DEPURATION

BY
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Division of Environmental Engineering
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MEMO TO: Mr. Eugene T. Jensen, Chief
Shellfish Sanitation Branch, DEEFP, PHS, Washington 25, D.C.

FROM: C. B. Kelly, Chief
Research and Investigations Section, DEEFP, PHS,
Davisville, R. I.

SUBJECT: Depuration

I. Public Health Service Research

A. Laboratory Scale Studies on the Depuration of Soft Clams Conducted at Woods Hole

These investigations were carried out on soft clams which had been artificially polluted with Salmonella. These studies were reported in Public Health reports. The work indicated that the process of submitting clean unpolluted sea water to soft clams in a flowing through tank resulting in the complete cleansing of the soft clam in a period of two to three days. The effect of temperature was also studied. Although the process reduced in rate during colder weather, the soft clam still purified within the stipulated period.

II. Development and Evaluation of Apparatus for the Sterilization of Sea Water by Ultraviolet Radiation

These experiments were started at Pensacola, using laboratory scale equipment on flows of salt water up to twenty gallons per minute. The process was evaluated using this equipment and proved to be quite efficient; in fact, more than 99.9% kill of Gran negative organisms in sea water. This method of treatment was also found not to produce detrimental effect on the feeding of oysters kept in the treated sea water. Later, in Purdy a commercial scale apparatus was designed, developed and evaluated. The Purdy apparatus was capable of treatment of sea water in quantities up to 2000 gallons per hour. The equipment was found to be equally effective as the Pensacola model and is relatively simple and inexpensive. On publication of a report on the studies of ultra-violet sterilization of sea water numerous inquiries have been made concerning the unit and we know of four Purdy type units in operation in this country.

III. Depuration of Pacific Coast Oysters

Laboratory experiment on depuration of the Pacific oyster, Crassostrea gigas and the Olympic oyster, Ostrea lurida conducted during an eighteen month period using ultraviolet sterilized sea water demonstrated the effectiveness of the process in the depuration of the two west coast species of oysters. As with the soft clams, definite temperature influences were found, both species reducing in activity with drop in temperature. However, even at the coldest water temperatures encountered at the Purdy Laboratory purification was accomplished in three or four days. These experiments have been terminated and reports on the work are in process.

IV. Laboratory Studies on the Depuration

Laboratory studies have been initiated on depuration of the Manila Clam, Tapes japonica and the Native Little Neck Clam, Protothaca staminea. One series of experiments was completed during the fall period 1962 and another series will be initiated this month. As with the two western oysters a species difference in the rate of accumulation and depuration was found as well as differences in the sensitivity to water temperature. This latter factor will be investigated during the course of future experiments by the use of heated water to determine whether the effect is in fact one of temperature or one of physiological state.

Experimentation to date has been primarily on gaining a better knowledge of the well recognized principal of purging the shellfish by presenting them with a water free from pollution and one which has the factors necessary for active feeding of the animals. We recognize that this principal is expensive. However, with certain species the cost of the process is not exorbitant since it could be absorbed in the relatively high market price of the product. Thus, field studies are now under way on certain species attempting to convert the process to one commercially applicable. In the plan of operation for the Shellfish Research Centers, studies on depuration have been placed in high priority. We recognize that we must return to more fundamental studies to learn the physiological factors involved in the feeding process and by so doing perhaps learn of some mechanism which will stimulate the process making the depuration time shorter and therefore less expensive. We also recognize that fundamental studies might reveal entirely different biological processes that might prove to be more effective in rendering the molluscs free from contamination.

V. Cooperative Studies

A. Maine

The Department of Sea and Shore Fisheries of the state of Maine have initiated pilot scale investigations into the depuration of soft clams. Two Purdy type ultraviolet treatment units have been constructed, one to be used at the laboratory at Boothbay Harbor, the other in a field installation now located at Biddeford, Maine. Preliminary investigations at Boothbay Harbor have again demonstrated the feasibility of the process for soft clams and initial studies have been made on loading of the tanks and water requirements. The Maine units will be flow through tanks utilizing sea water drawn from the floor of the bay through well points. The effect of such a salt water system will be investigated at Biddeford. Other studies at Biddeford will be in the nature of determining the water requirements, design of trays or other utensils to hold the soft clams in the tanks and finally the evaluation of the complete system, using clams from the polluted area in the Biddeford Pool district. The state of Maine has received an ARA grant and, after evaluation of the system, intended to go into commercial operations which will allow the utilization of the soft clam resources in the Biddeford Pool area by local fishermen.

Public Health Service participation in this program has been planned to include temporary assignment of a Bacteriologist and possibly a Sanitary Engineer to the project. We will also effect temporary transfer of laboratory equipment needed by Public Health Service and Maine personnel.

B. Massachusetts

The Department of Natural Resources has acquired the Newburyport Shellfish Depuration Plant and a cooperative investigation has been initiated by the Division of Fish and Game; the Lawrence Experiment Station; and the Division of Sanitary Engineering, Massachusetts State Department of Health. A report on a conference held at Newburyport to discuss plans of action by this group was made in the form of a memo to Mr. Jensen dated 12-14-62 (attached hereto). Investigations at Massachusetts will initially be toward a study of ultraviolet treatment of sea water. Mr. Worthen Taylor and others present at this conference were of the opinion that with the resources, both material and scientific personnel available from the three agencies, studies of this nature would be most appropriate. In accordance with previous conversations Public Health Service participation would be to assign at least two persons to this project on a temporary basis pending the construction of the Northeast Research Center. Recruitment is in process for filling these two billets.

C. Rhode Island

The Department of Fish and Game has indicatd a serious interest in studies in the depuration of hard clams. The resources of this species in upper Narragansett Bay are quite extensive and to date have been utilized only in a limited way by transplanting from the polluted areas to cleaner waters to the south. Mortality, expense of operation and the difficulty of control has suggested inquiry into the tank method of depuration. A Purdy type unit is now under construction and it will be installed in the National Guard Armory at Bristol where preliminary pilot scale studies will be conducted. A conference will be held with Regional, State Health and Conservation officials to develop a plan of operation of the study and to determine the participation by the cooperating agencies.

VI. Review of Depuration Facilities in Foreign Countries

A. Japan

During the course of the 1961 Shellfish Mission to Japan we had opportunity to visit several oyster depuration facilities and to consult with Fishery Technologists and Public Health workers on depuration as practiced in Japan. The process has been quite intensively investigated by Japanese Technologists using both the flow through and recirculating systems with ultraviolet light treatment of the sea water. The process receives only limited application in Japan because the use of oysters in the shell by Japanese is very limited if at all. Small plants furnish adequate quantitites to large hotels frequented by Americans and Europeans who desire the raw oysters on the half shell.

B. England

Some six or seven years ago several outbreaks of typhoid fever from oysters produced in the West Mersea area precipitated the need for development of facilities for depuration of oysters. Prominent in these investigations was Mr. P. C. Wood of the Fisheries Laboratory, Ministry of Agriculture, Fisheries and Food, Burnham-on-Grouch, Essex. Mr. Wood was put to the task of developing a simple inexpensive system and turned to the use of ultraviolet light for the treatment of sea water. Selection of ultraviolet light was prompted primarily by poor experiences with the simple pit method and the Dodgson chlorinated-dechlorinated water system. A small ultraviolet light unit was designed, using one or two 15-watt germicidal lamps. This, serving a series of

depuration tanks of up to 6,000 gallon capacity with recirculation effects 80 to 90% destruction of the coliform organisms of sea water within a period of three to six hours. The oysters are maintained in the tank during the period, the principal being that the oysters will eventually be presented with a sterilized sea water during the course of the 20 to 24 hour exposure. Of interest in the MAFF system is that the depuration facilities are all small installations, treating no more than 50 to 100 bushels of oysters at a time and they are all privately owned and operated, scattered fairly well throughout the two major oyster production areas in England-Essex and Cornwall. Control by Public Health officials is in the nature of periodic inspection and sampling at the plants usually on a weekly basis. Design and operating protocol for each individual plant is developed by the Fisheries Laboratory in consultation with local health authorities. Maintaining records and operation are the responsibility of the individual owner, they being checked by the local Sanitary Officer. The weakness of such a system is quite obvious, it being dependent to a large degree on the integrity of the Plant Manager and the ability of the local Sanitary Officer to carry out inspections of the facilities at adequate frequencies. The physical structure and the design of tanks is quite varied sometimes utilizing facilities that formerly were used for purification by the chlorinating water system and in all cases is quite simple.

The mussel purification plant at Conway, North Wales is still in operation using the process designed and evaluated by Mr. Dodgson in 1928 with little modification. There is no plan for changing the system. Since it appears to be operating quite effectively there is no thought of converting to ultraviolet.

The plant at Brightingslea, however, has been operating for the past few years only in a very limited way, treating oysters. Plans are now under development for conversion of part of Brightingslea facilities to a UV system hoping that with the decrease in cost of operation there might be greater use of the facility.

To sum up the observations in England, no startling technical knowledge was available. Except for the development of the Wood model ultraviolet treatment system, no major changes have taken place since Dodgson. There have been no investigations into the nature of making the process more efficient.

C. France

Review of facilities in France were pleasantly surprising. In the first place there is a very active central government control of purification stemming from the central office in Paris. We visited Mr. Boury and Mr. Ladouce both of whom were very active in the development of purification processes as exercised in France. A branch office of the institute is established in the major production areas and in these offices two key personnel are assigned, one to Administration and Biological Control, the other to Bacteriological and Laboratory Control. At Toulon, for example, the depuration facility, owned and operated by a private coop has on its staff a scientist who is a member of the staff of the institute located at Marseille. A small bacteriological chemical laboratory are a part of the facility and close bacteriological and chemical control are carried out, with sampling of the raw product and of the product after 24 to 48 hours of depuration. If indicated by the laboratory examination, the shellfish are submitted to additional treatment time of two or three days. Similar facilities located at Sete are under the general administration of the Marseille office but with two resident scientists at a local laboratory exercising control of the depuration facility.

Again, as in England, no basic studies are underway toward learning of the physiological factors involved. In contrast are the major developments in intensive farming of both mussels as well as oysters, both at Toulon and at Sete. The cultural methods are quite similar to those which we saw in Japan except that the supporting structures are racks suspended from the bottom rather than floats used by the Japanese. Rates of growth of the Portuguese oyster exceeded even those that we saw in Japan. Seed oysters approximately one inch in length grew to approximately five to six inches in six to eight months.

Summing up our observations in France we found tighter central government control than in England, closer control of the commercial processes of purification by agencies of central government and much larger installations more modern in design, with a greater amount of technology being applied to the design, construction and operation of the unit.

D. Spain

A visit was made to a pilot depuration facility at Terragona, South of Barcelona, on the east coast of Spain. Mussels are shipped here from Vigo in the northwest section of Spain for temporary transplantation for a period of three or four days in the outer harbor of Terragona. Since the area is at least moderately polluted, Dr. Ramagosa, associated with the Ministry of Health, developed and installed a pilot depuration facility for treatment of these mussels prior to distribution. This facility is the only flowing through ultraviolet treatment system seen in our entire European trip. It uses a battery of tube within tube units. The apparatus is of Belgian design and manufacture. Laboratory control has revealed that the process is quite effective and the plant will soon be enlarged and put into commercial operation.

E. Portugal

We reviewed a Dodgson type plant constructed some six or seven years ago for the treatment of oysters from the Tagus River area. Since that time industrial pollution has encroached to the oyster areas, rendering the utilization of the oysters from the area impossible. The plant therefore is treated only a limited amount of oysters taken from the Sado River to the south of Lisbon and the Tagus River. The plant has been fully described in a publication by Mr. Velala, a copy of which is on file at headquarters. Innovations of the original Conway tank were introduced mostly in the nature of improvement and change of tank design.

Mechanical features, except for a very primitive monorail in one of the oyster plants at West Mersea, England and a small endless belt conveyor at Conway, we saw no mechanical devices for handling packaging or other types of treatment of shellfish during our entire European trip. Obviously, this is an area which will require investigations by the Shellfish Centers. It should be repeated that we learned of no fundamental studies into the biological principals involved in depuration. Again it is intended that this will be a major area of study by the Shellfish Center.

Laboratory control both, in the area of methodology and in the area of actual control of depuration was found to be in many cases quite simple, sometimes marginal. The roll tube method followed by the English is quite promising, but many English scientists recognize the need for development and evaluation. If any shortcomings occurred in France it was in laboratory methods, although I feel that they were adequate for the purpose. The Portuguese methods were amazingly elementary and left much to be desired. Here again we saw the need for investigation into methodology by the Shellfish Research Centers.

United States Government

Public Health Service

MEMORANDUM

TO: Mr. E. T. Jensen, Chief 12/14/62
Shellfish Sanitation Branch, DEEFP, PHS,
Washington 25, D. C.

FROM: C. B. Kelly, Chief
Research and Investigation Section, PHS., DEEFP,
Davisville, R. I.

SUBJECT: Massachusetts Soft Clam Depuration Studies

On Tuesday, December 11, 1962 a trip was made to Newburyport, Massachusetts to visit the new soft clam purification plant and to discuss possible Public Health Service participation in studies now conducted jointly by the Department of Public Health and the Department of Natural Resources. Among those present were Mr. Worthen H. Taylor, Mr. Joseph McCarthy, Mr. Sevell, in charge of the plant, and others from the Department of Health and the Department of Natural Resources. Public Health Service representation was Mr. Clem, Mr. William Beck, and the writer.

An ultraviolet treatment unit similar in design to the Purdy unit has been constructed and installed. The unit has been fitted with a pump installed to receive either salt water directly from the adjoining estuary or to act as a recirculating device pumping water to and from one of the soft clam treatment tanks.

Mr. Taylor outlined his views on the nature of investigations that could be conducted at the Newburyport Treatment Plant and the Lawrence Experiment Station. He stated that with the construction and installation of the ultraviolet treatment unit facilities are available for conducting studies on ultraviolet treatment of sea water including evaluation of the method, determination of optimum exposure times and bacterial densities, the effect of turbidity, including particle size, on the efficiency of the system, the effect of temperature and other water characteristics. He also pointed out the possibility of fundamental studies in tanks on loading, water demands and other factors in a recirculating depuration facility.

He stated that Massachusetts had good facilities for this type of investigation because of the plentiful supply of soft clams for experimental purposes and the availability of laboratory facilities and opportunity for advice and counsel at the Lawrence Experiment Station. Mr. Taylor offered the use of these facilities to the Research and Investigations Section,

suggesting that the Section might assign scientists to work with the Massachusetts authorities in studies as outlined above. Discussion on this point indicated that for the present at least the assignment of a bacteriologist and a marine biologist would be most desirable.

I informed Mr. Taylor that we recognized the possibility of such a request based on previous conversations we had tentatively scheduled the assignment of a bacteriologist and a marine biologist to work with Massachusetts on this problem. I also informed him that we were in the process of recruiting personnel for this purpose. Mr. Taylor indicated that he would welcome the assignment of the two scientists as soon as possible.

Discussions concerning the administration of this project resulted in mutual agreement that the State would exercise immediate supervision over the activities of the PHS personnel but that they would be retained on the payroll and as members of the staff of the Northeast Shellfish Sanitation Research Center, and on Mr. Taylor's suggestion it was agreed that on or before the assignment of these persons to the project a program of study would be developed in collaboration with the Massachusetts authorities to set down guide paths for the type of work to be done. Mr. Taylor agreed on the propriety of a written agreement between the PHS and Massachusetts, without stating the levels of interchange, to record an understanding between the participating agencies on the nature and extent of collaboration.

Mr. Taylor inquired concerning the availability of special equipment for the project and I informed him that we would be in a position to supply on a loan basis special scientific equipment that would be needed for the project. Such equipment would include temperature and salinity recording devices, special sampling equipment, special bacteriological equipment and supplies of media, chemicals and possibly glass ware if needed.

C. B. Kelly

CBK:aa
CC: A. Freeman, Region I

State Improves Anti Contamination Methods

by William R. Bibber

The lowly clam is due to get a better bath--one that's considerably cheaper and more efficient than he and his millions of brothers get daily at the Department of Natural Resources shellfish treatment plant at Newburyport.

The reason: The scavenger's diet includes items harmful to humans.

"About 85 per cent of the coast from Boston Harbor to the New Hampshire line is contaminated," said Fred Wilbour, director of marine fisheries. "Last year we treated between 20,000 and 25,000 bushels of clams for commercial use--they left here as if they had just been dug from the cleanest of water."

Test Encouraging

These thousands of bushels were processed through lightly chlorinated water. The new bath will eliminate the chlorinated process that requires constant attention and will use ultra-violet light to kill bacteria.

"The first tests look very good," said Russel Courvels, a biologist in charge of program.

Under departmental rules, every commercial digger is required to bring the product of his labors to the plant for treatment. When they arrive there in half-bushel baskets samples are taken and tested for bacteria count.

The baskets--as many as 120 of them--are placed in one of the six 3500 gallon tanks which are filled with sea water and a trace of chlorine.

Workers keep an around-the-clock check on the chlorine level and add more when it's necessary. Twenty-four hours later the clams, fed on the purified sea water, are turned over to the digger who parts with $1 for every bushel treated.

"The most common disease from eating bad clams is dysentery and the worst is typhoid fever," said Courvels.

"I remember an old-time digger who thought it was quite a joke to give clams a bath. When he was out on the flats digging, he'd pause every now and then to eat a raw clam. He ended up with a case of typhoid."

Should anyone hasten to say let the clam lovers pay the price. Worthen Taylor, chief engineer of the state department of public health, said that eating an untreated clam is the equivalent of ingesting all the bacteria in 10 gallons of water.

"The state is concerned with shellfish because the intestinal tract is consumed. What is in the clam depends on where it was dug, and many places are contaminated."

Unique in Nation

The plant still the only one of its kind in the country was built by the city of Newburyport in 1930 to treat shellfish taken from the Merrimack River. The state took over operations a few years later, and in 1961 it was assigned to the natural resources division.

The only bivalves treated here are the soft-shelled clams which come from the upper Massachusetts coast. Quahogs common in Cape Cod cannot be handled because they live in water about 55 degrees or about 20 degrees warmer than the soft-shell variety.

"The whole idea is simply to let the clams feed on plankton from clean water for a day or so and replace whatever high bacteria feed they had eaten from contaminated areas," Courvels said.

By keeping a check on bacteria count, the biologists can also watch for changes in water pollution. When a bacteria count appears higher than it should be, public health inspectors make on-the-spot checks. They may order clam flats to be closed.

To keep uncleaned clams out of the hands of eager buyers is another problem among them. Each license holder has a card which he is required to fill out each day whether or not he digs. On it he's required to list the time he left the flats and the amount dug.

Each slip is timestamped when it arrives at the plant. An unusual delay is cause for suspension. A digger may have stopped to unload a few bushels of untreated clams.

Each digger is also required to park his truck in a specified place at the flats and to take a specified route to the plant. He never knows when he's being followed by a contaminated clam cop.

(This is a news item appearing in the Providence Evening Bulletin, Thursday, December 6, 1962.)

State Plant at Bristol will Purify Quahaugs--By John N. Rippey

A quahaug purification plant that holds hope of revitalizing the quahaug industry will be started on an experimental basis by the state next month, Francis N. Perry, director of the Department of Agriculture and Conservation, announced today.

He said it is conservatively estimated there are 1,000,000 bushels of quahaugs with a potential value of five million dollars in polluted areas.

These quahaugs, Mr. Perry said, are primarily in Mount Hope Bay and in the Providence River, which he said is almost "paved" with them.

The plant will be located in the old National Guard Armory on the Bristol waterfront and will use ultraviolet light in the purification process.

Mr. Perry said he hopes the plant could be purifying quahaugs for commercial marketing within a year, but said it might be as long as one and a half or two years.

Eventually, he said, success of the purification plant could mean that 500 additional men could find employment harvesting quahaugs in Rhode Island waters.

"I'm very confident this plant is going to work," Mr. Perry said. "This is going to be a tremendous shot in the arm to the industry."

Mr. Perry said he has been given assurances by federal officials that a state request for a grant of $40,516 to finance the plant during its first year will be approved. Application for the grant under the Area Redevelopment Act is on its way through official channels.

The plant will cost the state $16,000 to operate in its first year, but these funds will come out of the existing department budget. The state money primarily represents personnel who will be diverted from other jobs.

The state division of fish and game will operate the project.

Mr. Perry said the purification plant would allow the state to improve upon the present slow and costly method of transplanting quahaugs from polluted areas to clear areas in the bay, where they purge themselves by natural means and proliferate. He said there is only a 60 per cent recovery on transplanted quahaugs.

Dealers or quahaugers would bring quahaugs from polluted areas to the plant and would pay the state about $1 a bushel for the purification process, or less as the operation became more economical.

"It certainly should be self-supporting," Mr. Perry said.

The director said it should be possible for the state to prevent a glut of quahaugs on the market and a consequent depression of quahaugers income by merely shutting down the purification plant for a week or two when an over-supply is foreseen.

Mr. Perry said he sees the day when "buy boats," which collect quahaugs from the shellfishermen out in the bay for transportation to market, will transport the quahaugs to the plant in Bristol.

Rhode Island is fortunate in having a unique market that would stabilize the quahaug industry here, Mr. Perry said. This market is the Blount Seafood Corporation plant in Warren which is the largest commercial user of chowder quahaugs in the nation, Mr. Perry said.

It currently gets 70 per cent of its quahaugs from out-of-state but the purification plant could mean that Rhode Island would return to its larger share of the total, Mr. Perry said.

He said the decline in the industry here is illustrated by the 1955 total of 5,020,000 bushels of quahaugs taken in Rhode Island waters by 2,490 licensed shellfishermen compared to the 2,636,000 bushels taken in 1961 by 694 licensed shellfishermen.

The only areas that can be opened up to quahaug dredgers under the law, are in the Sakonnet River in the East Passage between Portsmouth and Prudence Island, and in Mount Hope Bay.

Mount Hope Bay has long been closed due to Massachusetts pollution. An area around Dyer Island in the East Passage is now open but is just about depleted, Mr. Perry said. The Sakonnet River was reopened December 1 after being closed for three years. Mr. Perry said he would like to have kept it closed for another year or two.

The purification plant will enable the state to close some depleted areas, he said, for reseeding and renewal.

Actual operation of the purification plant is relatively simple. Mr. Perry said salt water would be run under the ultraviolet light, which will kill harmful bacteria that may be present.

Then the water will be sent into tanks containing the quahaugs. The quahaugs will then purge themselves.

Mr. Perry said purging at the plant is expected to take only about 24 hours, compared to two weeks needed by transplants.

He said one problem is in keeping the water warm. Quahaugs, he said, will not draw water for purging unless it is 50 degrees or higher. He said the plant hopes to keep the water at about 65 degrees.

The division of fish and game has already reinstalled heat and power in the armory, which it acquired in 1955, Mr. Perry said. Wooden tanks are being constructed by the division of forestry. When operating, the plant will employ about three or four persons, under direction of Manual T. Canario Jr., division marine biologist.

They will be assisted by a bacteriologist loaned from the new federal Northeast Shellfish Sanitation Research Center at Saunderstrown, which has been giving active advice and encouragement to the state project.