

Reports

---

1968

## Let's Be Oyster Farmers

Robert S. Bailey  
*Virginia Institute of Marine Science*

Fred C. Briggs  
*Virginia Institute of Marine Science*

Follow this and additional works at: <https://scholarworks.wm.edu/reports>



Part of the [Aquaculture and Fisheries Commons](#)

---

### Recommended Citation

Bailey, R. S., & Briggs, F. C. (1968) Let's Be Oyster Farmers. Educational series (Virginia Fisheries Laboratory) ; no. 8.. Virginia Institute of Marine Science, College of William and Mary. <https://doi.org/10.21220/V58C92>

This Report is brought to you for free and open access by W&M ScholarWorks. It has been accepted for inclusion in Reports by an authorized administrator of W&M ScholarWorks. For more information, please contact [scholarworks@wm.edu](mailto:scholarworks@wm.edu).

**LET'S**

**BE**

**OYSTER**

**FARMERS**

ROBERT S. BAILEY  
FRED C. BIGGS



**VIRGINIA INSTITUTE OF MARINE SCIENCE**

GLOUCESTER POINT, VIRGINIA

# LET'S BE OYSTER FARMERS

*Information in this Booklet Compiled and  
Edited Through the Facilities of the*

VIRGINIA INSTITUTE OF MARINE SCIENCE  
Gloucester Point, Virginia

\* \* \*

*by*

*Staff Information Officers*

ROBERT S. BAILEY

FRED C. BIGGS

1958, Revised 1968

*Published and Distributed by*

VIRGINIA INSTITUTE OF MARINE SCIENCE

*and the*

SCHOOL OF MARINE SCIENCE

COLLEGE OF WILLIAM AND MARY

*as a project of the*

VIRGINIA STATE TECHNICAL SERVICES PROGRAM

*under authority of the*

STATE TECHNICAL SERVICES ACT OF 1965





# TABLE OF CONTENTS

	<i>Page</i>
INTRODUCTION .....	7
HISTORY .....	9
Period of Natural Abundance.....	9
Period of Exploitation .....	10
Period of Management .....	10
Development of the oyster industry.....	10
Baylor survey .....	11
Virginia's interest in the Potomac River.....	11
Evolving management practices .....	12
BIOLOGY OF THE OYSTER.....	15
Sex and Spawning .....	15
Larval Development .....	15
"Setting," "Striking," "Spatfall" .....	15
The Maturing Oyster .....	16
Quality and Yield of Oysters .....	17
Predators and Microparasites .....	17
Oyster drills .....	17
Boring sponges and mud-blister worms.....	21
Flatworms .....	22
Microparasites .....	22
<i>Dermocystidium marinum</i> .....	22
MSX .....	22
SSO .....	23
MANAGEMENT OF PUBLIC OYSTER GROUNDS.....	23
Licenses and Gears .....	23
Relationship Between Public and Private Production of Oysters.....	23
Seed Production .....	25
MANAGEMENT OF PRIVATE OYSTER GROUNDS.....	31
Developing Private Oyster Grounds.....	31
Evaluating Leased Grounds .....	31
Obtaining and Planting Seed Oysters.....	33
Harvesting and Marketing Oysters.....	34
CONDITIONS AFFECTING OYSTER CULTURE.....	36
Flood and Drought .....	36
Engineering Projects .....	36
Pollution .....	41
Discoloration of Oysters .....	42
The "R" Months .....	43
Contaminated Oysters .....	43
CULTURE TECHNIQUES FOR THE FUTURE.....	44
Spawning Oysters .....	44
Salt-Water Pond Culture .....	44
Controlling Eel Grass .....	45
Collecting Spat .....	45
Oysters for the Raw Bar.....	46
Escalator Oyster Harvester .....	46
CONTRIBUTIONS OF SCIENTISTS TO OYSTER CULTURE.....	47
Culture Practices Based on Biological Studies.....	47
Identifying Diseases and Controlling Predators.....	47
Aims of Research .....	48
BIBLIOGRAPHY .....	59







Photo By A. AUBREY BODINE

*Let's Be  
Oyster Farmers*

## INTRODUCTION

This pamphlet, prepared by the Virginia Institute of Marine Science at Gloucester Point, provides certain historical and scientific information on oyster culture. It may be of special use to those who wish to raise oysters for home consumption. School teachers, students and other persons interested in the biology of oysters and their culture should find this to be a useful source or enlightenment.

The information reported in these pages is the result of research conducted at VIMS and in similar institutions throughout the country and world. Oyster culture methods described are employed by successful planters.

Virginia oystermen exploited a seemingly inexhaustible supply of wild oysters well into the last half of the nineteenth century. However, certain astute men saw that such intensive harvesting was removing oysters faster than they could be naturally replaced, and that this would surely exhaust the supply in time. Responding to suggestions of citizens interested in improving oyster production in the state, the Virginia General Assembly, through many years of legislation, has designated natural beds as public grounds, has regulated both gear and time for harvesting oysters on public grounds, and has established a system whereby certain grounds may be leased for private cultivation of oysters. In 1940 it established the Virginia Institute of Marine Science (formerly the Virginia Fisheries Laboratory) to secure scientific enlightenment on all problems of the marine area.

Since the 1920-21 season when 2,146,000 bushels of market oysters were taken from public rocks in Virginia and 2,359,000 bushels from private rocks, the yield has fluctuated between a high of 1,905,000 bushels and a low of 585,000 bushels on public rocks and a high of 4,675,000 bushels and a low of 1,356,000 bushels on private rocks.

The available area for oyster production has been reduced over the years by demands of commerce and industry on tidal waters, and by the use of these waters for disposal of domestic and industrial wastes. In order to create a more vigorous oyster industry in the state, managers of the industry are seeking improved methods of culture. They look to marine scientists and engineers to supply the information necessary for increased production.



## HISTORY

### Period of Natural Abundance

When George Percy and his intrepid associates landed at Cape Henry on a spring day in 1607, they happened upon a band of Indians roasting oysters. This description of the incident was sent back to England.

“We came to a place where they (Indians) had made a great fire, and had been newly roasting oysters. When they perceived our coming, they fled away to the mountains and left many of the oysters in the fire. We ate some of the oysters, which were very large and delicate in taste.”

When Indians were the sole inhabitants of North America, oysters were in abundance all along the Atlantic coast. Huge mounds of oyster shells in middens adjacent to Indian villages along the shores of salt water bays and rivers attest to the importance of oysters in the natives' diet. It is estimated that one such midden in Maine contained about 7,000,000 bushels of shells.

An early settler reported that oysters a foot long were not uncommon in oyster banks seen at low tide in the Elizabeth River. He also noted that in the fall of 1609 a large number of famished colonists were sent to these banks to avert starvation, and they remained there for nine weeks, sustaining life on oysters to which a pint of Indian corn for each man was added as a week's allowance.

During colonial days, and into the mid-19th century, the supply of oysters throughout Tidewater Virginia more than met the needs for local consumption, and during the first quarter of the 1800's they were transported to distant markets.

Lt. P. deBroca, sent as a special envoy to the United States in 1862 to learn of the oyster industry and to explore the possibility of introducing the Virginia oyster into French waters, in one of his reports states, “The American oyster . . . , exists in such profusion that it seems to be gathered as plenteously as manna was in the Exodus of Israel . . . Chesapeake Bay, in which is kept a large proportion of the oysters cultivated in America, has a magnificent basin in which Providence seems to have accumulated every necessary condition for forming an admirable locality for the fishery.”

The demand for oysters in northern markets had already depleted many beds north of Delaware Bay at the time of deBroca's visit. Chesapeake Bay oysters were even then being brought to New York and Boston markets to fill the void. Meeting these demands, through practices to be described later, was the first step in the gradual depletion of natural beds in both Virginia and Maryland.

### Period of Exploitation

Along New England Shores, oysters were an important food source for the early settlers, but in such cold waters reproduction was irregular

and survival and growth of young was inadequate to supply the increased demand of growing communities; hence limited harvesting was instituted by law.

A writer in the American Institute of 1859 reported that in the City of New York more money was spent for oysters than for butcher's meat. In 1865 the citizens of New York City, which then had a population of less than 900,000, consumed 7,000,000 bushels of oysters. If this rate of consumption had persisted until today, about 61,000,000 bushels of oysters would be required by that city each year, many times the present oyster production of the entire United States.

That the oyster industry of Virginia needed regulation is attested to by the fact that during the middle 1800's, oysters of all sizes and condition were delivered to shucking houses, and oysters with meats still intact were manufactured into lime. Oysters were dredged up during both winter and summer, day in and day out, and transplanted in Rhode Island, New York and Delaware or sold directly to the northern markets.

Some order was finally brought out of the chaos and confusion of the oyster business in the late 1800's and early 1900's with the completion of the Baylor Survey, the enactment of statutes to regulate oyster production and the creation of the Commission of Fisheries (The General Assembly in 1968 changed the name to Marine Resources Commission and assigned to it the management of all Virginia's principle marine resources as well as the enforcement of laws relating to these resources.)

## **Period of Management**

### *Development of the oyster industry*

Prior to the Civil War, bay sailors in distinctive Chesapeake sailing ships moved oysters to city markets in Wilmington, Baltimore, Washington and Norfolk. Slaves and small land owners supplied local needs for oysters in the Chesapeake Bay country. Coasting vessels carried cargoes of oysters to northern areas as late as the early 1900's. As transportation by steamboats and railroads improved, and later refrigerated trucks and planes sped delivery, it became feasible to supply fresh oysters to distant markets.

Canned oysters found a ready market during the second half of the 19th century. The first Chesapeake Bay cannery began operation in Baltimore in 1844, and in 1865, one thousand eight hundred and seventy-five bushels were packed raw in that city while 1,360,000 bushels were canned. The first Virginia cannery opened in 1859, but this state never developed a canning industry equal to Maryland's.

Fresh-shucked refrigerated oysters gradually eased canned oysters out of the market, but in recent years soup companies with nation-wide distribution have again placed canned oyster soup on the market. Frozen oyster stew is also a popular food item, along with frozen raw oysters and popular ready-to-fry frozen breaded oysters.

Marketing of frozen soup oysters has benefitted oyster farmers since the soup market demands small oysters. Harvesting younger oysters in-



creases the total yield because fewer are lost to predators, parasites and other natural causes during the year or two they must be held to attain larger size.

Processors of soups and frozen oysters can buy them on a favorable market at seasons when quality is high and demand for fresh oysters is low. These products have a much longer shelf life than fresh-shucked oysters which must be marketed and consumed promptly.

Better methods of processing oysters for market need to be developed. Improved quick-freeze packaging is finding increased favor with housewives and perhaps "oyster sticks" and other such products may become popular seafood items. One Virginia company specializing in frozen oysters distributes its products in thirty states.

### *Baylor Survey*

During the last quarter of the 19th century, prominent citizens of Virginia expressed alarm that the oyster industry of the state would be destroyed unless proper steps were taken immediately to prevent wanton exploitation.

In 1891 Governor P. W. McKinney outlined to the General Assembly the unsatisfactory conditions then prevailing in the Virginia oyster industry and he proposed that properly surveyed grounds be leased with legal safeguards assuring oystermen their rights in courts. He also recommended that a license tax be put on tongs and dredges rather than on the oysters caught. He further recommended a survey of all natural oyster lands of the state by competent officers of the U.S. Government.

The legislature provided for the well-known Baylor Survey which, with few revisions, still designates the public oyster grounds of the state. Lt. James B. Baylor of the U.S. Coast and Geodetic Survey was hired to survey and chart all grounds in Virginia which were producing oysters naturally. These were designated as public grounds open to any licensed citizen of the state. They include about 210,000 acres. Grounds not included in the Baylor Survey were made available for rental to qualified citizens. Of the thousands of acres of leased grounds, few receive a natural set of oysters, and, therefore, require intelligent management to make them productive.

### *Virginia's interest in the Potomac River*

The Potomac River, once the source of many fine oysters, became largely depleted through overfishing and lack of sound management practices. This river, though it is Maryland territorial water, has been open to oystermen of both Maryland and Virginia under provisions of the 1785 compact between the two states instituted under the watchful eye of George Washington. A new compact, effective December 7, 1962, replaced the original one. It established the Potomac River Fisheries Commission, composed of representatives from both states, with jurisdiction over the fisheries of the river. Under its management, augmented by scientific advice from both the Chesapeake Biological

Laboratory, Solomons, Maryland and the Virginia Institute of Marine Science, Gloucester Point, Virginia, substantial improvement has been made in oyster production.

*Evolving management practices*

The first efforts at management consisted simply of dredging oysters where they were plentiful and transplanting them to barren but good growing waters to be harvested in time for favorable markets. Oysters of all sizes from Chesapeake Bay were placed on bottoms in states north of Delaware in spring and were harvested as market oysters the following fall. Virginia planters often removed oysters from crowded public grounds and planted them on grounds legally assigned them by the state where they grew to market size.

Development of the private oyster industry grounds in Virginia made slow progress immediately following the Baylor Survey. Even in the beginning of the 20th century oysters were too easily obtained from public rocks to justify the cost of acquiring extensive lands and transplanting seed. In 1900 only 35,000 acres were rented, but following World War II a demand for planting grounds arose and by 1963 about 133,000 acres, many marginal in quality, were in private hands.

Leased oyster grounds in Virginia (Commission of Fisheries Report for 1960-61)

1909 .....	35,500 acres
1911 .....	46,000 acres
1921 .....	47,000 acres
1931 .....	62,000 acres
1941 .....	67,500 acres
1951 .....	106,000 acres
1961 .....	132,500 acres

Few planters found it possible to raise market oysters from spat collected on shells planted on their grounds. The success of private planting operations has depended largely on their ability to secure seed oysters which could be planted and later harvested as market oysters with a reasonable margin of profit. At times this margin has been severely reduced by the high price paid for seed oysters.

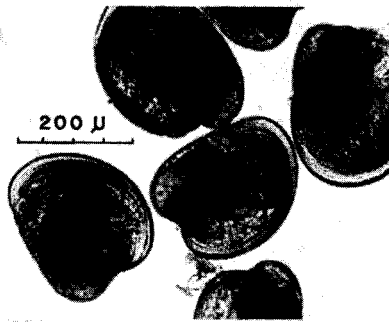
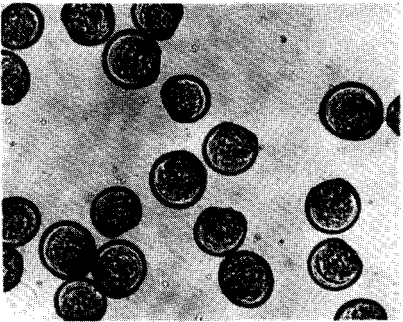
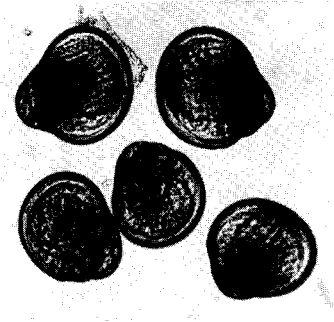
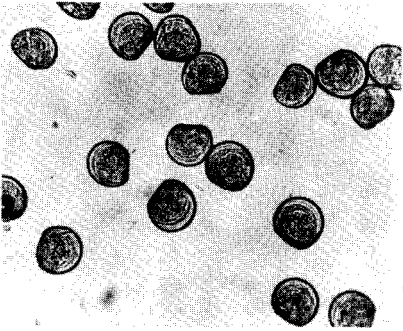
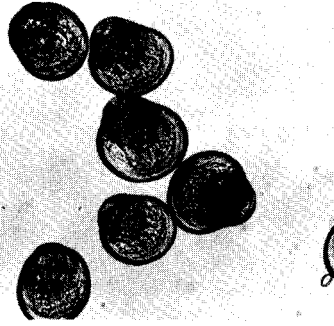
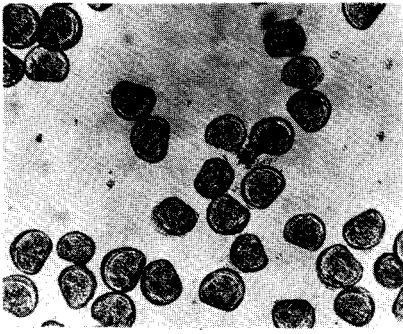
About 1958 some progressive planters began testing the feasibility of improving natural set of spat by placing shells in bags rather than scattering them over the bottom. This special handling of clutch made the difference between successful spatfall and failure on marginal setting grounds. Many planters today use shell bags and secure adequate strikes to produce a market crop without the expense of planting seed.

As good growing grounds available for lease became more and more scarce, inferior grounds were rented and made productive by planting shells on muddy bottoms to firm them so they could support seed oysters. (See p. 32).

In areas heavily infested with oyster drills, attempts have been made to protect seed oysters, but only with limited success. (See p. 18).

Although seed oysters are still abundant in Virginia, some oyster farmers are looking to the day when they can produce seed having special characteristics, such as rapid growth and resistance to disease. Techniques for operating hatcheries to produce seed oysters of known characteristics on a commercial scale at reasonable costs are being explored. At least one company is involved in attempting to engineer the production of oysters from larvae to market size, eliminating the need for cultch and increasing the production per acre.

Scientific examination of problems involving setting of oysters and pilot methods for producing seed oysters commercially point the way to improved oyster farming methods. In 1968 a major breakthrough in collecting spat while eliminating the use of shells or other permanent or semi-permanent materials for cultch, was made in three separate laboratories. (W. W. Budge, Pacific Mariculture, Inc., Pigeon Point, California; Edwin H. Powell, Windmill Point Oyster Co., Urbanna, Virginia; John L. Dupuy, Paul Chanley and J. D. Andrews, VIMS, Gloucester Point, Virginia).



*Development of oyster larvae from 1-day-old stage (upper left) to setting stage (lower right) normally takes about twelve days. These photomicrographs show the various stages of oyster larval growth: (Left, top to bottom) one-day-old, straight-hinge, early umbo; (center, top to bottom) umbo, old umbo, eyed larvae; (right, top to bottom) development from one-day-old until ready to set.*

## BIOLOGY OF THE OYSTER

Biology students as well as oyster farmers will be interested in the oyster's life and habits. The following information has been gathered through many years of painstaking work by marine biologists.

### Sex and Spawning

The sexes in oysters are separate. Spawning, the discharge of eggs and sperm into the water, occurs in Virginia when water temperatures reach 77° F., usually from mid-June until October. A large female oyster may produce 100,000,000 eggs in a season. They are microscopic in size, about 600 eggs side by side would measure 1 inch. One male may produce many times that number of sperm. Both eggs and sperm are released into the water, where fertilization of eggs occurs.

Oysters resorb their gonads during the winter months and may change sex when the gonads redevelop during the following spring. Hermaphroditic (producing both male and female sex cells) individuals occur but are rare. Biologists determine sex of oysters by observing the manner of spawning or by examining the genital products under a microscope. Most oysters are males first but with increase in size a majority become females. They may become sexually mature within less than a year.

### Larval Development

Oysters pass through a free-swimming larval stage for a period of approximately two weeks. At this time they are part of the plankton. Immediately after sperm and eggs unite, the very young oysters (larvae) begin to grow rapidly. In about 30 hours they develop into straight-hinge larvae (see p. 14). Four hundred of these placed side by side would measure about an inch. Each larva possesses a small, hinged shell, shaped much like that of a hard clam.

Larvae are transported by tidal currents, sometimes to great distances from where they originate. Their velum (swimming organ) propels them upward for a time and then they drift slowly downward through the water column. This alteration of swimming and sinking, occurring throughout larval life seems to be regulated by little understood environmental factors, possibly light, salinity, tidal currents, or a combination of all these factors, plus others yet undetermined.

Many oyster larvae are eaten by fish, shrimp, barnacles, sea squirts, jellyfish and other animals. Many die when they drift into unfavorable surroundings. Some survive to "set" (settle and attach themselves) on cultch (some hard substance, usually empty shells) or on living oysters and may become market oysters in 3 to 5 years.

### "Setting", "Striking", "Spatfall"

At the end of about two weeks, most larval oysters settle to the bottom, extend their soft fleshy feet and crawl about actively seeking

suitable spots for attachment. "Setting", "striking" and "spatfall" are terms commonly used to describe this phenomenon. In seeking a place for attachment, the larva may settle on an object on the bottom, explore it, find it unsuited for attachment and swim away seeking a more desirable spot. There is a limit to the time a larva may continue this exploration. If at the end of its larval life, the young oyster lands in mud or on shifting sands, it will die.

When a larva lands on a suitable object, it deposits a glue secreted by its byssal gland and spreads it out with its foot. The young oyster then turns on its left side and cements itself to the substrate. Once attached it cannot move itself again. Oysters set on many surfaces such as pilings, cans, rubber tires, etc., but shells, either those of living oysters or empty shells, provide the most abundant cultch. Although sets of spat may occur as late as early November, evidence of successful setting in late fall, winter or early spring is lacking.

### **The Maturing Oyster**

The bay and its rivers are actually great bowls of plankton soup consisting largely of minute plants and animals, including the larval forms of crabs, fishes, shrimps, oysters, and a host of other animals. Sometimes the soup is thick, sometimes thin. It does not contain the same ingredients at all times, and even the same one-celled plants present at different seasons may contain varying amounts of nutrients. Oyster larvae floating in this soup do not always find food suitable for their development.

Once set, the oyster must await the arrival of food transported to it by the flowing tides. In obtaining its food, a single oyster may filter 100 gallons of water during a 24-hour period, from which it selects both plant and animal food. Some investigators claim that silt with organic matter adhering to clay particles forms part of the oyster's diet.

Food collects in a layer of mucus covering the gills and is transported by cilia to the mouth. Much of the material, including some algae, may not be utilized by the oyster but passes through the digestive tract partially or entirely undigested. Other particles unsuitable for food are rejected by the labial palps (lips) before they enter the digestive tube. Trash and excessive food is rejected at times by the palps and moved by cilia to the edge of the mantle where it is flushed out by the sudden closing of the shells. This material is known as "pseudo-feces."

Oysters which chance upon unusually "green pastures" may grow to market size in two years, while those in "desert areas" may be stunted and never reach legal market size of 1½ to 3 inches. Many market oysters are 4 to 5 years old.

Oyster growth depends upon abundance of suitable food, favorable temperatures and optimum salinities among other factors. Oysters cease to feed when temperatures drop to near freezing and they may consume little food when water temperatures are unusually high. Oysters planted in high quality low salinity beds in the upper Rappahannock

River may require an additional year of growth to reach a size equal to those grown downriver in higher salinities. Oysters at Deep Water Shoals in the James River may require five years to reach market size, or may never reach it if salinities remain abnormally low for several years, while several miles below they will reach market size in three to four years. Growth may vary considerably from one region to another, or even from one part to another of the same ground, and from year to year on the same grounds.

**Quality and Yield of Oysters**

A fat oyster is generally creamy-white, plump, full on the half-shell, and shows no trace of dark-colored liver. Oysters fatten in spring when plankton growth is abundant, and they again approach maximum quality between October and early December, having fed on the rich fall growth of plankton. Although an estimate of oyster growth rates can be obtained from measuring the shell, or better by weighing the oyster live in its shell, neither method gives a reliable measure of the condition of the oyster itself. Scientists use the ratio of the volume of the shell to dry weight of the oyster for judging the conditions of oysters. Using this index, they grade oyster meats from place to place, from season to season, and from year to year.

Operators of shucking houses grade oysters according to the number of pints that can be produced from a bushel of culled oysters. For example:

*yield per bushel*

4 pints .....	poor
5 pints .....	below average
6 pints .....	average
7 pints .....	good
8 pints .....	very good
9-10 pints .....	exceptional

From this it can readily be seen that the processor will find it to his advantage to buy oysters which promise to yield the most meats per bushel, for in this way he reduces the volume of shell stock he must handle and the extra price he pays for oysters of high yield is more than made up for in increased yield per bushel.

Though large oysters are highly esteemed by some customers, and command the highest prices, it would be to the advantage of growers and consumers alike if demand were shifted to smaller sizes. Growers could then harvest oysters a year or more earlier than at present and would obtain higher yields of meats per acre of planted grounds. Losses of oysters in areas subjected to diseases would also be greatly reduced. Consumers would benefit by receiving generally better quality oysters of good flavor. Possibly, a reduction in production costs would be reflected in lower consumer prices.

**Predators and Microparasites**

*Oyster drills (Urosalpinx cinerea*—Atlantic oyster drill; *Eupleura caudata*—sharp ribbed drill)

Oysters are menaced by predators and pests mostly in waters of high salinity, above 12 parts salt per thousand. Drills kill many spat, not only on Eastern Shore but also in the lower James River, Hampton Roads, lower York River and the lower part of Chesapeake Bay on both shores. They can also kill and consume larger oysters.

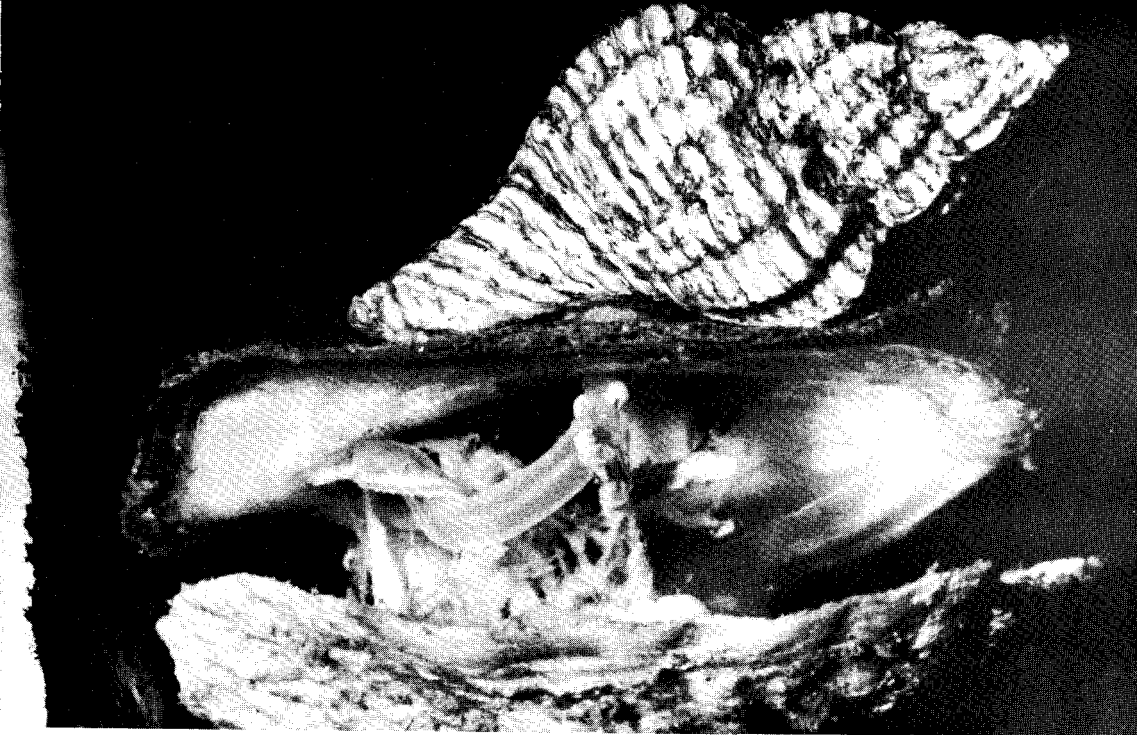
The oyster drill is a small marine snail, seldom more than an inch long on the western shores of Chesapeake, but reaching almost 2 inches at times on the Eastern Shore of Virginia. These snails are equipped with a long feeding tube (proboscis) at the end of which is a tongue equipped with rows of fine teeth. The drill makes holes in the shells of oysters by first secreting a substance which loosens the binding material holding the calcium carbonate crystals together and then rasping them away with its file-like tongue (radula). This may require several hours of work and drills do not generally attack large oysters, but feed mostly on spat and smaller seed oysters. After the hole has once been made, the feeding tube is forced through it and the meat of the oyster is rasped away by the rough tongue and consumed. Usually the drill loses much of its dinner to small fish, shrimp, crabs and other animals which feed on the oyster meat once its shell is opened.

These drills may destroy nearly 100% of the spat and thereby account for destruction of an entire small set of oysters in heavily infested regions. Their efficiency in killing oysters decreases with the thickness of the shell of the oyster so that large seed oysters planted in drill infested areas may survive to market size. Prior to the invasion of MSX into high salinity oyster beds, drills and *Dermocystidium* were the principal destroyers of oysters in these areas. Some planters on Eastern Shore whose seed producing beds are exposed to low tide, attempted to control drills by hand picking them. Drills are sometimes trapped using wire bags baited with small oysters and placed about 10 feet apart over the beds. These are fished (lifted into a boat and the drills shaken out) regularly at intervals of about 10 days to two weeks. These management practices have not proven very effective, chiefly because drills migrate from adjacent areas to those where they are fished.

When time and labor are available, some planters (mostly on the Eastern Shore where drills are large and numerous) pass seed oysters through a rotating screen to shake out the drills before the seed oysters are planted. A more general practice today on Eastern Shore is to transplant seed oysters during cold weather when drills have crawled down from exposed intertidal seed beds to nearby bottoms covered with water.

Dr. Victor L. Loosanoff and his associates at the Fish and Wildlife Laboratory in Milford, Connecticut reported success in controlling drills by applying Polystream-Sevin to sand and spreading it lightly over affected acres. Carefully conducted field testing of this method was carried out by VIMS scientists on the Eastern Shore of Virginia in 1963. Application of the chemicals to planted oyster beds did not reduce drill populations or numbers of drill egg cases deposited. Oyster production was not increased and treatment had an adverse effect on





*The remarkable photograph above shows an oyster drill that has rasped a hole in the oyster's shell, extended through the hole its long, flexible feeding tube and is consuming the oyster meat. Drills lay eggs in capsules (egg cases) on oysters or oyster shells as shown below.*





*Pea Crabs live in a niche they make for themselves in the gills of oysters, as shown above. Boring sponges erode and weaken the shell (below). They appear as small protrusions on oyster shells.*



most species of bottom dwelling and sedentary invertebrates such as crabs, barnacles, worms, etc. The scientists concluded: that, "Under the conditions encountered in Hog Island Bay, treatment with Polystream-Sevin did not reduce predation and it had a deleterious effect on the natural community."

VIMS scientists, working out of this Wachapreague laboratory with assistance from several oyster companies \* and a chemical company,\*\* conducted experiments on Eastern Shore from 1964 through 1966 to determine the economic feasibility of using Polystream to increase production of oyster spat on commercially planted shell cultch. On a commercial basis, the number of spat surviving at the end of a year on shells sprayed with undiluted Polystream at the rate of 55 gallons per 1000 bushels of shells was from 12 to 76 per cent above the survival on untreated shells in areas where light sets occur, and treated shells may make the difference between a successful set and complete failure in such areas.

Polystream has an oily base and may persist for several years in bottom deposits. Therefore, it is recommended that it be used only on seed beds sufficiently removed from growing areas to prevent contamination of market oysters, and that the seed be taken up and planted on clean growing grounds, not left on the setting grounds until they reach market size. Unless reasonable care is exercised, it is possible to impart unpleasant taste to market oysters and the person responsible for imparting this taste may be prosecuted by laws relating to the pollution of state waters.

Used with caution Polystream may be useful in the propagation of seed oysters. Any planter intending to use this chemical in the treatment of clutch should first secure the services of a professional marine biologist to avoid possible violation of water-use laws.

Oystermen can do little to control predators and pests once seed are planted. Optimum yields are derived from planting clean pest-free seed on grounds from which old shell, rubble and drills have been removed.

#### *Boring sponges and mud-blister worms*

Boring sponges and mud-blister worms weaken shells and make them unattractive to the raw-bar trade. They generally interfere with the fattening of oysters as the shell they destroy must be replaced, thus consuming the energy of the oyster. It is impossible to treat great masses of oysters infested with these pests, but dipping oysters into concentrated brine solution for a few minutes every ten days to two weeks will help keep the shells clean without injuring the oysters.

---

\*Ballard Fish and Oyster Company, Harvey L. and Robert L. Bowen Oyster Company, the H. M. Terry Oyster Company, and Walker Brothers, Inc. supplied boats, equipment, shells, labor, and oyster reefs, all essential for the success of the experiments.

\*\*Hooker Chemical Company supplied the Polystream and provided the analysis of residual chemicals in oysters and bottom deposits.

### Flatworms

Oyster drills are often thought to be the greatest menace to spat, but small flatworms are also suspected of being highly destructive. Strong evidence indicates that flatworms destroy many spat only a few days old. Further investigations are needed to determine the range of this predator and to ascertain what damage can be properly attributed to it.

### Microparasites

Serious oyster mortalities occur throughout the world from time to time. Epidemics are most likely to occur where oyster populations are concentrated for cultivation. In 1914 an unknown microorganism decimated oysters on Prince Edward Island, Canada. Dutch shell disease plagued the oyster growers of Europe in the 1940's. A "terrific scourge" destroyed planted oysters in the York River and Mobjack Bay in 1930 and heavy mortalities wreaked havoc with oysters in many parts of Virginia in 1936. The causative agent of most of these past mortalities will never be determined, but within the past twenty years marine biologists have identified several organisms which destroy oysters and they have suggested ways of minimizing their effects. None of these organisms render oysters unfit for human consumption since humans are not susceptible to them.

*Dermocystidium marinum*, more often called "Dermo", was discovered in the Gulf of Mexico about 1950 and was recognized in Virginia a few years later. This fungus was the worst known killer of market size oysters in Virginia prior to 1959. During the decade of the 1950's it accounted for about 90% of the deaths when predation and physical causes were eliminated.

"Dermo" is prevalent in the saltier waters of Chesapeake Bay, but not on the seaside of Eastern Shore. Oysters grown in creeks and rivers of low salinity are less likely to become infected with this organism than oysters living in saltier waters. High temperatures favor the growth of "Dermo" and young small oysters are less susceptible to infection than older larger ones. During years of heavy infections a planter may lose from  $\frac{1}{4}$  to  $\frac{1}{2}$  of those oysters which have remained planted more than three years.

Another organism which became prevalent in Delaware Bay in 1957 and within two years wiped out most oysters in that area, is "MSX." Expecting this organism to invade oyster beds on the seaside of Virginia and in lower Chesapeake Bay, VIMS biologists set up a monitoring program to detect its presence. In this way they were able to forewarn planters of impending disaster and they charted areas subject to infection very early.

"MSX" was the term first used to designate the causative organism responsible for high mortalities of oysters in Delaware Bay, and simply stood for what scientists saw under the microscope—multi-nucleated spheres unknown and unnamed. Recently three scientists, Haskin, Stauber and Mackin, having carefully studied its characteristics, identified its relationships and named it *Minchinia nelsoni*, but its old name "MSX" persists. It is a protozoan (one-celled animal), not a virus or bacterium as is often reported.

Scientists at VIMS, while investigating MSX, discovered another organism causing destruction of oysters on the seaside of Eastern Shore. They first called it SSO (Seaside Organism), and after learning more about it gave it the scientific name *Minchinia costalis* (Wood and Andrews).

SSO kills oysters in early June and is epidemic for only about six weeks. Heaviest losses occur among old oysters. Careful timing of planting and harvesting enable oystermen to avoid serious losses. To date this protozoan is destructive of oysters only on seaside of Eastern Shore.

## MANAGEMENT OF PUBLIC OYSTER GROUNDS

### Licenses and Gears

All oyster grounds within the Baylor Survey have been designated public grounds, from which any citizen of Virginia who pays a license fee of \$5.25 \* may remove oysters in season by hand or with ordinary tongs. A license for operating patent tongs costs \$15.75 \*, and such tongs may be used on public rocks only in designated areas and depths as prescribed by law.

Hand dredges and scrapes may be used legally on designated rocks in Chesapeake Bay and Tangier Sound when they are specifically authorized by the Commission of Marine Resources, but otherwise these may not be used on public rocks.

### Relationship Between Public and Private Production of Oysters

The public rocks (210,000 acres) are the best bottoms in the state for growing oysters. These may not be leased to individuals or corporations for cultivation. They supply most of the seed oysters required by private planters, but public grounds are not as productive of market oysters as are those privately managed. Through private enterprise, planters have made sub-marginal oyster grounds more productive than public grounds. The relative production and value of market oysters on public and private grounds from 1956 through 1966 is presented in the table below. Reductions in production of oysters in recent years

#### *Virginia Oyster Production 1956-66*

Public grounds (210,000 acres) year	Public grounds		Private grounds (134,492 acres)	
	Bushels**	Value	Bushels	Value
1956	924,832	\$1,980,822	3,653,467	\$ 7,920,035
1957	742,762	1,668,321	3,725,382	8,178,548
1958	960,372	2,622,158	4,735,041	11,504,264
1959	972,446	2,480,123	4,231,717	10,894,175
1960	904,799	2,841,400	2,755,032	8,041,546
1961	734,873	2,646,523	3,180,120	11,285,584
1962	337,662	1,184,104	2,476,915	8,589,765
1963	459,823	1,557,906	2,039,346	6,552,283
1964	729,778	2,411,099	2,550,398	7,933,985
1965	1,035,736	3,499,884	1,354,733	6,791,369
1966***	963,100	3,159,169	1,087,320	3,334,813

\*All license fees are established by law and may be changed by the General Assembly.

\*\*U. S. Standard Bushel 2,150.4 cu. in.

\*\*\*Preliminary report.

nas been due to high mortalities from the disease MSX. About half of the private growing grounds have been out of production since 1960.

Nearly 1.1 million bushels of seed oysters were harvested in 1965. Of these, 151,000 bushels came mostly from private grounds or seaside waters of the Eastern Shore, while 931,000 bushels came from public grounds; nearly 80 per cent came from the James River.

Only residents of Virginia are allowed to harvest oysters commercially. They are required to apply to the local oyster inspector for licenses to take seed and market oysters from state-owned rocks. Oystermen are subject to the laws regulating the use of these public grounds. Information listing the inspectors serving the various districts of the state, and laws regulating the taking of oysters may be obtained from the Commission of Marine Resources, Newport News, Virginia.

The Commission of Marine Resources has authority to make such regulations as it deems necessary to promote the general welfare of the seafood industry and to conserve and promote the seafood and marine resources of the state. It issues licenses, rents oyster grounds, and enforces laws regulating the taking of oysters and other seafoods. A special officer of the Commission is in charge of the oyster and shellfish repletion program.

Public oyster grounds are located in the major rivers of Virginia—the James, York and Rappahannock, and many others are found in the lesser bays and rivers tributary to these and the Potomac River. Plats of public grounds within the bounds of each county are on file at each county courthouse. The Commission of Marine Resources has complete plats of all public and rental grounds in its office in Newport News.

Oysters tonged from seed beds may be planted by the tonger on his private grounds or may be sold to any buyer for planting within the state. Under certain regulations established by the Commission of Marine Resources, seed oysters may be sold out of state. Market oysters taken from public rocks are usually sold to nearby shucking houses of which there are about ninety in Tidewater Virginia. Some are sold "in the barrel" for the half-shell trade.

Once delivered to the shucking house, the operator is responsible for having the oysters shucked, packaged and delivered to market in a sanitary, wholesome manner.

### **Seed Production**

As scientists probe deeper into problems of oyster culture, it becomes evident that it is more desirable to use seed oysters secured from nearby waters than it is to import them from distant places. When seed oysters are secured from distant places, disease organisms and predators may be introduced into hitherto uninfested areas. Foreign stock may interbreed with native stock and degrade valuable inherent adaptations of native oysters.

The Commission of Marine Resources has for years improved public grounds by planting shells for cultch both on grounds designated for market oyster production and on grounds set aside for seed production. It has also at times removed seed oysters to good growing grounds, but the improvement of public grounds depends largely on re-shelling grounds which have adequate strikes of spat.

Shells, which are used as cultch to which oyster spat may attach themselves, and also to reclaim muddy bottoms for planting grounds are of prime importance to the oyster industry. The state and private planters compete with each other and with industries which use shells for road construction, chicken feed, lime, manufacture of wallboard and in certain industrial chemical processing.

Shells from the piles which accumulate around shucking houses cannot supply the demands of all consumers.

Oystermen have known of "reef shells" (old oyster reefs built up during the past ten thousand years or so and then covered over with sediments for generations) and occasionally a few of these have been utilized. For many years both reef and recent shells have been burned for lime. As oysters become scarcer this practice has been stringently regulated and at present no shells may be processed for lime without the permission of the Commission. In 1963 the first commercial operation for mining reef shells in Virginia was undertaken, the operator being licensed by the then Commission of Fisheries. The Commission used royalties it received to buy shell, to improve public grounds in Machodoc Creek, Nomini Creek, and the Yeocomico, Coan, Great Wicomico and Piankatank rivers and elsewhere. After a few years the mining company discontinued operations because it could no longer find deposits in areas suitable to work. It would be desirable for marine geologists to completely survey the marine waters for deposits of these shells and to determine what further potential there is for exploiting this resource.

In spite of the ravages of MSX in Hampton Roads, James River continues to be an important source of seed. Supplementing this source of seed, the Commission, following the advice of scientists at VIMS, has had great success in producing seed in the Great Wicomico, Piankatank and other rivers and tidal creeks. Reef shells in these rivers produced about 200,000 bushels of seed in 1965. Other areas could be developed as seed beds.


The proper time for planting shells varies from river to river, and can be determined only by spatfall surveys. Clean shells (cultch) should be planted just prior to expected setting to avoid fouling of the shells with young barnacles and other marine growth before oyster spat are ready to set. Some planters have harrowed their grounds near time of setting to expose clean shell surfaces to the oyster larvae. Setting occurs in various waters of the state from July through September. However, spatfall is abundant only during early July in some areas, while it is best in late summer in other areas. In still others setting may continue from late June through September.

Records of setting from test shellbags have been kept by VIMS for over 20 years. From these long-term studies, it is known about what to expect in Virginia's major tributaries regarding regularity and quality of setting. This information has contributed to the decisions of the Commission of Marine Resources and private oystermen in developing areas for seed or market oyster production.

*Commissioner Milton T. Hickman (center) Charles R. Bagnell and Mrs. Virginia E. Jones of the Virginia Marine Resources Commission are shown discussing rehabilitation programs for oyster production on public rocks.*







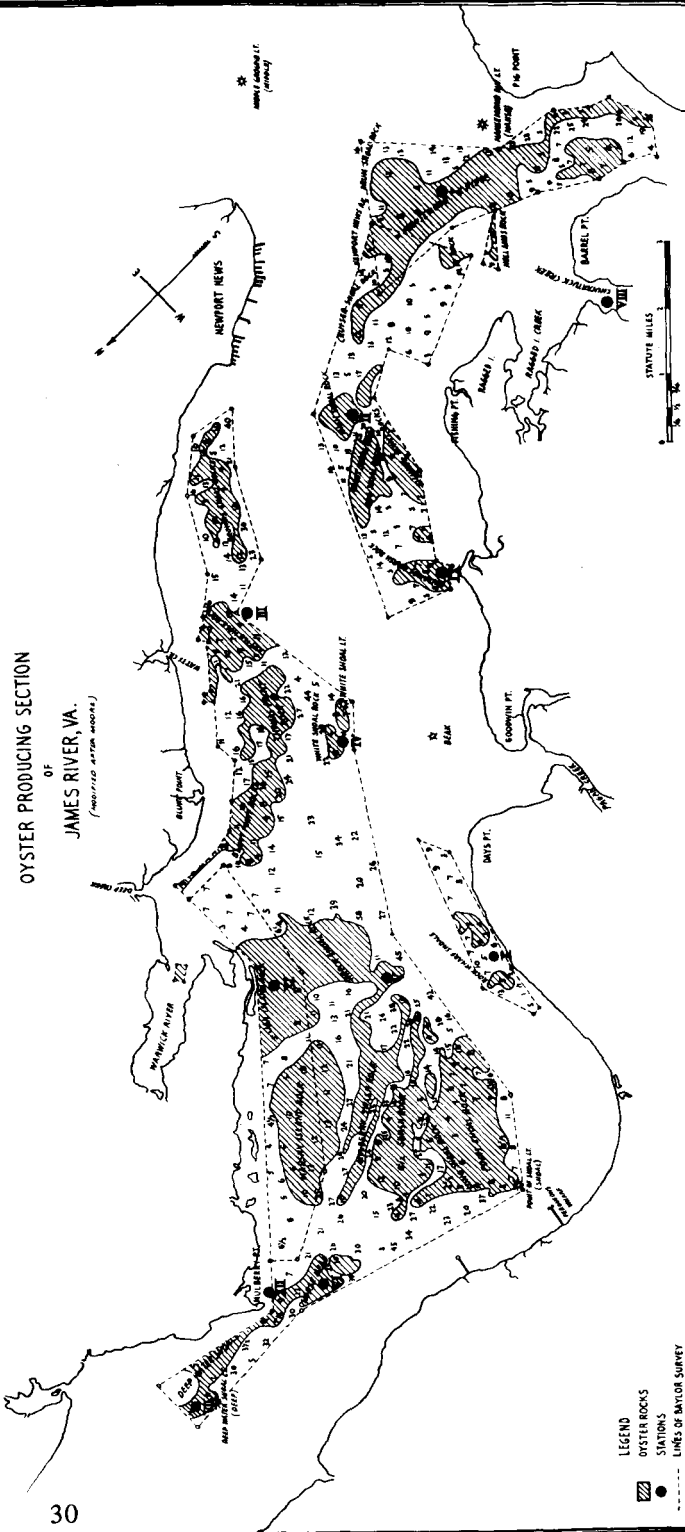
SHELLFISH  
PERMIT  
REQUIRED  
→  
DEPT. OF FISHERIES



*The Virginia Health Department and the Marine Resources Commission regulate harvesting of shellfish in polluted areas by special permit (left). Commission officers (above) issue licenses, collect taxes and enforce fishing laws. The Commission also plants shell for on seed-producing public grounds (below).*



OYSTER PRODUCING SECTION  
 OF  
 JAMES RIVER, VA.  
 (INDICATED BY SHADINGS)



*Lt. James B. Baylor of the U.S. Coast and Geodetic Survey was hired in 1891 to survey and chart all grounds in Virginia which were producing oysters naturally. These were designated as public grounds open to any licensed citizen of the state. The highly productive public seed beds in James River, surveyed by Baylor, are shown above. These have supplied seed oysters to private planters for generations.*

# MANAGEMENT OF PRIVATE OYSTER GROUNDS

## Developing Private Oyster Grounds

The Virginia Company, which established the colony at Jamestown, claimed rights to whatever was taken from the waters as well as from the land. This position proved untenable and regulations were soon changed to give individuals the right to take fish and oysters for personal use. Following the Revolutionary War, the state, while holding claim to all submerged bottoms, provided for conveyance of rights to certain bottoms to citizens, but few individuals acquired acreage for oyster culture prior to 1900.

Many problems confront the Commonwealth in determining a suitable policy for regulating the oyster fishery in a manner that will protect the public interests and at the same time encourage private enterprise. Commissioners of Fisheries have for many years encouraged private ownership and management of grounds, realizing that thereby production of market oysters could be sustained at a higher level than is possible under public management. This has also created a fairly steady market for seed oysters produced on public grounds.

Applications for assignment of oyster planting grounds must be made to the inspector of the district wherein the ground lies. He can supply information about acquiring land and about the lawful use of various harvesting gear. Once a lease has been secured, the owner may convey it to his heirs or may sell his right to lease to some other person.

Each year rent is paid on tens of thousands of acres of ground by planters who hope to make them produce oysters. Much of this area requires special treatment before oysters can thrive. Most productive grounds have been leased for many years and anyone entering the oyster business at this time will probably have to pay high prices to secure high quality beds. Five hundred dollars per acre was considered a fair price for good grounds in 1960, and prices over \$1,000 per acre have been paid. Many planters rent acres around their planted beds which they never cultivate but hold as buffer zones against encroachment of would be poachers. In some areas the same technique is used to keep oyster drills off "cleaned" grounds. Some planters rent large acreage which they divide into several plots. Each year some plots are seeded, some are harvested and the remaining ones have oysters in several stages of growth on them. When oysters on a plot reach market size, they are harvested. Planters in drill-infested areas may then dredge the harvested plot to remove as much debris as possible and leave it fallow for a year or more before re-seeding it, believing that thereby the drill population is reduced.

## Evaluating Leased Grounds

The greatest production on leased grounds will result from careful management practices based on accurate information about the characteristics of the grounds. The oyster farmer should consider as early as possible such factors as these:

- 1) What is the structure of the bottom?
  - a) Is it shifting sand where oysters may be buried or washed away during severe storms?
  - b) Does it have a substrate suitable for supporting seed oysters until they reach market size?
  - c) Is it likely to be silted over?
- 2) Are diseases and predators prevalent?
- 3) What is the setting potential?
- 4) How will production be affected by the surrounding waters?
  - a) Is the depth of water such that oysters will be exposed to freezing winds or burning sun during extreme low tides, or to oxygen-deficient water during summer?
  - b) Is the area flooded with fresh water when heavy run off occurs? This may stunt growth or kill many oysters.
  - c) Is pollution likely to become a problem?
  - d) Will currents deposit sediment or debris over the oysters?
- 5) Do oysters grow rapidly in the area? Do they fatten well?
- 6) Are the meats attractive?

Management plans should be based on detailed notes and records of observations, **not on memory alone**. Pencil and paper are still the most important tools of management. Where good sets occur regularly, seed oysters need not be planted. If setting is good but growth slow, it may be more profitable to produce seed rather than market oysters. Some planters possess excellent fattening grounds where oysters may be placed for only a few months to reach prime condition just prior to harvesting. Oysters suitable for the raw bar trade command premium prices and should be so utilized.

The best oyster bottoms are those which are stable. Oysters planted on sand may be shifted, rolled about and buried. A suitable mixture of clay and sand produces the best planting grounds, but many productive beds are on soft bottoms which have been stiffened with shells.

Extremely soft bottoms cannot be reclaimed for oyster culture, but moderately stiff, muddy sand may be successfully improved. Canadians maintain that placing sand over muddy bottoms before planting shells is preferable to using shells alone. Approximately 800 cu. yds. of sand are required to put a layer 6 in. deep over an acre. Between 1000 and 5000 bushels of shells per acre are required in addition to the sand. This has not been evaluated for waters in Chesapeake Bay. The traditional planting of shells alone has proved satisfactory.

In deciding whether or not to reclaim bottoms not naturally suited to oyster culture, it is wise to seek knowledge of the grounds from local planters. If a planter has successfully developed similar bottom close to that you plan to improve, you have some assurance of equal success. Bear in mind, however, that improved muddy bottoms may silt over again within a few years. Some planters find that if they tong up oysters and return the undersized oysters and empty shells to the bottom,



the increase in shell by oysters growing there is sufficient to maintain the stiffened bottom. Other planters find it necessary to remove all oysters periodically and re-shell a built-up bottom.

Bags or strings of shells suspended in the water from mid-June to fall may be used to determine the level and regularity of spatfall (setting) on the area to be cultivated. Spat should be counted not earlier than November or December but counting can be delayed until spring if spat are very small. A simple magnifying lens and bright light will help in counting the smaller spat. If there is an average of two or three oysters per shell in most years these grounds may be used for seed production. If the average count is below two per shell but from 200-300 per bushel of cultch, and well distributed, the grounds may be self-sustaining with shell plantings alone, thus eliminating the more costly procedure of planting seed oysters. Lesser sets indicate that seed oysters should be planted to assure a crop.

Trays of oysters suspended over the grounds may be examined to detect growth and mortality patterns. Wire or plastic mesh bags of small oysters can be placed on the bottom and easily recovered. A periodic count of drilled oysters will establish the losses attributable to oyster drills.

If a planter will make a careful examination of oysters left on his grounds for a season to detect such fouling organisms as mud blister worms, boring sponges, hydroids, mussels, barnacles and tunicates he will be able to estimate the quality of oysters he may expect to raise. Oysters free of fouling organisms give higher counts per bushel and are usually fatter than fouled oysters.

### **Obtaining and Planting Seed Oysters**

Most private grounds do not have a natural strike of oysters, but seed oysters planted on them may grow well. Through the history of private oyster culture in Virginia, James River beds have supplied most of the seed planted. Production prior to the 1960's was about 2 million bushels annually. The spatfall characteristics of the river changed after MSX killed most brood oysters in the Ocean View-Hampton Roads area. Since then, spatfall in the seed area has seldom been adequate for sustained seed production. Some planters are able to produce their own seed oysters and new seed beds developed by the state (see p. 25) are providing seed for planting in the vicinity where they are located. Unfortunately the quantity and quality is variable from year to year. Securing or producing adequate seed oysters remains a problem of both public and private management and of marine scientists.

The price of seed oysters has varied in recent years from 75 cents to \$2.00 per bushel, depending not only on supply and demand but also on the quality of the seed. The best seed oysters are of good shape, in small clusters, and free of shell, attached mussels, and trash. Seed oysters infested with oyster drills and their egg cases, or containing other predators and competitors, or which are infected with diseases,

are to be avoided. Large, thick-shelled seed oysters are preferable for planting on grounds where drills are a menace, since drills encounter difficulty in penetrating heavy shells.

VIMS scientists, conducting studies of the destruction of oysters by the MSX protozoans, have planted seed oysters obtained from several localities in MSX infested waters to test their survival. Seed oysters from the Piankatank River (which is MSX infested) when planted in Mobjack Bay (heavily infested with MSX since 1959) reached marketable size in three years and showed only moderate losses from this disease. Planters leasing MSX infested planting grounds might make test plantings of seed produced in MSX infested waters, but they are advised to proceed with caution. The explanation for the high survival of such seed is that early exposure to MSX may enable oysters to develop natural immunity.

Small seed oysters planted in waters of moderate salinity may yield 3 bushels of market oysters for each bushel of seed planted, but such yields are uncommon and occur only in very favorable environments. Most planters are willing to operate grounds which yield one bushel of market oysters for each bushel of seed planted. Oysters grow slowly in low-salinity waters and those planted well upriver and near headwaters of creeks may require an extra year to reach market size. They may also occasionally be killed by unusual freshets.

Seed oysters should be distributed evenly over the entire acreage to be planted. The amount planted per acre should be about 500 bushels on hard bottoms and 750 bushels on soft bottoms stiffened with shell to compensate for the inevitable losses associated with such bottoms. Low-count seed should be planted even more thickly. Mussels on seed usually die when planted in saltier waters, but they will survive and become a nuisance in brackish waters. Some planters pull a spiked-toothed harrow over their grounds soon after planting is completed in order to smooth out high mounds and distribute the oysters more evenly. Later harrowing of beds may increase production of 10–20 per cent, increased growth being thus stimulated by lifting half-buried oysters to the surface and facilitating the flushing away of waste products which have accumulated on the beds.

### **Harvesting and Marketing Oysters**

Most private planters harvest their oysters with dredges. To do so a permit must be secured from the Commission of Marine Resources through the local oyster inspector and bond must be posted. Some planters prefer to use tongs, especially if the crust supporting the oysters is thin. They believe that tongs are less damaging than dredges to built-up beds.

Dredged oysters are seldom sorted to remove empty shells, undersized oysters or debris before they are delivered to a shucking house. The prices paid, therefore, are based on the number of good oysters per bushel of unloaded material. Many small planters prefer to cull



dredged oysters to return shells and small oysters to their own grounds and deliver only marketable oysters to the dealers. Tonged oysters are always culled.

The greatest demand for oysters is around Thanksgiving, Christmas and Lent. Planters may develop special markets directly with restaurant owners and seafood dealers if their oysters are above average in quality and flavor. A premium price is paid for fine oysters.

## CONDITIONS AFFECTING OYSTER CULTURE

Marine Scientists have been gathering information about biological and environmental conditions affecting oyster production in Virginia since before the Virginia Fisheries Laboratory (now VIMS) was established in 1940. Scientists employed by the state or Federal government began work as early as 1931 though the effort was rather sporadic until about 1950. The activities of many marine scientists are focused on oyster culture and its many problems. Similar work has gone on at marine stations in other states and abroad. The complex relationships between oysters, their environment and associated organisms which are recognizable today were not known a generation back.

### **Flood and Drought**

In 1955 torrential rains from hurricanes Connie—(Aug. 12, 1955) and Diane—(Aug. 18, 1955), occurring within a week of each other, fell in the drainage basins of Virginia rivers, flooding the tributaries and flushing much organic matter from river banks, marshes and lowlands into the system. Hundreds of thousands of bushels of oysters died in the highly productive beds of the upper Rappahannock River and planters appealed to scientists to determine the cause. Virginia marine scientists immediately began physical, chemical and biological tests in the river. After careful evaluation of data they were able to assure oystermen that deaths were due to adverse environmental conditions brought on by run-off of fresh water.

The report of the scientists that the disastrous loss of oysters in the Rappahannock resulted from a combination of fresh water, low oxygen and high temperatures rather than disease was reassuring to the planters and led the way for them to obtain loans from the Small Business Administration (an independent Federal Agency) to replant their grounds. Thus, productivity was restored to that area of the river just before the more saline growing areas in the lower bay were struck by the MSX killer.

Drought in river drainage systems feeding water into the bay in the mid-60's resulted in the gradual increase of salinity within Chesapeake Bay and intrusion of salt water as much as 30 miles farther up tributary rivers in Virginia than normal. As a consequence, oyster diseases and predators damaged oyster populations further than usual up the bay and its tributaries. Normal runoff in recent years has driven back the diseases and predators from these areas.

### **Engineering Projects**

Engineering projects are frequently proposed to control floods, alleviate drought, deepen channels and to provide fresh water for municipi-

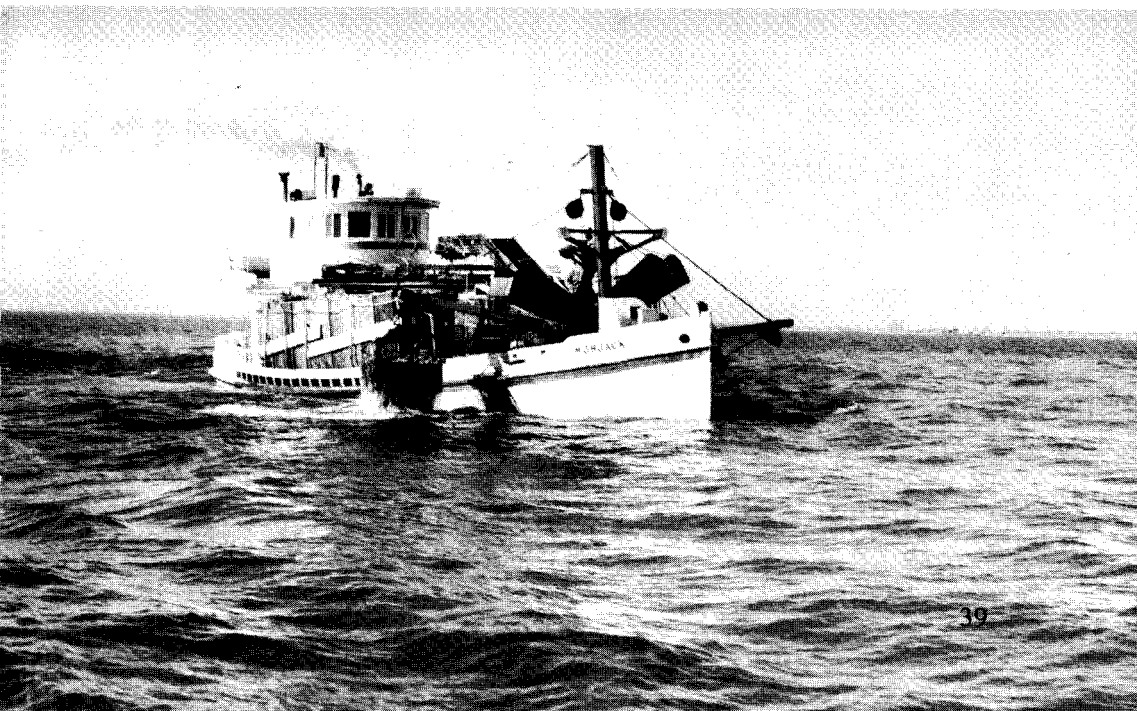
*Seed oysters are bought by the standard oyster bushel (3,000.9 cu.in.) from tongers on public rocks and are transplanted to private grounds for growth to market size.*







*Mechanical conveyors are used to unload oysters from dredge boats and buy boats at oyster shucking houses (left). Licensed tongers using hand tongs (above) harvest both seed and market oysters from public rocks. Mechanical dredges (below) are prohibited from use on public oyster rocks, but they are widely used to harvest market oysters from private grounds.*







palities. Only recently has man begun to consider the effects of local engineering projects, including the ecology of oysters, on the ecology of entire river systems.

A dam has been proposed to be constructed at Salem Church (just above Fredericksburg) to control flooding in the Rappahannock River drainage area. VIMS scientists have considered how the development of such a project would affect the oyster industry in the lower river. If incorporated into the building and operation of the dam, suggestions they have made to the Corps of Engineers regarding storage and release of water, will mitigate damage to oysters from environmental changes which would be expected from changing the natural flow of the river. Planned release of water at proper seasons is expected to actually benefit oyster production in some years.

Management of river flow could prevent sudden flooding of oyster beds with fresh water and by judicious release of impounded water would tend to keep drills and other pests below Towles Point, the present level of upriver intrusion. Information supplied from adequate salinity monitoring at downstream stations would be conveyed to dam operators enabling them to release water from the impoundment in a manner which will maintain desired salinities with a minimum of drawdown and disruptions of reservoir operations. Plans for regulating waterflow on all watersheds of Virginia's tidal rivers should be drawn carefully to protect the interests of marine fisheries and other down-river users of river water. This same care should be exercised with use of Potomac and Susquehanna River waters because of their great significance to Bay salinities.

The proposal to deepen the James River channel from Hampton Roads to Richmond emphasized the need for better information on the effects of such projects on the oyster industry. VIMS scientists were largely involved in measuring the probable effects of such an undertaking on the production of seed oysters in the James. A model of the river was constructed to measure effects of deepening on currents, salinity and circulation. Biologists appraised the effects of the proposed channel deepening on oysters and other estuarine organisms prior to the actual construction. These scientific studies indicated that changes in current patterns and salinity distribution resulting from the James River Navigation Project (Army Corps of Engineers) channel dredging will have no significant effect on seed or market oyster production in the James estuary.

## **Pollution**

Problems of pollution mount as population densities increase. Sewage is not the only pollutant which may affect oyster production. Others, such as silt, industrial wastes, nutrients, insecticides and herbicides

*Mountains of shells accumulate outside shucking houses. These are hauled away in spring and summer to stiffen muddy bottoms for seed planting or to provide cultch in spat setting areas. Some shells are manufactured into lime for agricultural and other uses.*

leaching into estuarine waters, and heating great masses of water in cooling condensers and generators may affect oysters directly or may affect food organisms on which oysters feed.

Siltation may raise the cost of maintaining rented grounds at a productive level. This may arise from soil erosion, dredging of channels, or mining buried oyster shells, gravel and sand. Hydrographic studies are helpful in determining areas likely to be adversely affected and in selecting spoil areas where waste soil from dredging operations is least likely to be washed back into the river.

### **Discoloration of Oysters**

At certain times of the year oysters may develop unusual colors, particularly in the gills. "Green gill" oysters are caused by pigments acquired while feeding on certain species of diatom (microscopic plants). This condition does not harm the flesh or the flavor of the oyster. In fact, some epicures maintain that this is a sign of quality oysters. Oysters feeding in lush green pastures are usually fat and flavorful. The French prefer "green gill" oysters to the less colorful variety, and, before placing them on the market, oystermen in that country move them to ponds in which the color-producing plants are prevalent.

Although diatoms account for most discoloration of oysters, they may also acquire blue-green spots or hues from excess amounts of copper. Some heavy metals may cause unpleasant taste without discoloration. This is most likely to occur in areas where industries dump minute quantities of these metals, which are first taken up by algae, then passed on to oysters which feed on them. Eating large numbers of such oysters may be harmful.

Occasionally packers are plagued with outbreaks of "pink" or "red" oysters which appear normal when shucked into containers but after being refrigerated for several days develop bright red coloration in the liquor. If the cause is plant pigments derived from the food in natural waters, only the esthetic value of oysters is involved. However, oysters may be contaminated in processing plants with a mold called "pink yeast", and the pink coloration may indicate they have been held too long and are turning sour.

Records of brightly-colored oysters have been reported since the late 1800's. Scientists know that occasionally pink and red coloration is caused by yeasts but usually color results from an accumulation of plant pigments from food similar to the green-gill condition previously described.

Red oysters appear most commonly in warm weather. Some packers protect themselves from losses from this cause by taking samples before harvesting a bed. If red coloration appears in shucked samples, the beds are left to harvest at a later date. Usually the trouble disappears within a few weeks when the causative algae becomes less plentiful in the water.



## **The "R" Months**

Oysters are suitable for food at any time of the year. The idea that they should not be consumed in summer probably came from Europe, where the common oyster (*Ostrea edulis*) holds the developing larvae within its gills. The shells of these tiny oysters would feel gritty to anyone eating raw oysters during the breeding season. Spoilage due to poor refrigeration led at least one state in the United States to outlaw their sale during the summer back in the 1800's.

Actually, oysters are in poorest condition in September, the first "R" month after summer, due to exhaustion from spawning. During early fall customers will likely find packaged oysters, frozen while in prime condition, preferable to fresh-shucked oysters of inferior quality.

## **Contaminated Oysters**

Persons gathering oysters for private consumption should never eat oysters taken directly from contaminated areas. Unfortunately, sewage from dwellings along many creeks and rivers drains into nearby waters containing oyster beds. Concentration of pleasure boats in marinas may add to contamination of local waters. Sewage can induce a growth of organisms suitable for oysters to feed on and they may grow fast and fat, but diseases related to sewage may also be acquired by eating raw oysters raised in polluted waters. When temperatures are above 50°F. contaminated oysters clean themselves thoroughly when transferred to clean water for a few weeks. The State Department of Health rigidly monitors oyster grounds, processing houses and marketing of oysters to insure wholesome commercial products.

## **CULTURE TECHNIQUES FOR THE FUTURE**

It is still possible to utilize present simple farming techniques to rear oysters. Nature produces an abundance of larvae and spat which man is not likely to duplicate in the near future. However, scientists are working hard to bring oyster culture under laboratory control for the benefit of the oyster industry. The industry itself, aided by engineers and technicians, must incorporate into their farming practices useful information gleaned from the scientists if the industry is to progress.

People retiring to Tidewater Virginia counties often consider the possibility of raising oysters for their personal use or for sale. Some may become interested in attempting to apply discoveries made by scientists to their own oyster culture practices. For those who would like to become involved in projects suggested from research, there are these possibilities:

### **Spawning Oysters**

Techniques have been worked out for spawning and stripping oysters (cutting into the gonads and flushing out sperm and eggs), fertilizing the eggs and carrying the young through their larval development and obtaining a set on shells. Using these techniques, it is possible to select and to breed oysters for certain desirable characteristics such as rapid growth and resistance to diseases.

Although some knowledge of biological principles is necessary to achieve success in hatchery and nursery culture, the space requirements are not great, and the cost of equipment may not be prohibitive. Information on producing controlled stocks of seed oysters may be obtained from VIMS.

### **Salt-Water Pond Culture**

Biologists have suggested that specially bred stock once built up under laboratory conditions might best be developed in shallow, salt-water ponds, and later be transferred to growing areas.

If ponds are used for production of spat, interchange of water could be cut off during the most active larval development stage, thereby keeping large numbers of larvae of known stock in a confined area until after setting.

There are many salt ponds in Tidewater Virginia which can support an oyster population. It may be feasible to develop some of these for oyster culture. Mud could be removed by pumping, dredging, or bulldozing to provide a clean hard bottom for supporting cultch to which larva would attach. Specially bred parent stock might be allowed to spawn naturally in these ponds, or laboratory bred larvae might be introduced.

Such ponds might be used (1) to produce seed oysters which would be transferred as early as possible to growing grounds in the open rivers;

(2) to produce market oysters on a limited scale; or (3), to fatten oysters just before marketing them.

Providing adequate volumes of water may challenge engineering ingenuity. Fresh sea water may be made available through tidal gates, or through large capacity pumps or special flow-through systems. Large quantities of water will be required, for it has been shown under laboratory conditions that 25 market oysters need a minimum of two quarts of sea water flowing over them per minute.

The use of ponds for producing spat and for growing and fattening oysters is completely unexplored, therefore, the problems which will be encountered are little known. It is essential that the oysters have an adequate volume of water moving over them and that temperatures should not exceed 86°F. The volume of water can be materially reduced by feeding starch in the ratio of 1:1,000,000 sea water and such minute amounts of starch may increase the yield 20% to 30% within six weeks. Temperatures may be regulated by the flow of incoming water or by shading the ponds or by a combination of the two.

### **Controlling Eel Grass**

Eel grass growing near oyster beds may break loose and pile up, killing planted oysters. Some Canadian oystermen have reclaimed ground infested with eelgrass by putting down tar paper and covering it with sand and gravel. Dr. Victor Loosanoff, while Director of the Fish and Wildlife Laboratory at Milford, Connecticut, tested the use of polyethylene sheeting on soft bottoms to support planted seed oysters. He reported that neither walking on these sheets nor the sharp shells seriously hurt the plastic, and that after three years it was still useful. While such methods are not yet practical for large operations, they may suggest ideas for small planters to experiment with.

### **Collecting Spat**

The Japanese collect spat on shells strung on wire and suspended off bottoms. They later separate the shells with bamboo spacers to allow for growth of the oyster spat to market size. Bags made of chicken wire to hold about 2 or 3 pecks of clean shells make excellent spat collectors either suspended in the water or stacked on the bottom. Strike on bagged shells is regularly 2 to 3-times heavier than on shells scattered over the bottom and some oystermen use shell bags to collect spat for seed. Dutch and French oystermen have successfully used roofing tile coated with a mixture of lime and sand as collectors for spat, which are removed by hand when they reach a proper seed size.

The development of cheap cultch materials easy to handle and from which seed oysters may be removed easily, would be a great boon to the industry. Reference has already been made to the development of methods for getting spat to develop in the laboratory without the necessity for employing cumbersome cultch. The next step is to adapt these methods to commercial needs. The production of "free standing"

(each oyster separate from other oysters or cultch material) oysters would be a forward step in improving oyster production. Their development may eventually lead to the elimination of shells for cultch.

Until economical systems for providing free standing oysters are developed, shells scattered over the bottom or placed in wire bags offer the most economical substrate for collecting spat.

Canadians have found heavy duty cardboard egg crate fillers dipped in cement, bagged and wired to be very efficient collectors, but the cost of materials and preparing the collectors has made this method prohibitive to most oystermen. New Zealanders use treated sticks to collect and rear spat to marketable size. The Dutch use mussel shells as collectors. These do not collect many oyster predators and competitors and after a year or two in the water tend to go to pieces leaving individual or small clumps of oysters. Where surf clam shells are readily available in some areas of Maryland, local oyster farmers claim that they are excellent cultch.

### **Oysters for the Raw Bar**

Good quality seed oysters of pleasing shape may be grown for home use or the raw bar trade on firm bottoms in areas free from boring sponges and mud-blister worms. Where fouling organisms abound, oysters for the raw bar may be grown in trays supported by a firm structure or suspended from a dockside. Periodic dipping of trays in a saturated brine solution for about five minutes will kill or damage many fouling organisms including mud-blister worms and boring sponge and will not harm the oysters.

### **Escalator Oyster Harvester**

One breakthrough that would spur the oyster industry to more efficient production would be the introduction of more mechanized harvesting techniques. In Canada in 1959 an escalator oyster harvester was put to practical use. The cost of this device in Canada ranged from \$7,000 to \$10,000, including a boat and auxiliary equipment. Whether such harvesters can be operated successfully in Virginia awaits testing. Ten feet is the greatest depth at which these Canadian rigs operate efficiently. (Description of an escalator harvester may be found in Oyster Farming in the Maritimes, by J. C. Medcof. Bulletin 131, 1961. Fisheries Research Board, Ottawa, Canada. Price \$1.75).

A similar device has been used to a limited extent in Maryland oyster culture and plays an important part in harvesting clams. The Hanks rig is reported to be operative up to 25 feet deep.

# CONTRIBUTIONS OF SCIENTISTS TO OYSTER CULTURE

## **Culture Practices Based on Biological Studies**

Areas suited for seed production can be determined by estimating the set of oysters on shells in spat collectors (either strings of shells or bags of shells) over a period of years.

In setting areas, clean shells for collecting spat should be planted not later than July 1 in rivers north of the James; since the major set of spat occurs later in James River, shells may be planted there up to mid-August.

Areas best suited for (1) seed production, (2) growth, and (3) fattening on public grounds in Virginia have been plotted by VIMS scientists, using accumulated records of intensity of set of spat, rate of growth, and condition of oysters. Areas change from time to time, but scientists, by referring to their records, are able to designate which bottoms should be temporarily converted from seed production to market production or vice-versa.

Areas selected for seed production should be used for that purpose only. For maximum efficiency, seed oysters should be removed to growing grounds within eight months to a year after they set. All young seed oysters should be removed from seed beds to growing grounds each year to avoid stunted growth due to crowding on seed beds. Once oysters become stunted they never fully recover the capacity for fast growth. Also, many oysters are smothered under crowded conditions which induce stunting.

Oysters to be planted in MSX infested areas should be placed there during the season of low infectivity (October 1 to May 1). Spat exposed to MSX before reaching seed size build up some immunity, which is reflected in the lower death rates of oysters raised to market-size, therefore it is desirable to secure seed from MSX infested grounds to plant on growing grounds subject to MSX. Piankatank seed beds have been a source of such seed in recent years.

In general, years of low rainfall favor good sets of seed oysters in creeks, bays and sections of rivers which have a low flushing rate and thus tend to trap oyster larvae.

## **Identifying Diseases and Controlling Predators**

There has been little advancement in our ability to directly control predators and diseases of oysters, but scientists have been able to outline patterns of management to minimize their destructive effects and reduce or avoid losses.

Effective chemical control of drills awaits the development of compounds which will leave no dangerous residues in oysters and which can be applied in restricted areas in a controlled manner. Biological

control may, in the long run, prove to be more useful, but despite considerable effort to devise such control there has been no significant breakthrough thus far.

Perhaps the greatest contribution made to the oyster industry by scientists is in pinpointing the various causes of oyster mortalities and separating disease epidemics from other factors affecting oyster populations. Recognition of disease-causing organisms and of the conditions favoring epidemics have enabled scientists to suggest various culture practices which will minimize losses from these causes.

In seeking information about microorganisms harmful to oysters, scientists at the Virginia Institute of Marine Science have had over 90,000 slides of oyster tissue prepared for microscopic examination. These provide a valuable bank of material which may be drawn on for further studies and for future reference. Along with other oyster biologists interested in diseases affecting oysters, they have made significant contributions to learning the biology and habits of MSX, Dermo, and SSO.

Efforts are presently being made to produce oysters resistant to diseases and capable of rapid growth. If it is possible to successfully breed such characteristics into oysters, the industry may then develop techniques to utilize such superior strains. Development of mass culture capabilities will require engineering skill to economically handle large quantities of spat and seed bred from selected stock.

### **Aims of Research**

Year after year, with incessant and painstaking labor, scientists have eliminated from the field of speculation one factor after another affecting oyster production. The aims of their research continue to be: (1) prediction of place, time and intensity of setting and improving collection of spat, (2) appraisal of conditions existing on public grounds through annual surveys, (3) anticipation of losses from any cause, (4) tabulation of the condition of oysters from time to time and place to place and determining factors which influence their "fatness", (5) controlling diseases, (6) improving breeding of oysters for fast growth and resistance to disease, and (7) control of predators.

As new information is gathered, evaluated and added to previously acquired knowledge, the whole will be re-evaluated in the light of new discoveries and improved information will help develop new technology to advance oyster culture.

*Along with other biologists interested in diseases affecting oysters, scientists at the Virginia Institute of Marine Science have made significant contributions toward learning the biology and habits of the disease organisms of MSX, Dermo and SSO.*

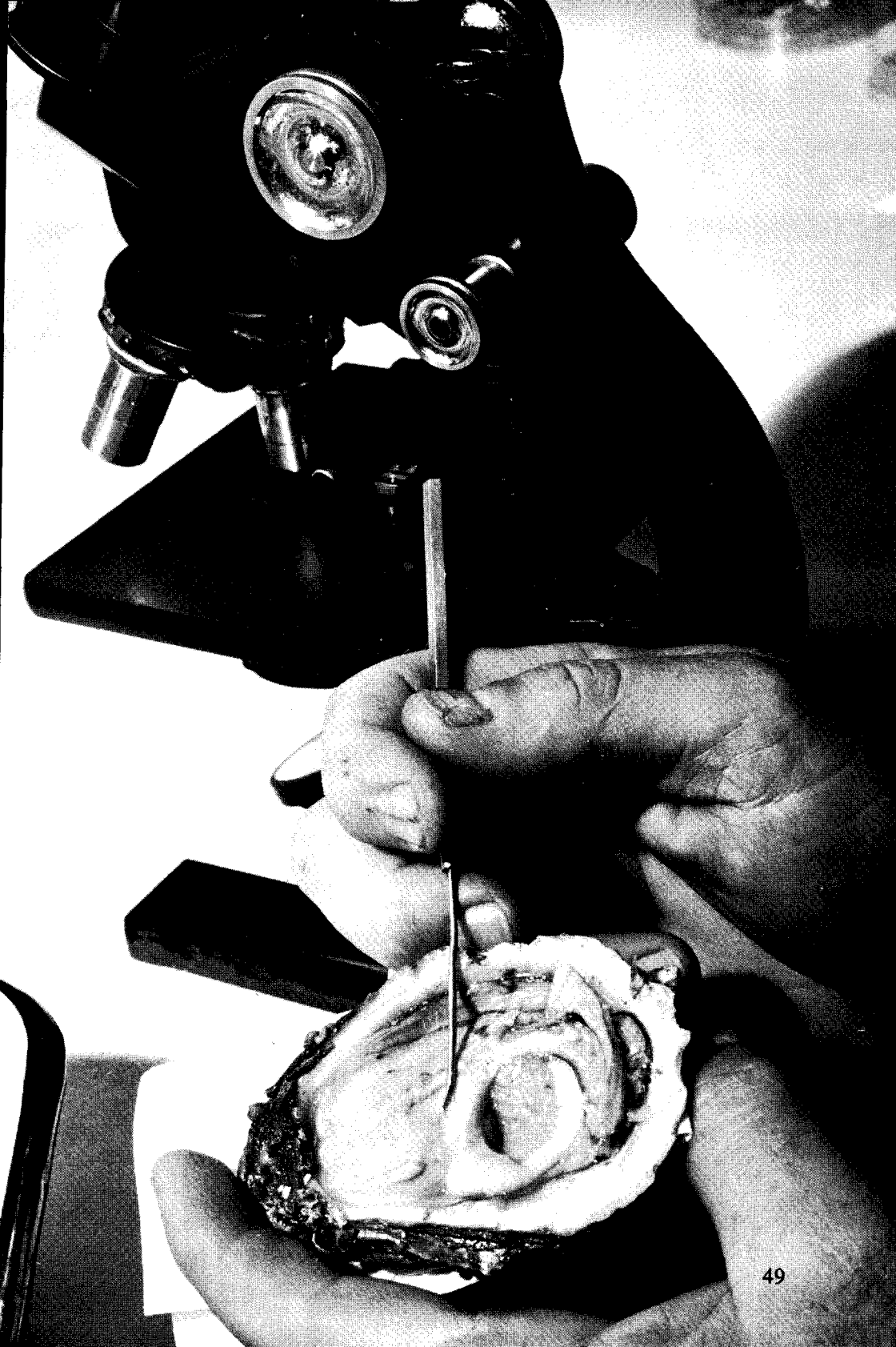




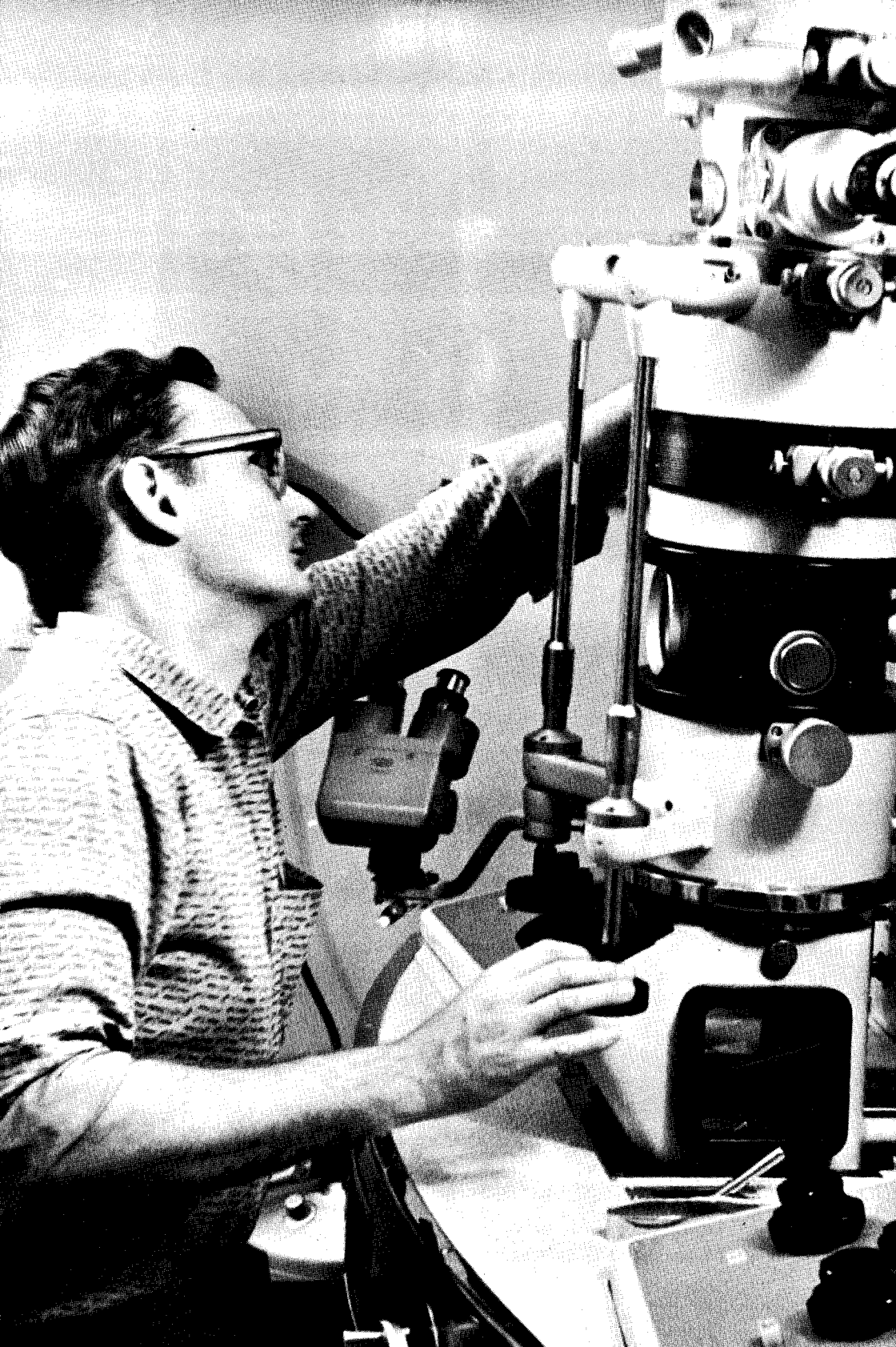


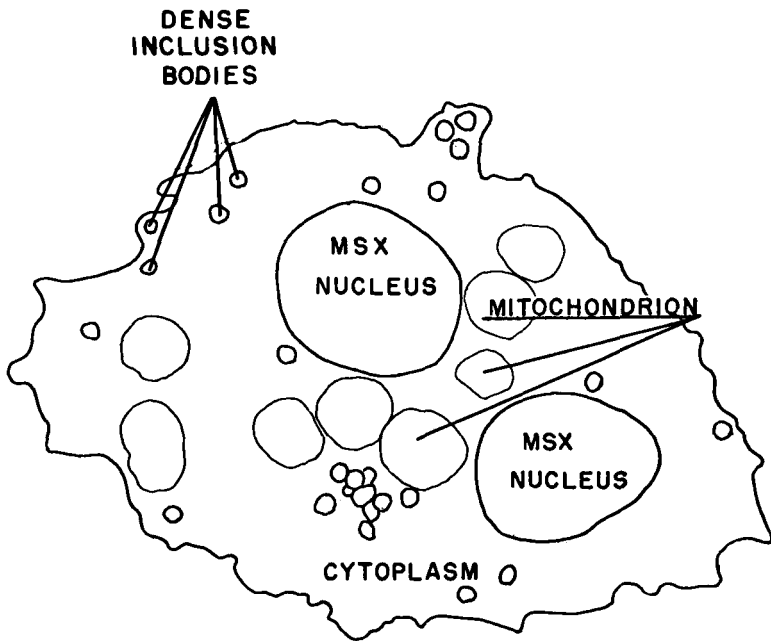
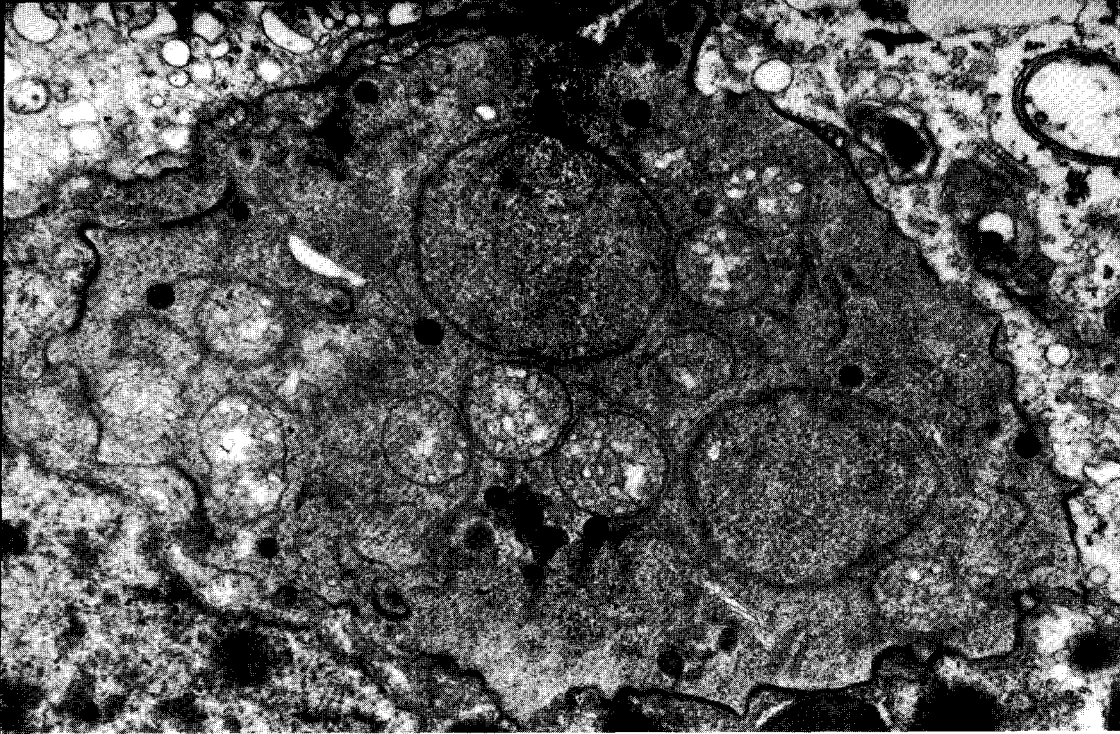


Photo By A. AUBREY BODINE

*Dr. J. D. Andrews (above) directs oyster research at VIMS. He has been a member of the scientific staff since 1948 and has earned widespread acclaim for his work on oyster diseases here.*

*The VIMS campus at Gloucester Point provides laboratories and other facilities for scientists studying all aspects of the state's marine area. A sizable field laboratory is operated by VIMS at Wachapreague on the seaside of Eastern Shore.*





*The internal structure of the cells of micro-organisms which cause oyster diseases are magnified many thousands of times by the VIMS electron microscope (left), operated by Dr. Frank Perkins. One of his electron photomicrographs of an MSX cell is shown above with a diagram explaining the various cell components.*



*Microscope slides of oyster tissue used in disease research are prepared in the VIMS Histology Laboratory (above). Laboratory breeding of oysters requires the feeding of algae to the larvae during early growth stages (below).*







*Efforts are presently being made to product oysters resistant to MSX and capable of rapid growth. Parent oysters are being prepared, above, for special laboratory breeding. Specially bred oysters are later removed to a salt water pond (below) for initial growth. The oysters are protected from predators in the pond.*





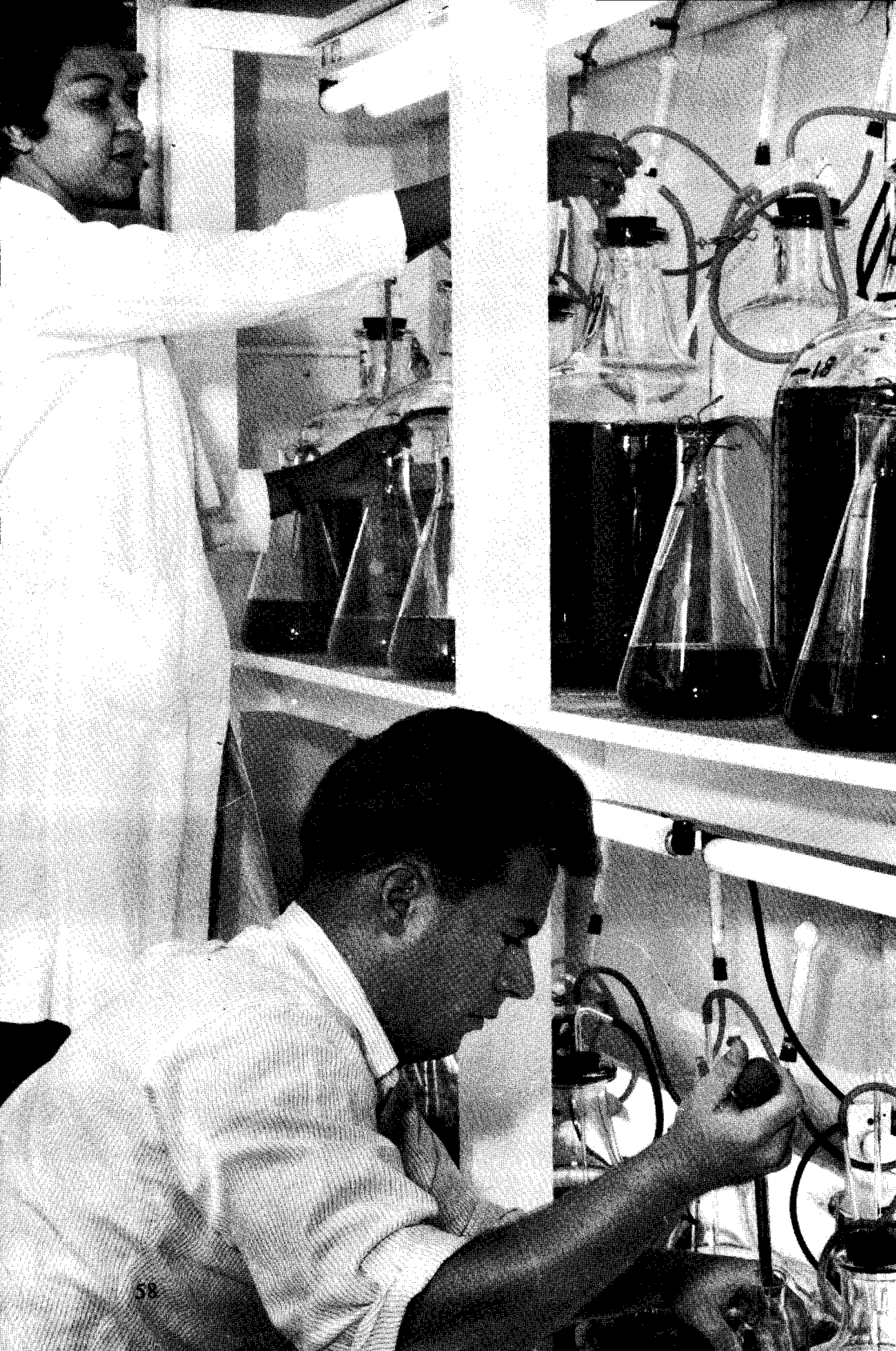
*Oysters are held in trays at VIMS (above) to enable scientists to study losses due to disease and for various other research projects. Experiments, such as the one shown below, have demonstrated that shells bagged in chicken wire containers collect more spat than the same number of shells scattered on the bottom.*





*Oyster biologists determine the most suitable oyster seed producing areas by counting spat (above) on collectors made of shells strung on heavy wire hung in the water. Each spat collected on a shell is indicated by penciled circle (below).*







## BIBLIOGRAPHY

ANNUAL REPORT—Virginia Institute of Marine Science, Gloucester Point, Virginia 23062. Contains summaries of each phase of research on oysters and research in other aspects of the marine science. Free

ANNUAL REPORT—Commission of Marine Resources (formerly Commission of Fisheries), Newport News, Virginia. General comments by the Commissioner about various aspects of the seafood industry, trends of the fisheries, licenses issued, etc. Free

GALTSOFF, PAUL S. 1964. The American oyster *Crassostrea Virginica* Gmelin. Fishery Bulletin of the Fish and Wildlife Service. Vol. 64. U.S. Government Printing Office, Washington, D.C. 20402. Price \$2.75 paper cover. pp. 457. General biology of the oyster; extensive bibliography following each subject.

LOOSANOFF, VICTOR L. 1965. The American or eastern oyster. Circular 205 of the Fish and Wildlife Service, Washington, D.C. pp. 36. Simply-phrased information about the biology, diseases, predators, and competitors of oysters; short statement about the oyster industry and sanitary control.

ORTON, JAMES HERBERT. 1935. Oyster biology and oyster culture. E. Arnold and Co., London.

WHARTON, JAMES. The turbulent oyster trade. Commonwealth, Nov. 1948. Part I, 15:11, March 1949, Part II, 16:3, published by the Virginia Chamber of Commerce, Richmond, Virginia.

BROOKS, WILLIAM K. 1905. The oyster, a popular summary of a scientific study. The Johns Hopkins Press, Baltimore.

*Special species of algae are grown in quantity in the VIMS Algae Culture Laboratory (left). This algae is used as food for oyster and fish larvae being bred by the scientists.*

