.

Shelter island, like the greater part of Long Island, supports an increasing summer population, which is already very large. In

recent years, these visitors, during their stay, probably have caused an increase in the demand for clams. It is a curious fact, however, that, while in New England the soft clam is used extensively during the summer months, in the popular clambake, there is very little demand for it anywhere on Long Island during that season. There the hard clam, or "little-neck," is in favor, and is used, too, in great numbers. It is probable, then, that on no part of the island does the influx of summer residents greatly stimulate the digging of the soft clam. However that may be, clams are certainly being dug much too rapidly in this region.

On following the coast eastward from Sag Harbor, to Fort pond bay, many small bays and inlets appear which are among the most favorable localities on the entire coast for the growth of the soft clam. Such a place as Napeague harbor, for example, contains a supply so great that it has been regarded as being inexhaustible. Comparatively few clams from this part of the island are sent to New York. Very many are marketed at New London and other New England centers for distribution. A great number, also, are used for bait by fishermen. It was stated that one vessel recently was able to secure at Napeague about three hundred bushels in a short visit, for such a purpose, and that this amount has been repeatedly taken. If such reports are true, the supply is still great; but at all points on this coast it is the almost universal testimony that the beds are being depleted and ruined at a surprisingly rapid rate. This condition has come about during the last two years, and is causing great concern. Measures should now be taken, before there is an actual destruction of the industry here, to conserve the supply of this remarkably productive region. With a little knowledge of the life history, the habits and needs of the clam, with little labor and a small outlay of capital, this can be accomplished easily, as we shall attempt to show later.

On the south side of the island, from Montauk point to Rockaway beach, is a straight reach of sand on which the surf continually rolls. On this exposed sea side, the conditions are nowhere favorable for the growth of either the soft or hard clam. The sand, however, forms a great spit which shuts in several large bodies of water, leav-

ing inlets here and there at rare intervals. In many parts of these bays the hard clam, or little-neck, was formerly very abundant, as will be shown presently, but, because there is very little tide, beaches and flats are not enough exposed to allow the digging of the soft clam. It is known that in some places this form lives below the low tide mark. There are such beds in the Great south bay, but, as the creatures are burrowed into the bottom from six to 12 inches, and even deeper, their capture under water becomes a laborious process, and is seldom resorted to. In Shinnecock, Moriches and Great South bays, then, comparatively few of the soft, or long-neck, clams are dug for market, though more of these forms than is ordinarily supposed may exist in the mud below the low water mark.

There is one locality on the south side of the island where M y a is apparently abundant, and is dug in great numbers. That is Jamaica bay, with its shallow water, and its relatively great rise and fall of tide, which alternately covers and exposes a large area of mud flats. Unfortunately, lack of time prevented a thorough examination of this bay. Many residents of its shores agree in stating that it contains an abundant supply of soft clams, many of which are sent to the New York markets, eight or 10 miles away. It is said that there are places on the flats where it is possible for a man to dig five or six bushels in a fair low tide. Assertions of this kind should be carefully verified before being accepted.

This bay, situated at the door of the New York market, a bay with extensive flats and rapid currents, affording most favorable conditions for the growth of clams, seems to be a very valuable property; and if the few reports we have about it are true, it should be carefully guarded and protected against that depletion and ruin which comes from excessive digging, and which has recently visited similar and equally extensive flats. Because the supply has apparently continued till now, and may seem to be inexhaustible, there is no reason why the beds may not become as barren as those at Duxbury and at Essex in Massachusetts. At one time in the latter town, 100 men steadily obtained from $2 to $5 a day by digging the soft clam. Today there are not 10 men engaged in the work, and, with a greatly increased price for the product, they

obtain from 50 cents to $1.50 a day for their labor. Practically no clams are allowed to grow to a size suitable for market, so closely are they sought by the diggers. The ruin of the great Duxbury flats is just as complete. These lessons should certainly be heeded by those who still possess productive clam flats.

Passing to the north side of the island, there are several arms of the sound, at its western end—Cow bay, Hempstead harbor, Oyster bay, Huntington bay and Smithtown bay—in which the history of the clam industry is very much the same. Several years ago, these extensive shores bore the soft clam in great numbers. The history of the New England coast has been repeated here. There was for many years a gradual diminution in the number of clams. During the past two years, the falling off in the supply has been very great, and the beaches are now becoming practically barren. No other part of the coast of Long Island seems to be in a more dangerously depleted condition. As in all similar cases, this is certainly not due to a change in the nature of the bottoms or of the waters of these bays, but has resulted solely from excessive digging. A close season extending through the summer months, is in operation, but it seems to have had little influence in checking the decrease.

To the east of Smithtown bay, the shore is bold and little broken by inlets, and here neither the soft nor the hard clam has ever been abundant.

From this hurried examination of the shores of Long Island, it appears that many extensive areas offer extraordinarily good natural conditions for the growth of *Mya*, the soft clam. The supply, also, is now much greater than on the New England coast except in Maine. This is fortunate; for, if immediate steps are taken to prevent it, the destruction of the industry may be averted, and the supply increased at a time when the demand is rapidly growing and prices are rising. The regions which, under these circumstances, first introduce culture methods are to derive great benefit from the enterprise, and, having obtained the market by means of this advantage, should for some time be able to hold it. This fact is recognized by one New England state, which has made appropriations that are available for a practical inquiry into the possibilities of clam culture.

Our chief conclusion must be that in most localities along the shore of Long Island the supply is now failing rapidly, and, unless these methods of artificial propagation are introduced, must soon fail completely.

Life history of Mya the soft clam

I have briefly traced the condition in which we find the soft clam industry at the present time, not only in New England, but in New York. We may now consider the question of a remedy for the disagreeable situation which confronts us. If we continue to depend simply on the natural powers of reproduction and recuperation of this form, we shall certainly soon see the end of the large supply on which we have so long depended. Fortunately there seems to be a way to meet the difficulty, and not only recover the original supply, but produce one even larger.

It has already been shown that, before it is possible to develop culture methods for the artificial rearing of any form, it is necessary to possess a knowledge of its habits, the character of its food, its relations to its enemies—in short, as complete an account as possible of its life history.

It is a curious, but common experience to find that we still lack such a knowledge of some of the most familiar animal forms. In a general way, we have for many years known something of the structure of the common clam, and something also of the character of its food. Till 1898, however, almost nothing whatever was known of its life history, including the limits of the breeding season, the habits of the young and the relations of the animal to its surroundings. In that year a study of the form was made in order, primarily, that the knowledge obtained might be applied in the elaboration of methods of artificial propagation. Since that time, many experiments, the results of which are not yet published, have been carried on for the United States fish commission, and have shown that the culture of the soft clam may easily and successfully be accomplished on a large scale. It may be noticed that we are still without knowledge of the life histories of the hard clam and the scallop, though the present necessity seems to demand it.

What we know of the life and habits of Mya may be summarized briefly.

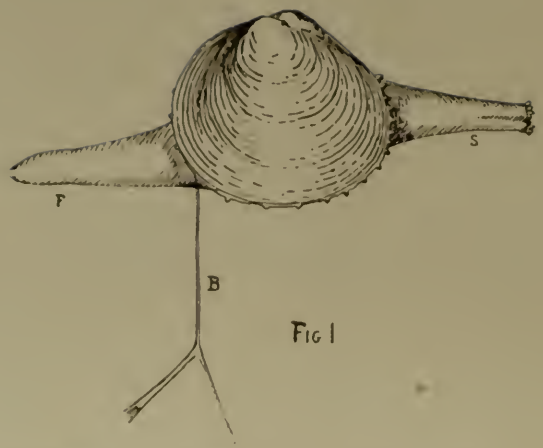


Fig. 1 Drawn from living clam .4mm (less than one fiftieth of an inch) in length. S, siphons, two tubes, one of which conducts water bearing food and oxygen to the body within the shell, the other conducting a stream containing waste matter to the exterior. F, foot, the organ of locomotion. B, byssus, a delicate thread for attachment, which is not present in the adult.

The breeding season extends through the months of May, June and July, though in this last month comparatively few young are produced. The sexes are separate, and the ova, or egg cells of the female, as well as the spermatozoa, or sexual cells of the male, are extruded directly into the water. Here a single spermatozoon unites with an ovum, the two becoming a single new cell. This cell multiplies and eventually builds the body of an embryo. By means of delicate, hairlike projections from the body, which lash very rapidly in a definite direction, the creature is enabled to swim. The details of these early stages in the clam are not known.

We do know, however, that eventually the swimming embryo develops a minute shell similar to that in the adult, in that it is made up of two pieces covering the right and left sides of the body.

During the continuance of the swimming period the creature may have been carried, not only by its own efforts in swimming, but also by tide currents, to some point far removed from that where its life began. A single pair of clams may give rise to millions of embryos during one season. The great majority of these are lost, but a few, losing their swimming organs, happen to settle in some locality which is favorable for their future growth and development.

From this time, their history has been followed in some detail. The small clams, when they cease swimming, are still minute in size. Many individuals only .4 of a millimeter in length have been observed, and their bodies are so small as to be indistinguishable to the unaided eye from the smallest grains of sand on which they may have fallen.

In its general outline, this small clam is very different from the adult, in that its body is very much rounded, instead of being elongated (fig. 1). As it grows, however, its shell elongates, but, at the same time, the two prominent points of the shell, or umbones, are shifted relatively farther forward, as in fig. 2; and then, eventually, they come to lie nearly in the middle of the shell on its upper side, as in the adult clam.

A glance at fig. 1, drawn from an individual .4 of a millimeter in length, will show two conspicuous structures projecting from the margins of the shell. One of these (s) is the pair of filmy siphons—

the "neck", or "snout", of the adult. There are here two separate tubes, one of which conducts water to, and the other from the body within the shell. These organs are long and fleshy in the adult, and reach from the clam's body in the mud up to the water above. In the young they are relatively small and very delicate.

The other projection is the so-called "foot" (f), the organ of locomotion. It is here relatively much larger than in the adult, and by its peculiar thrusting and retracting movements, the creature creeps on the surface of foreign bodies, or digs into the sand.

One of the most interesting features of the life history of Mya is the fact that from a special gland near the base of this foot, a long, nearly transparent thread, the byssus (b), is produced, which is attached to such bodies as stones or pebbles or to floating objects in the water. It acts as an anchor thread, and undoubtedly is developed that the light, minute body of the very small clam may not be floated about by water currents. It completely disappears before the adult condition is reached, and is developed very soon after the little clam ceases swimming.

These small clams are restless, and apparently always desire to creep about. Though the threads are many times the length of the body, they allow of little movement. From time to time the thread is cast off, for, once attached at its ends to sand grains (s. g. in the figure) or other bodies, it can not be loosed. The clam then slowly creeps about by means of its foot, but soon spins a new thread, at the same time attaching it by its free ends. This may be repeated many times, the clam never remaining for any length of time unattached.

Very early the young clam manifests the digging instinct. Being a helpless creature, and subject to attack by enemies (notably small starfish), it is necessary that it should cover itself in the bottom as soon as possible. When but little more than a millimeter in length, the creature thrusts its tiny foot down between the sand grains in a tireless effort to obtain a lodgment. This can not be accomplished, however, for the light body is still not much larger than the sand grains which it attempts to displace. When a length of two or three millimeters is reached, the body is sometimes partially or per-

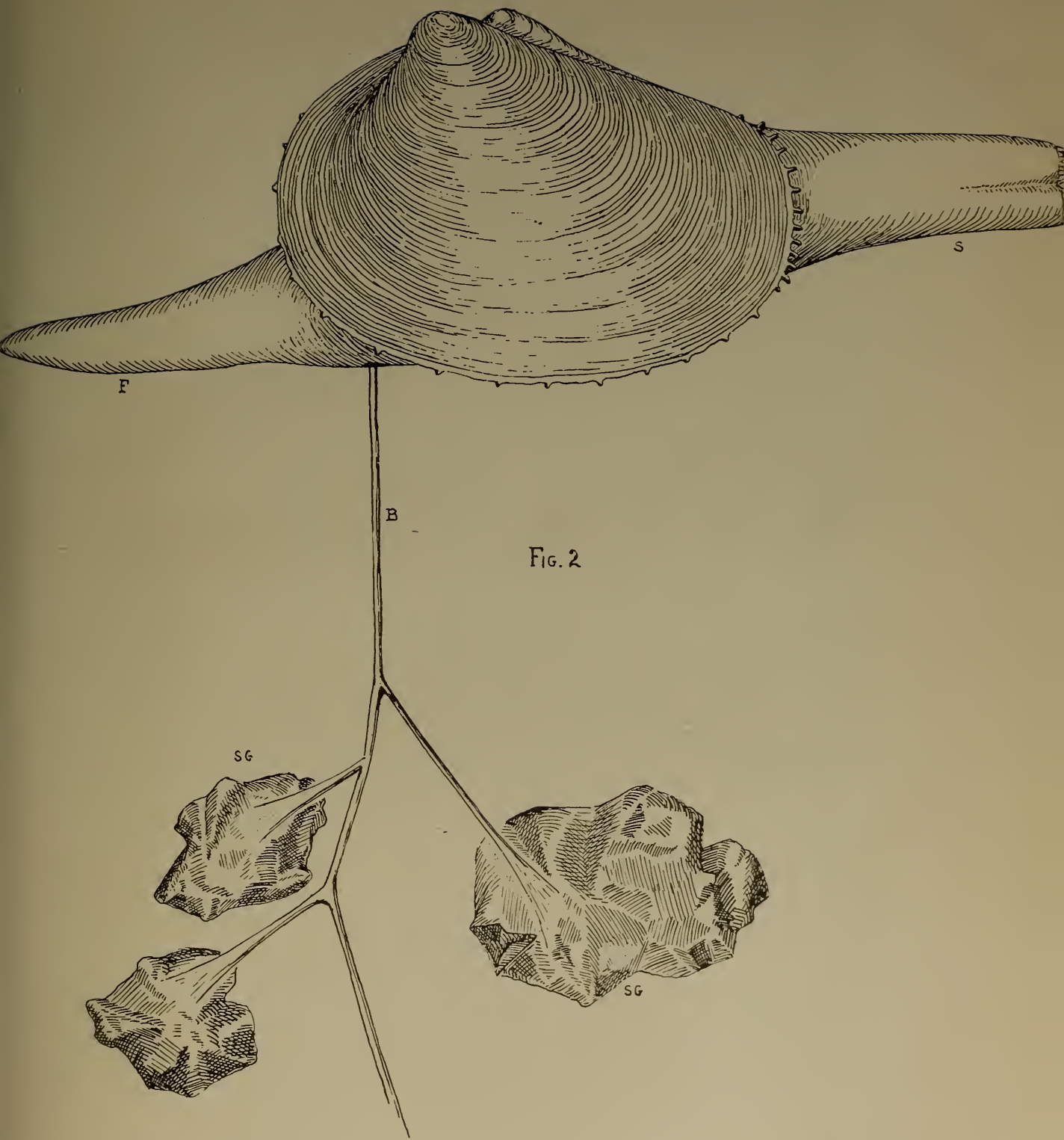


FIG. 2

Fig. 2 Drawn on a much smaller scale than fig. 1, from a clam 2.5mm (about one tenth of an inch) long, taken from its burrow. S, G, small sand-grains to which the byssus is attached. Other reference letters as in fig. 1.

haps wholly covered, if the sand of the bottom be very fine. When a length of 6 or 7 millimeters is reached, a clam is able to dig below the surface on any bottom, and is able to cover itself with much celerity.

As soon as burrowing is possible, the young clam remains buried most of the time, reaching up to the water with its siphons, by means of which it obtains its microscopic food (chiefly diatoms) and the oxygen used in breathing, both of which are suspended in the water. A very interesting fact is discovered when these burrowed clams are dug up and examined. It is that here also the byssus fiber is thrown out and attached firmly to the surrounding pebbles and sand grains, in order that the clam may not be dislodged from its shallow burrow by waves or currents and carried away, or perhaps thrown up on the beach to perish.

Even in its burrow, the small clam exhibits a strange restlessness. It repeatedly casts off the byssus from its body, digs out to the surface, and creeps away, only to go down and again attach itself.

As the clam becomes larger, this wandering habit manifests itself less frequently. It asserts itself, however, till the creature is 12 or 13 millimeters long (about half an inch). An individual of this length still possesses the byssus, but at about this time digs down to remain permanently, and the byssus gland is absorbed, and never reappears. It is simply an organ of the young, and, while in functional activity, performs a very important office, as has been shown. The clam now, except from accident, always remains buried, only reaching up to the surface by its siphons, which soon become long and heavy. If it should be dug up, it is still able to bury itself again, though the foot becomes relatively small. Large clams perform this act of burrowing with very great difficulty.

These, briefly stated, are the chief points of interest in the developmental history of Mya. We may now notice a few facts concerning the "set" of young clams.

The number produced varies greatly in different seasons. The reasons for this are complex and at present not well understood. Whenever a full "set" of clams occurs along the shore, the young are found to occupy certain restricted regions in vast numbers. This

is usually just below the low tide mark and only where currents are comparatively swift. In such favored localities, they often accumulate in such numbers as to touch each other, being crowded as close as they can stand. These are small clams, only large enough to dig beneath the surface. The swimming embryos settle to the bottom both above and below this line.

The subsequent history of their existence in this restricted locality just below the low tide mark is interesting. As they become older and larger, they die on the surface and in their burrows from lack of food.

Beds between tide-lines are recruited only from forms which happen to settle in them.

We thus have during the months of June and July a multitude of small clams which have settled just below the low tide mark in certain restricted localities near clam beds. They are engaged in a severe struggle for existence among themselves, and, if allowed to remain undisturbed, the great majority die. They are, however, only in great numbers during certain seasons. Not in every succeeding year are the numbers great. Observations have not been continued long enough to determine how often, on an average, we may expect a "set" such as was witnessed in 1899 in certain parts of Buzzards and Narragansett bays. Clam-diggers, however, generally state that it occurs every third or fourth year, though, so far as can be ascertained no one has observed the phenomenon closely.

With these data, and some additional points which will be mentioned as we proceed, we may induce certain conclusions which are of value in formulating a plan for clam culture.

1 **Artificial fertilization.** By cutting open the sexual glands of male and female and causing the sexual cells to mingle in a dish of water, fertilization can be effected easily in the case of the oyster. Apparently it is accomplished with difficulty in Mya, but it has been done, and embryos are brought into existence at the will of the operator during the breeding season. But all attempts to control and rear oyster embryos to the adult condition—at least in numbers—have failed. There is every reason to believe that they would fail in the clam. This point, then, may be passed over as being

impracticable, and in the case of the clam, the operation is certainly quite unnecessary, as will be shown.

2 **Tenacity of life in the young clam.** The adult dies quickly in aquariums in warm weather. Very small individuals are, on the contrary, very tenacious of life. They have been carried in an open bucket from Narragansett bay to Buzzards bay in the hottest days of summer, and, though the water in which they were transported became very warm, they had suffered no apparent injury when placed once more in cold water. Not only so, but many, subsequently kept in shallow dishes without change of water, lived for days after a bacteria zoogloea had formed over them. For purposes of planting, then, the young clams may be transported easily for long distances without harm.

3 **Effect of water of differing degrees of salinity.** Fortunately for the clam culturist, the adult Mya will thrive not only in water which is very salt, but also in that which is nearly fresh. At Woods Hole (Mass.) for example, where the salinity is great (about 1.024), many recent experiments have shown a remarkable rate of growth. Other regions have been observed where the degree of salinity is seldom more than 1.005, in which clams seemed to flourish equally well.

Not only is this true, but acclimatization is not necessary when a change is made from one locality to another. Many recent experiments, besides the one just referred to, show this to be true. Many, if not most, marine animals are very sensitive to changes in the saltness of the water. The fact that the soft clam is not so affected, even by a sudden transfer, is not only interesting of itself, but its significance in the development of a method of clam culture is evidently of the greatest importance. Many clam flats, today practically barren, may be planted with clams taken from any other locality without reference to the salinity of the water in either place.

4 **Character of the beach or flat favorable for growth.** Mya grows well in soils of many sorts. Some of the best clam flats are composed largely of sand. Flats also often contain quantities of fine mud. These of course are more favorable for planting because

they may be dug easily; but, when other conditions are good, clams grow equally well in gravelly or even rocky beaches. They are frequently found, also, thickly set in hard clay.

Unpublished observations show that certain definite conditions of the soil must be present in all these cases, and these conditions, too, are exact. Clams will not grow on every bottom; but enough has been said to indicate that soils of various kinds often are suitable for growth. One of the things about which the clam culturist need concern himself least is a bottom on which to plant his clams.

5 **Collection of clams for planting.** In almost all cases this should be an easy matter, and this fact is, of course, one of the greatest importance. It is one of the greatest difficulties encountered in oyster culture, and practically does not exist here.

On larger clam flats and beaches, great numbers of mature clams usually exist among the thatch plants. These are undisturbed on account of the difficulty in digging them. They give rise to many embryos which eventually appear in favorable localities in great numbers. Extensive flats always reveal patches of bottom, sometimes covering acres, where clams one or two inches long are packed too closely to grow, except at a very slow rate, from lack of sufficient food. When these small clams are dug and scattered over a larger area, they grow with great rapidity. Clams from these crowded beds may be had at any time of the year.

In addition to this supply, there appear in certain seasons great numbers of small clams below the low water mark. They are so closely crowded that, on those beds that have been studied, nearly all seem to die before the end of the summer. Though they appear only in certain years, and then on restricted spots, where currents are swift, their numbers are so great that they can be gathered from the surface almost in a solid mass and spread over large tracts. As has been shown, they are tenacious of life, and, when under water, will cover themselves in four or five minutes if conditions are favorable.

Observations extending over a considerable coast line, the details of which can not be given here, indicate that little trouble would be encountered in obtaining abundant material for planting.

6 **Rate of growth.** In developing methods of culture, nothing could concern us more than the rate of growth. The oyster reaches a marketable size in three or four years. In other important respects we find that clam production is much easier than oyster culture. It requires little labor and less capital. But what about the length of time required for clams to reach a marketable size?

We may answer with much certainty that it is *not more than half as long a period as in the case of the oyster*. We make the statement in a general way. Under varying conditions, an oyster or a clam may grow fast or slowly. There has been a general belief that this variation in oyster growth is a matter of food. The belief is probably well founded. Very little is known of the relation existing between growth and the food supply in marine animals. Much recently acquired evidence shows that, to a certain limit, which is a wide one, the clam's growth increases with an increase in the amount of food. Its position in reference to water currents, then, has much to do with the rate of growth. However, it is perfectly safe to say that, on an average, clams increase in volume twice as fast as do oysters.

Recently many experiments have been made under various conditions, showing just how rapid this increase actually is in Mya. We may cite a single example, not at all an extreme one, in which a clam half an inch long became one and a half inches long in two (summer) months. Under specially favorable conditions, clams probably may reach a fair marketable size in one year from the time when their life begins; while clams which have lived for two years, in almost any clam beach, if not too closely crowded, should certainly be large enough to bring high prices.

7 **Legislation.** Culture methods, we must conclude, are in themselves simple and easy of application. There should be no difficulty in reclaiming depleted flats, if indeed they may not be made to yield more than when in the most flourishing natural state. At the very least, ground still productive should be prevented from becoming barren.

But there is one serious difficulty which threatens to defeat all efforts at clam culture. That is in regard to the control of clam ground. I have elsewhere discussed this matter, attempting to show

the futility of a close season, and expressing the opinion that the lease to individuals is the only way by which this industry can be established. And, when the lease is issued, also, it is absolutely necessary that state—and not merely local—protection shall go with it.

To bring this about, many state and local laws must be repealed, and new and adequate ones formulated, passed, and *enforced*. All of which seems to the ordinary observer to be an almost impossible task.

That one of the north Atlantic states in which popular sentiment is aroused to the extent of bringing about these changes is certain to receive immense benefit from the effort.

VENUS MERCENARIA

Hard clam, or little-neck

In tracing the present distribution of the little-neck clam about Long Island, we reach essentially the same conclusion as with Mya. In many localities where it has been taken most abundantly, the failure has become alarming.

At the east end of the island in Peconic bay and in the region about Sag Harbor, the form still seems to be relatively abundant. This entire region, where Mya also abounds, is apparently an extremely rich one in its production of Venus. It is not possible at present to form an estimate of the annual production in these waters. We can only state that several centers are reported to ship tens of thousands of bushels every year. It is the general belief, however, that over the entire area the hard clam has been decreasing rapidly during the last two years. Other beds on the island, just as extensive as those in Peconic and Gardiners bays, are almost destroyed, but very fortunately the supply is still great here.

On the south side of the island, Shinnecock and Moriches bays have never produced many clams. The Great South bay, to the west of them, however, has the remnants of a hard clam industry with an eventful history. The clam supply from Patchogue to Freeport has been enormous. Almost all of the intermediate towns have had an extensive interest in clam tonging. The story of one of these is more or less typical of all.

Opposite Fire island inlet is the town of Islip, which has always been the center of the industry in the bay. Soon after the civil war, a factory for canning clams was established here. After struggling for several years to perfect the process of canning, and to obtain a market, the business grew to such proportions that 400 bushels (10,000 cans) of hard clams were canned daily. This output continued for years, clams being brought from all parts of the bay. About five years ago the supply began to decrease. Two years ago it became impossible to obtain clams, and today very few are canned there. The demand had steadily increased, and is now greater than ever. In order to keep its business, this company established another factory in one of the southern states.

The markets at Babylon, Amityville, Massapequa, and Freeport had also been quite extensive, but all report the same very recent failure of the little-neck in the Great South bay. As this region had supplied so great a market, the result of course is serious.

To the unprejudiced observer, it seems as if the enormous drain on the beds must in great part account for the ruin, but it must also be said that the growth of the oyster industry in the bay has had much to do with it. This point will be considered later.

In Jamaica bay, the little-neck is said to be abundant still, but in the short time at our disposal, it was not thoroughly examined.

On the sound shore, from Hempstead harbor eastward, most of the towns on the numerous small bays were visited; and it was the almost universal testimony, that, while Venus had formerly been taken in great numbers, the last two or three years had shown a surprising diminution in the number.

It will be seen, by comparing this with the report on Mya, that the results are practically identical. In Peconic bay and contiguous waters, and apparently in Jamaica bay, both clams are still taken in numbers. Almost everywhere else, both have practically failed, or are failing with great rapidity.

While we have described at some length the habits of Mya, and outlined a plan for its artificial culture, the life history of Venus is almost entirely unknown. There is evidently great need for such knowledge at present.

PECTEN IRRADIANS

Scallop

This peculiar form does not have so wide a distribution as either Venus or Mya. After attaining a certain size, Mya digs deep into the ground, and never removes itself from its burrow. Venus also covers its body in the sand or mud, though not deeply, and is able to creep on the bottom. But Pecten is a form which is able to swim by an opening and closing movement of the shell. This method of locomotion is not a skilful one, but is effectual, for the creature is able, in time, to compass considerable distances in its migrations. Pecten is a form which comes and goes, but it seems to choose definite localities for its resting places. These are usually small and more or less sheltered bays, where the creatures lie on the bottom, sometimes crowded together in great numbers, at other times much scattered. They may stay in one region for many months, and are taken from September till late in the winter.

The greater number of these forms are dredged along the shores of Peconic and Gardiners bays. A few are still taken in the bays on the sound. From the vicinity of Riverhead, nearly to Montauk, immense numbers of scallops are taken every year. There are probably few regions on the coast which compare with this in the richness of its supply of food mollusks. On account of the peculiar habits of the scallop, the catch in any single locality is always somewhat uncertain. Near Napeague harbor, for instance, for several years past the supply has been short, but during September of the present year (1900), dredgers who had been at work for several days reported unusually large catches. Marketmen seem to believe that the supply of scallops here is not diminishing. It was ascertained, however, that at many points more men than formerly had become engaged in the business of dredging. While the number of scallops sent to market may not be less, the beds are taxed more severely. Many of the older dredgers profess to believe that excessive dredging is already making a great difference in the average number of scallops taken each year.

To very many the scallop is the most highly prized of all mollusks, and it is to be hoped that it will long be spared. It must

be remembered, however, that it has been completely exterminated on some parts of the New England coast, and that, while the soft clam can undoubtedly be made again to flourish on depleted flats, it is to be doubted seriously if this can be accomplished with the scallop. The time to conserve the supply is while we still possess it.

Very little can be said of the life history of Pecten. Beyond the fact that it migrates and breeds during the summer (the limits of the breeding season have not definitely been determined), little is known of its life and habits. We do possess one other fact of interest concerning it, and that is that, when very young, it, like Mya, develops a byssus. In this case the structure is relatively large, and is made of many threads, by means of which the animal attaches itself firmly to foreign bodies. This byssus is retained till the shell is nearly or quite half an inch in diameter.

Many difficulties probably would be encountered in an attempt to rear Pecten by artificial means, the most serious of which might be in the habit of migrating from shallow to deeper water at certain times, though what the significance of these migrations may be is problematic. It is one of the most highly specialized and delicate forms in the group of mollusks, and the conditions necessary for its existence may be very exact, and hence difficult to discover. The fact that the young attaches itself to foreign bodies might be taken advantage of in the collection of large numbers, but it would not be easy, probably, to keep them till they had reached maturity, or to confine large numbers indefinitely on a restricted portion of the bottom. The only safe method now is to watch the supply as closely as possible, and to prevent its diminution by excessive dredging.

RELATIONS TO THE OYSTER INDUSTRY

In order to understand the clam problem in Long Island, it is necessary to refer to an apparent clash in the interests of oystermen and clam-diggers. It is claimed by the latter that the rapid extension of oyster beds in Great South and Peconic bays, as well as in other waters, is rapidly narrowing the area available for taking the hard clam. There is no question about the rapid spread of the

oyster industry, and it is a thing greatly to be desired. Unlike the depredations from which Chesapeake bay has always suffered, there is nothing piratical about the operations of the Long Island oysterman. He is a planter—not a mere dredger—and receives a title or a lease from the various towns for the territory which he occupies, and he is legally entitled to their protection.

It is to be hoped that this appropriation of the bottom is not to interfere seriously with the supply of clams and scallops. It seems that just now there is great need for the development of some method of hard clam culture. Oyster culture is well developed, and we know the conditions and the size of the area necessary for the production of a certain number. On the other hand, we know nothing of the possibilities of rearing the hard clam, and it may be that bottoms now not utilized may be made to produce—and perhaps in greater abundance than the natural beds.

It would probably be declared by oystermen that the spreading of oysters on a bottom does not destroy the clams which already exist there, and that, when the oysters are removed, the clams may then be taken also. It certainly would be an interesting thing to determine whether the presence of oysters on a clam bed would interfere greatly with the growth of the clams, or vice versa. This is simply a question of the necessary amount of food, for both certainly live on the same microscopic plants, which are borne by water currents. We should expect, then, to find the results of such an inquiry varying somewhat in different localities. If there should be areas, however, where food is so abundant as to allow the maximum rate of growth of both forms, it should be known, and the advantage of a double crop on one area realized so far as possible.

Surely this question of the relation between the oyster and clam industries is worthy of most careful consideration by the state of New York. Before it can be discussed intelligently, there must be a very careful investigation of the facts concerning the possibilities of growth of both forms. The life history of the oyster is fairly well known; but of the hard clam, almost nothing. We must become acquainted with the possibilities of the bottoms, considering not only the relations between oyster and hard clam, but also between

oyster and scallop. Without prejudice we must decide what would be the greatest good to the greatest number.

We need not here enter into a discussion of the ethical aspect of the case. One naturally has great sympathy for the weak, who are contending for existence against the strong. This is a practical question, and will be determined according to the desires of the majority of those interested. If we can not have them both in abundance, shall we have a sufficient supply of oysters or of clams and scallops? The answer to this question will determine the action. It is unfortunate in this case that we do not know more about the little-neck clam and the possibilities of its artificial propagation. For, under control, it is possible that the shores of Long Island are really sufficient to support both oysters and clams in such numbers as to supply the rapidly growing demand for both for some time to come. V e n u s can probably be cultivated as well as the oyster. The trouble lies in the difficulty of educating the public to an appreciation of the results already demonstrated in closely allied forms.

So far as the soft clam is concerned, the way is clear. When the general public has the facts which demonstrate the practicability of culture methods in this form, suitable legislation may be obtained for the protection of the new industry, which would surely arise. Not only is it absolutely essential that ancient laws governing the shore rights be repealed, but new and more favorable laws must be *enforced*.

When anyone is free to dig the beaches, it is folly to attempt culture methods. Suppose that laws are formulated, as they were in Massachusetts, which provide for the leasing of ground to individuals. Unless these laws are enforced by *state* authority, they are absolutely useless, as they were at Essex.

New York was far-sighted in providing for the oyster industry. Everyone rejoices in its great growth. Let us hope that, after a careful and unprejudiced examination of the possibilities of the new industries, and their relation to oyster culture, the state may also wisely provide for the development of clam and scallop culture.

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