HARD CLAM CLEANSING IN NEW YORK

Robert B. Mac Millan and James H. Redman

The State of New York (NY) has approximately 400,000 acres of underwater marine lands suitable for the cultivation of shellfish. Thirteen percent of this area is closed to the harvesting and marketing of shellfish due to microbial pollution. Many of these areas, including Jamaica Bay, Raritan Bay, Manhasset Bay, Hempstead Harbor and portions of Long Island Sound lying within Westchester County, support abundant populations of hard clams (Mercenaria mercenaria). These shellfish constitute a natural resource which is not being utilized and a public health menace if harvested and marketed illegally.

Interest and concern have been expressed by Federal and state regulatory agencies and members of the shellfish industry to exploit these areas. As a result, the N.Y. Department of Environmental Conservation initiated a transplant program in 1964: shellfish were removed from closed areas and placed in certified waters for a minimum of 30 days to achieve purification. An alternate process known as depuration offers purification under more stringent controls. Although the general concept of this process is not new, only limited laboratory data have been accumulated relative to the effectiveness of this process in cleansing hard clams.

New York initiated a study in 1964 to gather data for proper evaluation of a hard-clam commercial depuration plant operation. Following the preliminary investigations, funding was obtained in 1965 from the Bureau of Commercial Fisheries (BCF) under Public Law 88-309 to conduct a pilot-plant study of the depuration of hard clams.

Pilot Plant for Hard-Clam Depuration

The depuration plant has four essential components, including controlled dry storage for untreated and treated shellfish; depuration tanks; and sea-water treatment. Office and laboratory facilities are optional depending on a particular situation. A typical plant layout is shown in Figure 1.

The pilot plant was located on the Great South Bay at West Sayville. Great South Bay is located on the south shore of Long Island (Figure 2) and is a highly productive area with 1969 commercial landings of 6,280 million pounds of hard clams valued at $6,850,000. This site had been used in the initial 1964 studies. However, several modifications had to be completed prior to the operation of the plant.

A boiler-burner combination and heat exchanger were installed with the assumption that raw sea water taken from the bay would require a significant amount of heating for winter operations. The hard clam ceases to feed with water temperatures below 45 degrees Fahrenheit (°F). The recommended water temperature for the depuration process is 59° F. Since the water temperature for Great South Bay approaches 30° F. during the winter months, a 29° F. increase would be required prior to use in the system.

The clam holding tanks were redesigned and rebuilt to improve the flow of water through the system. Three tanks, each 9.1 feet long, 9.7 feet wide, and 1.375 feet deep, were built with sea water entering each tank at the rate of 20 gallons per minute (GPM).

Two settling tanks also were built adjacent to the holding tanks. Initial plans were prepared on the premise that sea water for the system would be drawn from Great South Bay. Since this water normally contains high levels of suspended particulate matter, the settling tanks were planned to remove this material prior to passage through the heat exchanger and sea-water sterilization units.

Mr. Mac Millan is Assistant Sanitary Engineer and Mr. Redman Senior Aquatic Biologist (Marine), N.Y. State Department of Environmental Conservation, Division of Marine and Coastal Resources, 4175 Veterans Memorial Highway, Ronkonkoma, N.Y. 11779. The study was conducted in cooperation with the Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service under Public Law 88-309, Project 3-68-D. Contribution No. 71-3, Division of Marine and Coastal Resources.

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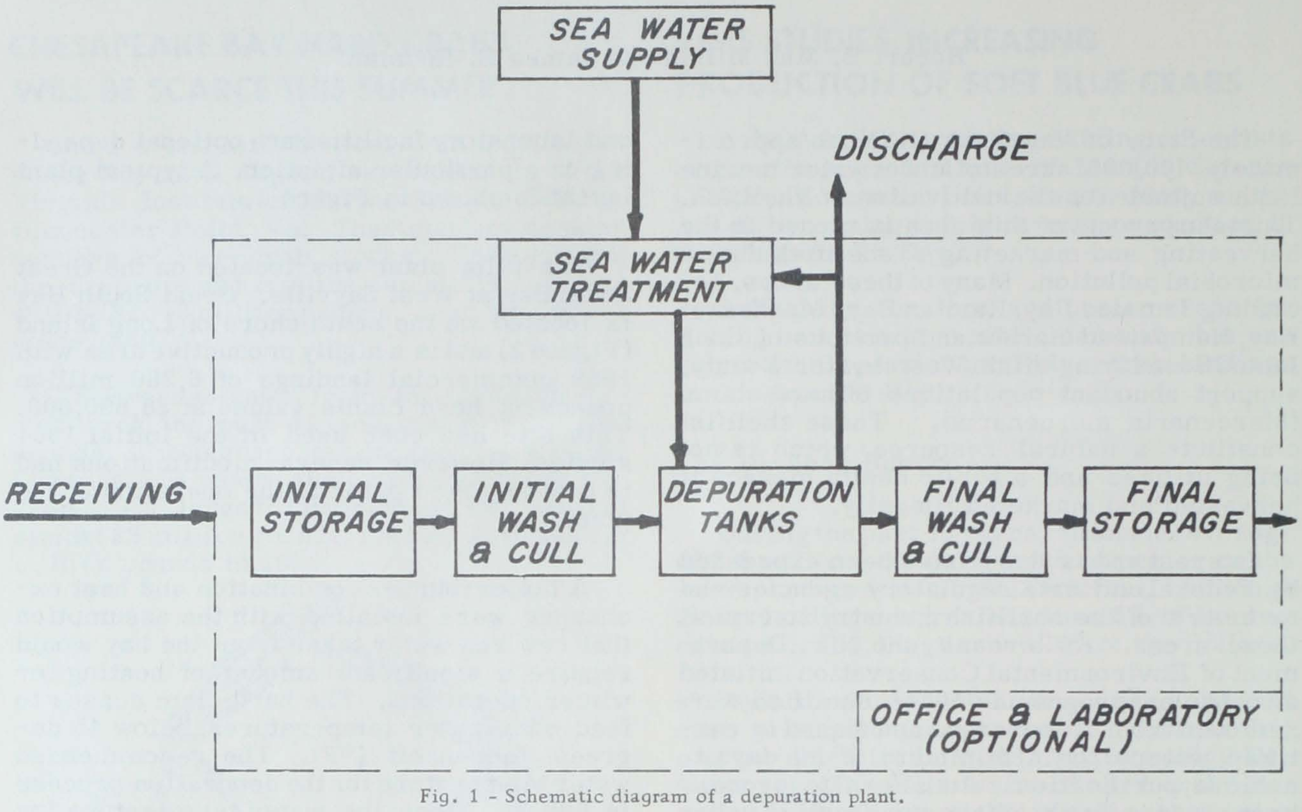

Fig. 1 - Schematic diagram of a depuration plant.

A sea-water well was installed as a supplementary water supply for the operation of the plant. Figure 3 shows the plant arrangement used throughout the test program.

Sea-Water Well System

Four experimental wells were driven. Each consisted of a 12-inch slotted point coupled to 5-foot lengths of 1.25-inch galvanized pipe. At each well site, water samples were collected at 5-foot intervals and analyzed for salinity and temperature.

Following the completion of each well, a centrifugal pump was connected to the system and operated for approximately 1 hour to determine flow characteristics and water quality at each site. A brief summary of the average data obtained at the four sites follows.

Summary of Experimental Well Point Data

Pumping Rate	- 30 GPM.
Water Temperature	- 54.5 - 55.5° F.
Salinity	- 24.0 - 25.5 parts per thousand (°/oo).
Bacteria/milliliter (ml)	- None readily detectable.

NOTE: These data are summarized from a well point depth range of 20 to 50 feet below tidal water level.

As a result of these data, a 4-inch-diameter well was installed in the plant adjacent to the settling tanks. This system included a 4-inch-diameter stainless steel intake screen, 10 feet in length, coupled to 35 feet of 4-inch-diameter steel well casing.

The pumping rate for this system of approximately 225 GPM was reduced by inserting a 2.5-inch diameter polyvinyl chloride (PVC) pipe inside the steel well casing and perforating the lower 6 inches of this pipe with 0.25-inch diameter holes. The flow rate was further controlled by the addition of a 2.5-inch diameter ball valve located on the discharge side of the pump. The final installation is shown in Figure 4.

The well proved to be extremely effective and offered several important advantages when compared to drawing sea water from Great South Bay. The advantages include:

1. Constant salinity.
2. Constant temperature year round.
3. Elimination of heating requirements for the water.

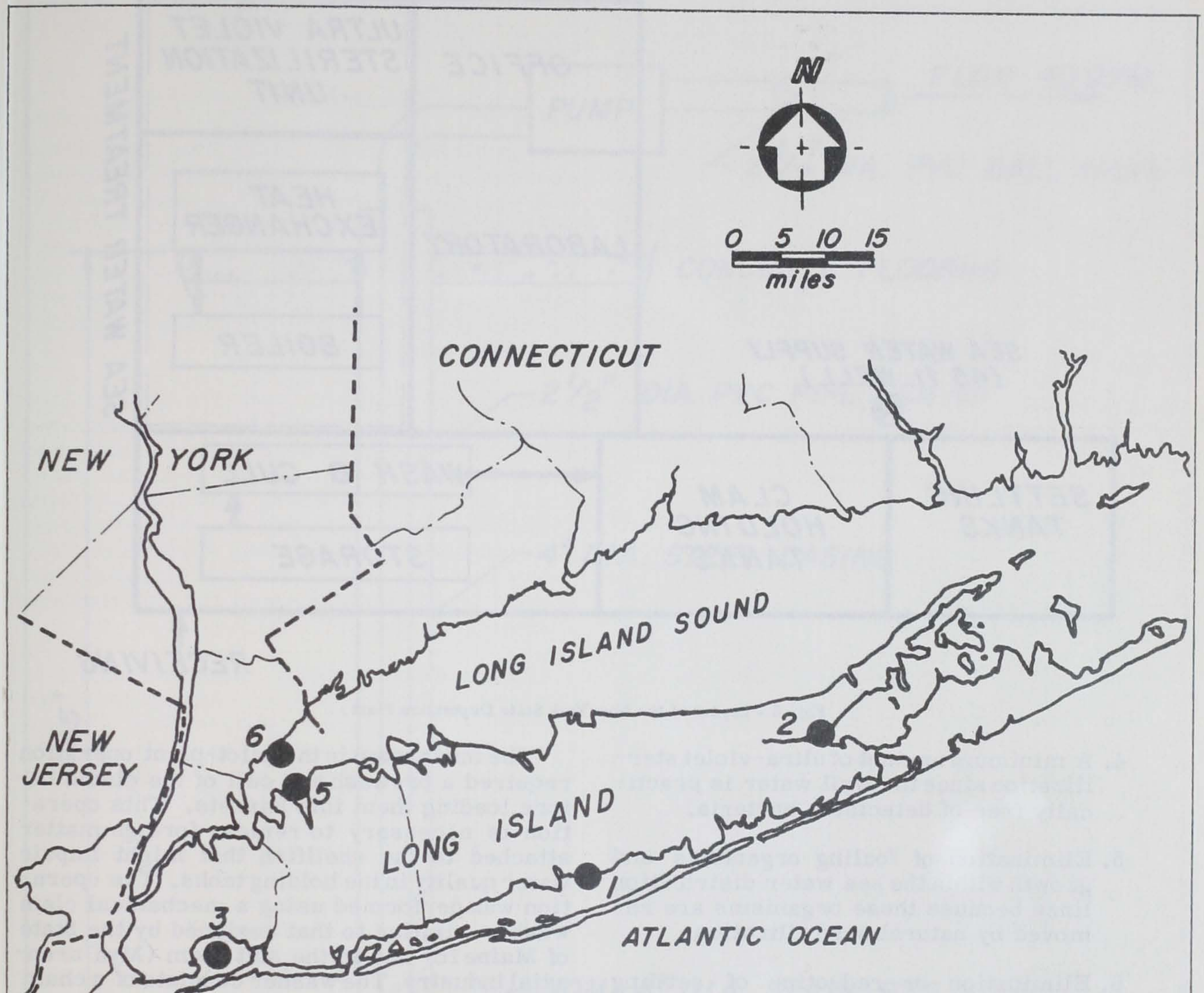

Fig. 2 - Location of New York State Depuration Plant and areas where hard clams were harvested.

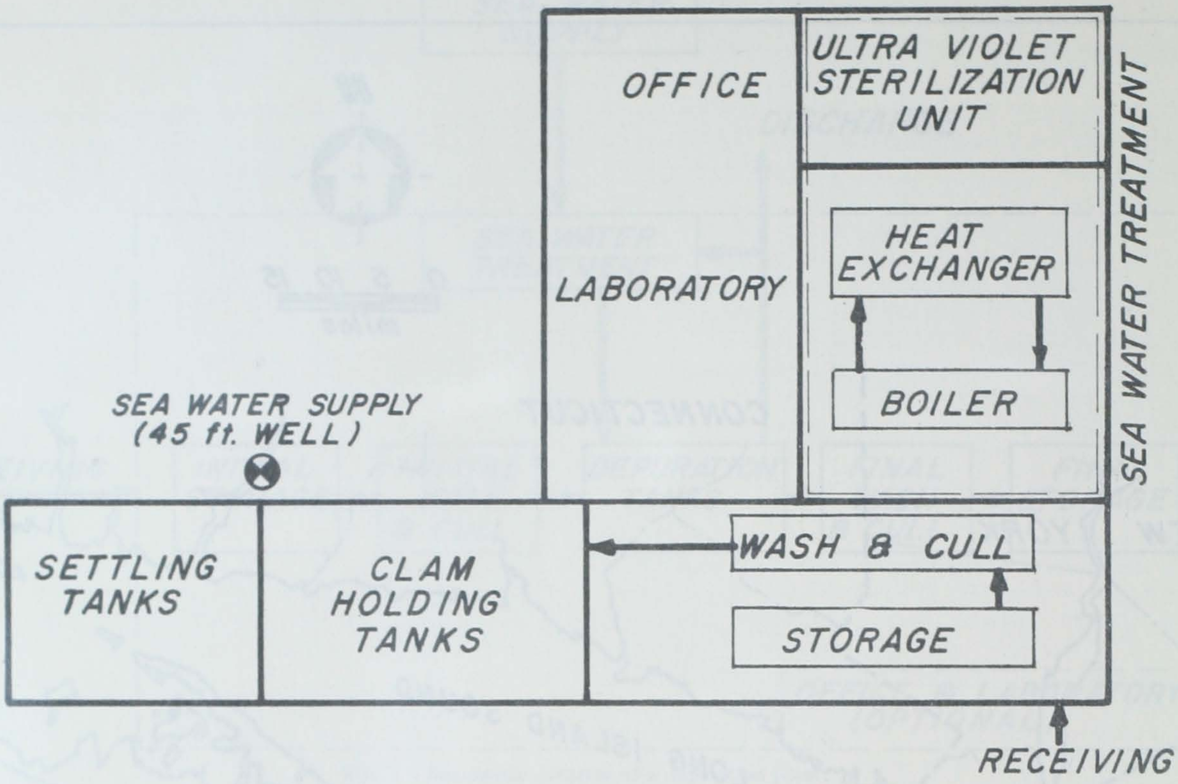

Fig. 3 - Layout of the New York State Depuration Plant.

4. A minimum amount of ultra-violet sterilization since the well water is practically free of detectable bacteria.

5. Elimination of fouling organisms and growth within the sea water distribution lines because these organisms are removed by natural sand filtration.

6. Elimination or reduction of settling tanks since no suspended matter is present.

Operation of the Depuration Plant

Following the completion of modifications on the depuration plant, a series of 42 experiments was conducted. Lot sizes varied from 5 to 45 bushels of hard clams per experiment, depending upon the availability of clams.

Hard clams for the experiments were obtained from several growing areas, including portions of Flanders Bay, Jamaica Bay, Raritan Bay, Hempstead Harbor, and portions of Long Island Sound lying within Westchester County.

The initial step in the pilot-plant operation required a prewash and cull of the clams before loading them into baskets. This operation is necessary to remove foreign matter attached to the shellfish that might impair water quality in the holding tanks. The operation was performed using a mechanical clam washer similar to that designed by the State of Maine for use in the soft clam (Mya arenaria) industry. The washer consists of a chain link conveyor belt and a series of spray nozzles to remove mud or other matter that might be attached to the shellfish. Following a high pressure spray, injured shellfish and other debris are removed from the belt. It should be noted that the design of this particular washer must be modified for use with the hard clam. The hopper portion of the washer uses an inclined plane, which is too steep for hard clams (see Figure 5).

After the prewash, the clams were loaded in baskets 20 inches long, 18 inches wide, and 6 inches deep. The baskets were made of wire coated with plastic (PVC) and held one-half bushel when filled to a depth of 3 inches. The shellfish were placed in the shellfish holding

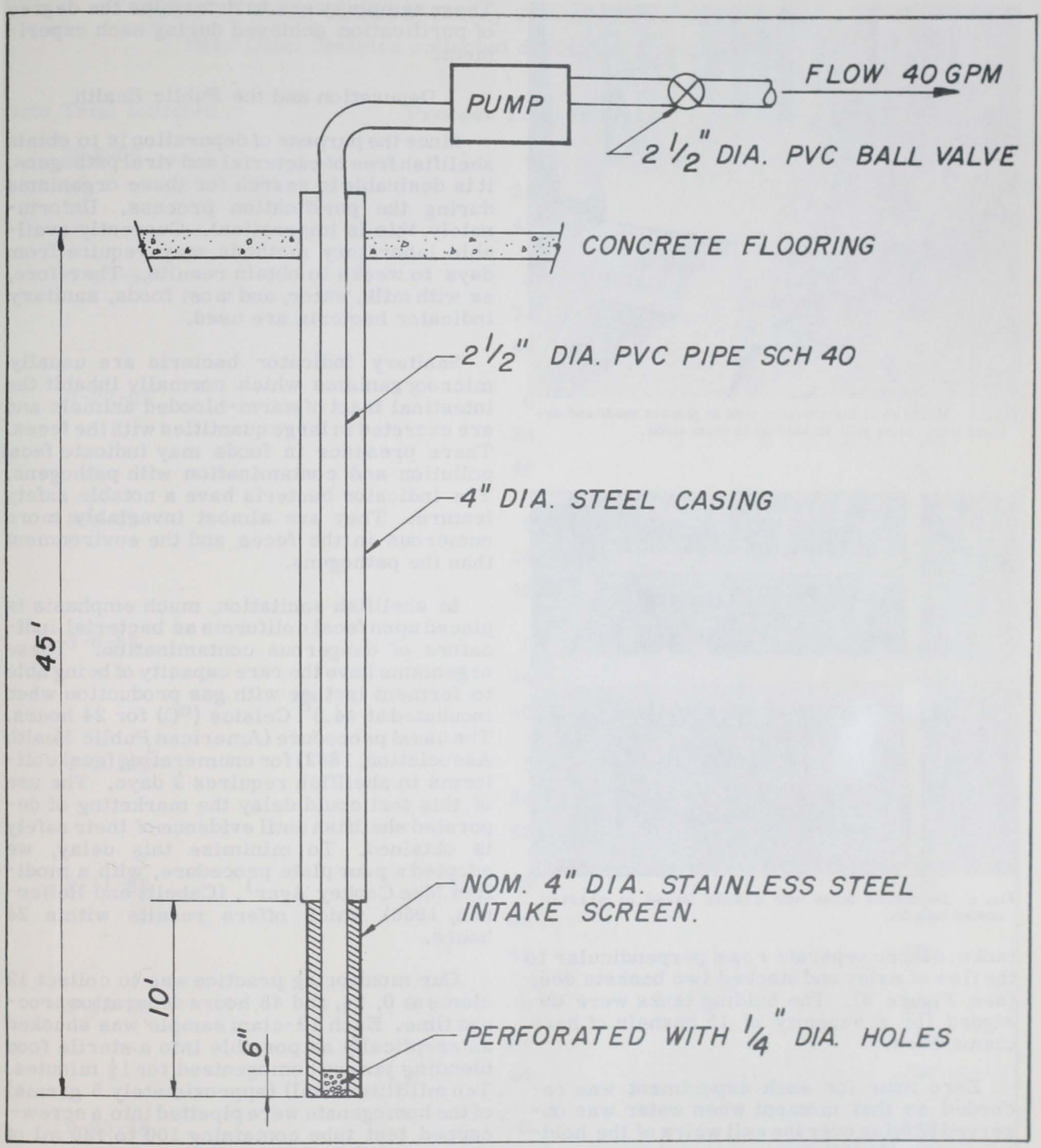

Fig. 4 - The sea water well system.

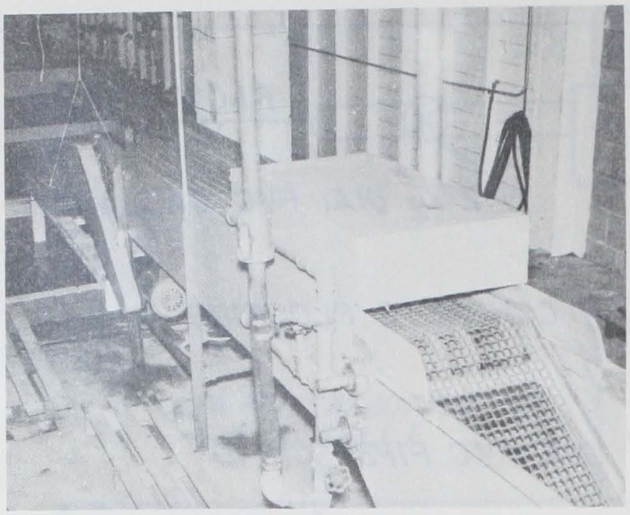

Fig. 5 - Mechanical clam washer used to remove muds and detritus from clams prior to loading in clam tanks.

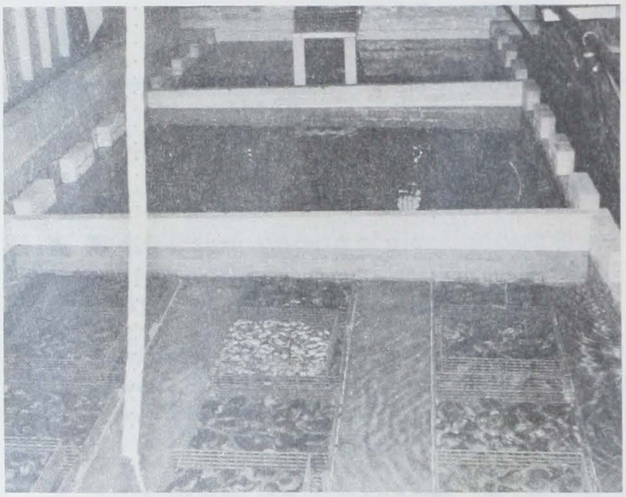

Fig. 6 - Depuration tanks with clams loaded in plastic coated baskets.

tanks in three separate rows perpendicular to the flow of water and stacked two baskets deep (see Figure 6). The holding tanks were designed for a capacity of 15 bushels of hard clams each.

Zero hour for each experiment was recorded as that moment when water was observed flowing over the exit weirs of the holding tanks. At this time, a zero-hour sample of clams was collected for bacteriological examination. A second sample was collected at 24 hours and a final sample at 48 hours. These samples were to determine the degree of purification achieved during each experiment.

Depuration and the Public Health

Since the purpose of depuration is to obtain shellfish free of bacterial and viral pathogens, it is desirable to search for these organisms during the purification process. Unfortunately, this is impractical. Currently available laboratory methods may require from days to weeks to obtain results. Therefore, as with milk, water, and most foods, sanitary indicator bacteria are used.

Sanitary indicator bacteria are usually microorganisms which normally inhabit the intestinal tract of warm-blooded animals and are excreted in large quantities with the feces. There presence in foods may indicate fecal pollution and contamination with pathogens. The indicator bacteria have a notable safety feature. They are almost invariably more numerous in the feces and the environment than the pathogens.

In shellfish sanitation, much emphasis is placed upon fecal coliforms as bacterial indicators of dangerous contamination. These organisms have the rare capacity of being able to ferment lactose with gas production when incubated at 44.5^{o} Celsius (^{o}C) for 24 hours. The usual procedure (American Public Health Association, 1962) for enumerating fecal coliforms in shellfish requires 3 days. The use of this test could delay the marketing of depurated shellfish until evidence of their safety is obtained. To minimize this delay, we adopted a pour plate procedure, with a modified Mac Conkey Agar[1], (Cabelli and Heffernan, 1966) which offers results within 24 hours.

Our monitoring practice was to collect 12 clams at 0, 24, and 48 hours depuration process time. Each 12-clam sample was shucked as aseptically as possible into a sterile food blending jar and homogenized for $1\frac{1}{2}$ minutes. Ten milliliters (ml) (approximately 5 grams) of the homogenate were pipetted into a screw-capped test tube containing 100 to 120 ml of the modified Mac Conkey Agar. The tube was gently inverted several times to insure adequate mixing and the contents distributed among 6 Petri plates which were incubated in

[1]Ingredients, modified Mac Conkey Agar: Gelysate, 17.000g; Polypeptone, 3.000g; Lactose, 10.000g; Bile Salts #3, 0.750g; Agar, 13.500g; Neutral Red, 0.30g; Crystal Violet, 0.001g; Sodium Chloride, 5.000g; Distilled Water, 1000ml.

Table 1 - Fecal Coliform Colony Forming Units per 100 grams for Hard Clam Samples collected during the Depuration Process

Date Trial Initiated	Process Time In Hours	Fecal Coliform CFU/100 g.
7-9-68	0	1000
	24	120
	48	20
7-15-68	0	2500
	24	<20
	48	<20
7-22-68	0	320
	24	20
	48	<20
8-6-68	0	5100
	24	100
	48	<20
8-6-68	0	200
	24	<20
	48	<20
8-13-68	0	180
	24	20
	48	<20
9-11-68	0	460
	24	40
	48	<20
9-18-68	0	200
	24	20
	48	<20
9-25-68	0	140
	24	20
	48	<20

CFU = COLONY FORMING UNITS.

an air incubator at 45° C. for 24 hours. Fecal coliform colonies[2] were totaled for the six plates, multiplied by 20, and reported as Fecal Coliform Colony Forming Units per 100 grams of sample. Results of 9 hard clam depuration trials are included in Table 1.

Bacterial monitoring of hard clam depuration is most successful during the warm months. Hard clams harvested in December, January, February, and March are practically free of fecal coliforms, regardless of the water quality of the growing area.

When sea-water temperatures fall below a certain value, the clams cease feeding and accumulating bacteria. We have, however, observed that a structure called the crystalline style is absent from winter-harvested hard clams but may be detected when the clams are exposed to sufficiently warmed water. The crystalline style is a semitransparent, cone-shaped organ found in the vicinity of the stomach.

Several winter trials were conducted to determine the value of the crystalline style as a measure of hard clam activity during the depuration process. Results of these trials are detailed in Table 2. They indicate that, while all clams lacked a style initially, the structure was visible in 50% to 92% of the clams after exposure to the purification process.

Table 2 - Development of a Crystalline Style in winter harvested Hard Clams Subjected to the Depuration Process

Date Trial Initiated	Depuration Process Time in Hours	No. of Clams Examined	No. of Clams Possessing a Crystalline Style
1-7-69	0	24	0
	24	24	18
	48	24	22
1-14-69	0	24	0
	24	24	19
	48	24	16
1-21-69	0	24	0
	24	24	17
	48	24	19
1-23-69	0	24	0
	24	24	22
	48	24	16
3-18-69	0	100	0
	24	100	90
	48	100	92

[2]Red or Pink Colonies $\frac{1}{2}$mm. or more in diameter usually surrounded by a zone of precipitated bile salts.

Summary and Conclusions

The term "depuration", as related to shellfish and the shellfish industry, involves a process whereby shellfish harvested from certain restricted areas are placed in a controlled environment for a specified period of time in order to remove any bacterial or viral contamination that may be present. These shellfish may then be placed on the market for human consumption.

A program to evaluate the feasibility of depurating hard clams, utilizing a pilot-plant operation, has been completed by the State of New York. Hard clams were harvested by commercial methods from closed growing areas and subjected to a 48-hour process using sea water obtained from a well system. Shellfish samples were analyzed at 0, 24, and 48 hours to evaluate the effectiveness of the depuration process.

An analysis of the data gathered during this study indicated that the depuration process may use hard clam resources in restricted waters. The term "restricted waters" is defined in Part I, National Shellfish Sanitation Program Manual of Operations, as waters where the coliform median MPN does not exceed 700 per 100 ml.--and not more than 10% of the samples exceed an MPN of 2,300 per 100 ml. Furthermore, the area may not be so contaminated with radio-nuclide or industrial wastes that consumption of the shellfish located therein might be hazardous.

As this definition implies, the depuration process is used only to remove bacterial and/or viral contamination. Contaminates such as heavy metals, pesticides, and radionuclides are not eliminated in the 48- or 72-hour process time.

The sea-water supply for the depuration process is of vital importance. The use of the salt-water well system in this program proved to be extremely effective; it is recommended that this source be considered and used, if available, at future depuration sites.

Data are presented for depuration trials conducted during the summer and winter seasons. The presence of the crystalline style does indicate hard-clam activity during the winter season, although the enumeration of a microbial indicator during this season would be more satisfactory in evaluating the process's effectiveness.

The program was terminated in 1969. An analysis of the data indicates that the depuration process may be used to cleanse hard clams taken from restricted waters. As a result, New York will authorize use of this process by private concerns. Specific growing area locations and plant designs will be considered and reviewed on an individual basis. New York will also provide laboratory support to ensure proper operation of the plant.

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