When exposed to running sea water, the clam uses its own filtering system to cleanse itself of sewage bacteria ingested in polluted waters. How this is accomplished was demonstrated in a series of experiments conducted by the Shellfish Sanitation Laboratory.

Self-Purification of the Soft Clam Mya arenaria

By WILLIAM ARCISZ and C. B. KELLY

DURING the past decade the supplies of the soft clam, *Mya arenaria*, have become seriously depleted. Attempts made by biologists (*1*) to increase clam populations to their former abundance by establishing clam farms and reseeding depleted areas have met with little or no success. However, large supplies of clams in areas which are polluted with domestic sewage are available.

The possibility of ridding shellfish of undesirable bacteria has been given some attention ever since epidemiological evidence indicated that shellfish from waters subject to fecal pollution were responsible for enteric disease (*2*). That polluted shellfish can be made safe for human consumption by the process of purification has been adequately demonstrated by Fabre-Domergue (*3*), Wells (*4*), and Dodgson (*5*).

Purification is a mechanical process effected by the physiological functioning of the shellfish in clean water. When shellfish are feeding, the gills act as a filter to strain out some of the material that may be brought in by the water which passes through them. If this water contains sewage, some of the micro-organisms in it are entrapped in the mucus on the body of the shellfish and transferred to the alimentary tract. Some of these are perhaps utilized as food (*6*) and the others discharged from the body in the form of feces and pseudofeces. When shellfish from polluted water are placed in clean water, the sewage bacteria are eliminated from the shellfish, and, since no more are ingested, purification is accomplished.

Two purification processes, based on the ability of shellfish to cleanse themselves, have been evolved:

Natural purification or relaying. Shellfish from polluted areas are transplanted into clean waters and allowed to purify themselves. This method of natural purification is widely used in the oyster industry. However, many biological factors combine to make it generally infeasible for use with soft clams.

Artificial purification or cleansing. Shellfish from polluted areas are placed in tanks which are filled with water that has been sterilized by filtration, chlorination, or by ozone. The water

---

Mr. Arcisz is bacteriologist at the Public Health Service Shellfish Sanitation Laboratory, Pensacola, Fla., and Mr. Kelly is chief of the laboratory. *Other studies in this series of reports on shellfish experiments conducted by the laboratory have appeared in Public Health Reports, August 1954 (p. 716) and December 1954 (p. 1205).*

may be drawn and replaced or recirculated after sterilization. The shellfish are kept in these tanks until purified. Cleansing of polluted clams has been practiced in Massachusetts for a number of years (*2, 7*).

Investigations by Galtsoff (*8*), Sandholzer (*9*), Dodgson (*5*), and others (*10*) have shown that shellfish are extremely sensitive to chlorine, slight amounts slowing down or completely inhibiting molluscan physiological processes. The Public Health Service Shellfish Sanitation Laboratory at its Woods Hole, Mass., location therefore undertook the investigation of purification rates of soft clams, using clean sea water obtained from a normally pollution-free source. The source of this water was Great Harbor, a sheltered continuation of Vineyard Sound, in Woods Hole, Mass.

Biological Activity of the Clam

The biological activities of the clam are of particular importance in considering pollution and purification of this species of shellfish.

The clam lives in burrows on the marine bottom between the high-water mark and as far as the 40-fathom mark. Although a substantial quantity of clams are taken in 1 to 2 fathoms of water, the bulk of the commercially available supply is obtained from the intertidal zone, that is, between the high- and low-water marks.

The clam obtains its food from the overlying water. Buried in the soil, the clam extrudes its "neck" which contains two connected tubes, the inhalant and exhalant siphons. The water which enters the inhalant siphon flows into the mantle chamber, passes through the basketlike gills and thence out of the exhalant siphon.

In addition to the function of respiration, the gills of the clam are used for food collecting. The gill filaments are lined with microscopic cilia which strain out minute forms of animal and plant life which serve the clam as food. These minute forms, when caught by the cilia, are bound together with mucus and normally transported by ciliary action to the edge of the gills and thence to the mouth by way of the labial palps. After passing through the stomach and intestine, the fecal material is extruded near the inner opening of the exhalant siphon through which it is discharged into the water.

The clam can protect itself from taking extraneous or noxious matter into its stomach. It can either close its siphon, or, if the noxious matter has entered the siphon, expel it by forcibly ejecting the matter as pseudofeces out of the inhalant siphon; or it can transport noxious matter by ciliary action away from the palps and thrust it out of the mantle at the pedal opening.

In view of this, it is quite obvious that the bacterial content of a clam is dependent on the bacterial density of the water in which the clam is resident and to a large degree on the amount of water the clam passes through itself. No data are available as to the exact amounts of water a clam filters in 24 hours. However, the work of Galtsoff (*11*), Loosanoff (*12*), and others indicates that, although there are individual differences in animals, an oyster may pass a maximum of 3.9 liters to a maximum of 20 liters per hour under normal conditions.

Temperature of the surrounding water plays an important role as to the amount of water an oyster or quahog will filter. Observations of Galtsoff (*13*) and Loosanoff (*14*) indicate that oysters become almost inactive at 6° C., or below. In contrast, the work of Belding (*15*) and Marston (*16*) demonstrates that clams are active and will "drink" for considerable periods at a water temperature below 39° F. (3.9° C.).

An important aid to sanitation is the fact that, just as the clam ingests bacteria, so, if placed in pure water, it will eventually free itself from bacteria. The question of primary interest is: How long does this take?

In order to answer this question, two series of experiments were conducted. The first of these experiments was made to determine the role of water pumping activity of the clam on purification. The second series of experiments was made to determine whether temperature of the water had any effect on the purification rate of clams.

Water Pumping Activity

The amount of water pumped through a shellfish is a factor in how rapidly an animal can be polluted and, conversely, how rapidly it can be purified. Unfortunately, no adequate methods are available for measuring the amount of water which the clam can pump through itself. Insertion of tubes into the inhalant and exhalant siphons by surgical means for the purpose of measuring water flow, although feasible, is not satisfactory, since the ciliary action of these apertures is disturbed.

The carmine cone method of Galtsoff (*17*) and the cornmeal method used by Dodgson (*5*) and by Marston (*16*), which can be used to indicate pumping, were not considered suitable for use in our experiments. Since it is not feasible to measure quantitively the amounts of water pumped through a clam, the most practical index of pumping activity appeared to be "openness" or "closedness" of the inhalant and exhalant siphons. For our purposes, an animal was considered to be pumping when its inhalant and exhalant siphons were open, and not pumping when both these orifices were closed.

It can be pointed out that this method may not be an accurate measure of pumping activity, if an analogy with measurement of pumping activity of oysters by the use of shell movement is made. Kymograph records, using "shell movement" as a measure of pumping activity, would indicate the passage of large volumes of water through an animal. However, observations of Loosanoff and Engle (*18*) on feeding of oysters, indicated that, under unfavorable conditions (heavy concentrations of organisms in the water), there was no correlation between the amount of water pumped and the kymograph record of shell movement. In their studies, they used the rubber dam technique of Nelson (*19*) by which the amount of water passed through an oyster can be accurately measured.

In our experiments, clams of 2½ to 3 inches in length were obtained from a commercial source and placed in an upright position in numbered, gridded trays, containing 98 to 144 animals. After being exposed to polluted water for 3 to 6 days, the clams in the trays were brought into the laboratory and washed with clean sea water. The trays were then placed into a wooden aquarium containing flowing sea water which was kept at all times 3 inches higher than the uppermost portion of the clam shells.

At 15-minute intervals the clams were observed for activity, which was noted as active or inactive. Owing to the sporadic activity of individual clams, it was difficult to obtain "lots" of shellfish which were 100 percent "active" and 100 percent "inactive" for any protracted length of time. Therefore, for sampling purposes, it was found necessary to class clams showing the least activity as inactive and clams which showed the least inactivity as active samples.

The average results of two clam purification runs conducted at temperatures from 17.5° C. (63.5° F.) to 18° C. (66° F.) are illustrated in figure 1.

It can be seen that coliform content of the more active animals is reduced more rapidly than that of the less active animals for the first 5 hours. However, it can be noted that after the 5th hour the "active" clams became progressively less active and the "inactive" clams conversely became more active, so that at the end of 14 hours the "active" group was inactive for 2½ hours and the "inactive" group had been active for 3 hours. This probably explains the fluctuations in the coliform content of the "active" and "inactive" clams from the 5th to the 14th hour. In the 14 hours of observation, there was enough activity even among the less active animals to effect a significant reduction of bacteria.

Temperature Effect on Purification

Marston (*16*) has shown that *Mya arenaria* can actively feed at water temperatures below 39° F. (3.9° C.) and even at 35° F. (1.7° C.), and that it can ingest bacteria as readily at 37° F. (2.8° C.) as at 73° F. (22.8° C.).

Studies soon to be published, conducted by the Shellfish Sanitation Laboratory, in which the rates of accumulation of pollution in oysters (*Crassostrea virginica*), quahogs (*Venus mercenaria*), and clams (*Mya arenaria*) were studied, show that there is a correlation between the amount of pollution accumulated and the temperature.

In view of these observations, a series of six experiments was conducted at Woods Hole during 1952 and 1953 to determine whether temperature had the same effect on the purification rate of clams as it did on their pollution.

Escherichia coli was chosen as the representative coliform organism. Since no data are available on the rates of cleansing of enteric pathogens from clams, *Salmonella schottmuelleri* was chosen as a representative of this group. *S. schottmuelleri* proved to be an excellent indicator organism for these studies, since our purification waters, usually of excellent bacterial quality, were occasionally subject to coliform pollution.

These studies were conducted in a small-scale purification plant (fig. 2). Clams from a commercial source, measuring between 2½ to 3 inches in length, were placed in heavy wire trays supported by 2-inch metal legs. Fifty clams were placed in each tray. Four trays were then placed in a wooden aquarium containing a wooden dam. The capacity of the aquarium was 200 liters of sea water, maintained at a height of 3 inches over the uppermost portions of the clam shells. The clams were held in this aquarium for a 48-hour acclimatization period during which they were continuously bathed with flowing sea water. Dead and weak animals were removed and replaced with healthy ones during this period of time.

At the beginning of each experiment the aquarium was drained and accumulated detritus on the clams and in the aquarium flushed out by a gentle hosing with sea water. The trays of clams were removed, and the aquarium was refilled with 200 liters of sea water. Bacterial suspensions of *E. coli* and *S. schottmuelleri*, calculated to give the overlying water a density of 10,000 *E. coli* and 1,000 *S. schottmuelleri* per 100 milliliters, were added. After a thorough mixing of the water, the 4 trays containing a total of 200 animals were placed in the aquarium. The animals were allowed to "drink" the polluted water for a period of 6 to 10 hours. The aquarium was drained and the shellfish placed in enamelware buckets and stored overnight. The aquarium and trays used in the

Figure 1. Effect of activity on reduction of coliforms in active and inactive clams. Numbers in parentheses indicate time in hours active or inactive.

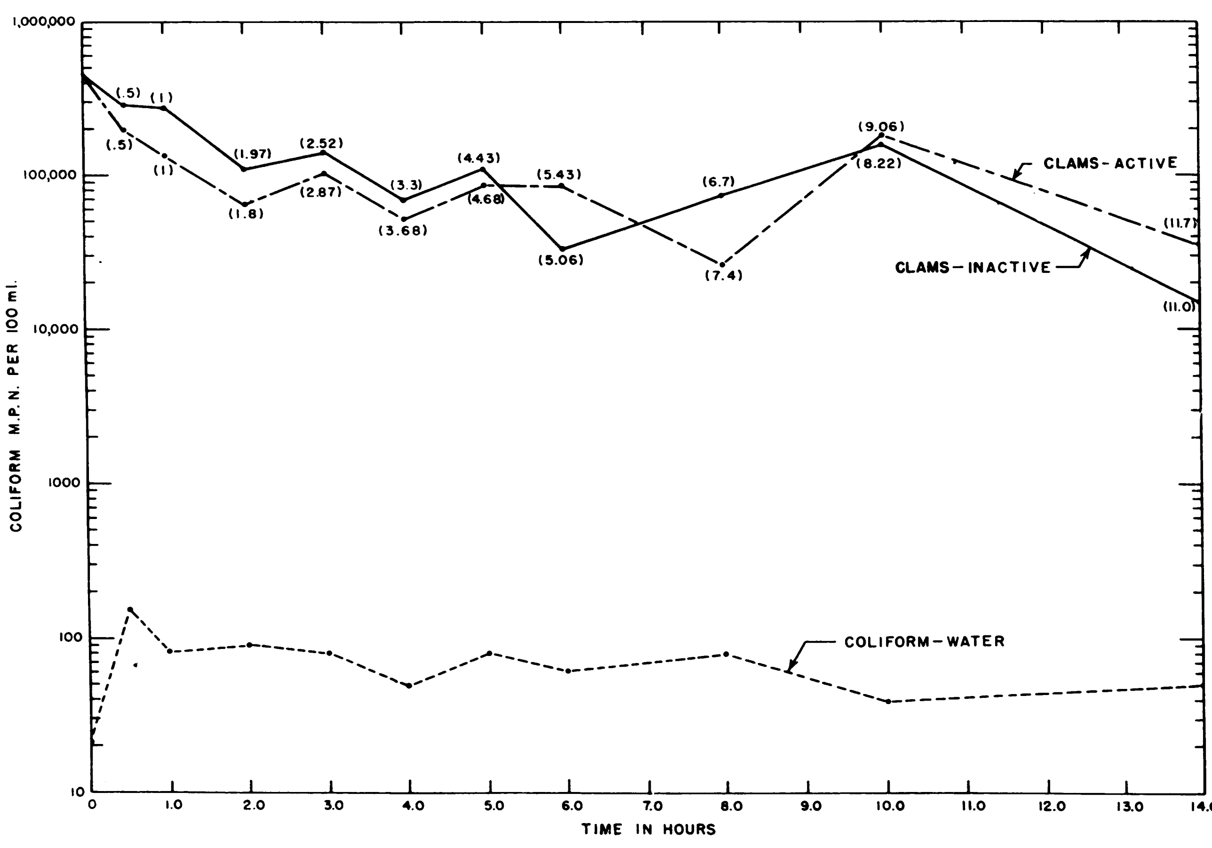
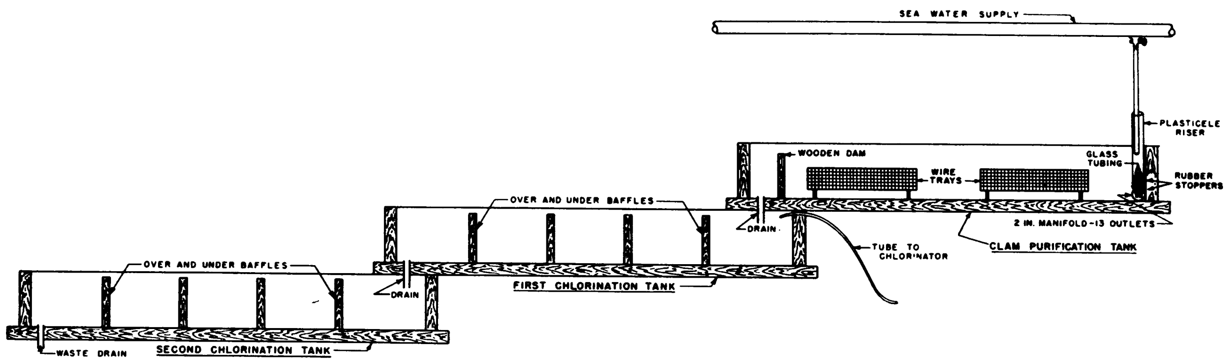


Figure 2. Pilot clam purification plant.



pollution were sterilized for 1 hour with chlorinated water maintained at 100 p.p.m. residual. The sterilized material was then rinsed by flowing sea water for a period of 18 hours.

After overnight storage at room temperature, the clams were replaced in the wire trays and immersed in the aquarium. The rate of flow of sea water was adjusted to 200 liters per hour, or 1 liter per animal per hour. This flow of water was maintained for the duration of the experiment.

To insure that no viable salmonella would be discharged into the receiving harbor, the effluent water from the purification tank was chlorinated by a solution-feed hypochlorinator. Sufficient chlorine was applied to produce a residual of at least 10 parts per million after a detention time of 2 hours in a series of 2 baffled, effluent treatment tanks.

With the exception of a few minor modifications, the bacteriological methods used for the examination of clams and water were those recommended by the American Public Health Association (*20*). Quantitative estimation of bacterial densities was conducted by the dilution method in which at least 4 decimal dilutions—5 tubes for each dilution—were used.

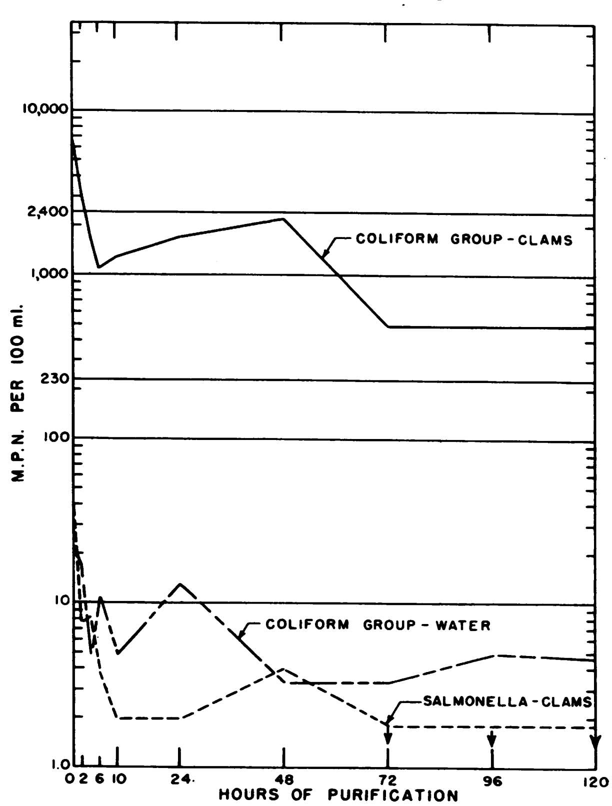
The method for enumerating *S. schottmuelleri* involved enrichment in Galton's (*21*) modification of Kauffman's brilliant green tetrathionate broth, with isolation of typical colonies from brilliant green agar. The test was completed by confirmation on Russell's double sugar agar, with occasional confirmation serologically, using salmonella group B antiserum.

The test for enumerating coliforms consisted of preliminary plantings in lactose broth, with confirmation in brilliant green lactose bile broth.

Results of tests for both organisms were expressed as most probable numbers (MPN) per 100 milliliters, according to Hoskin's tables (*22*).

Samples of clams and overlying waters were

Figure 3. Purification of soft clams—Experiment 1. Water temperature range 2.5–4° C.



taken at designated intervals and examined for the presence of coliforms and salmonellae. Sampling was terminated when two consecutive samples showed the absence of salmonellae in the lowest dilution planted.

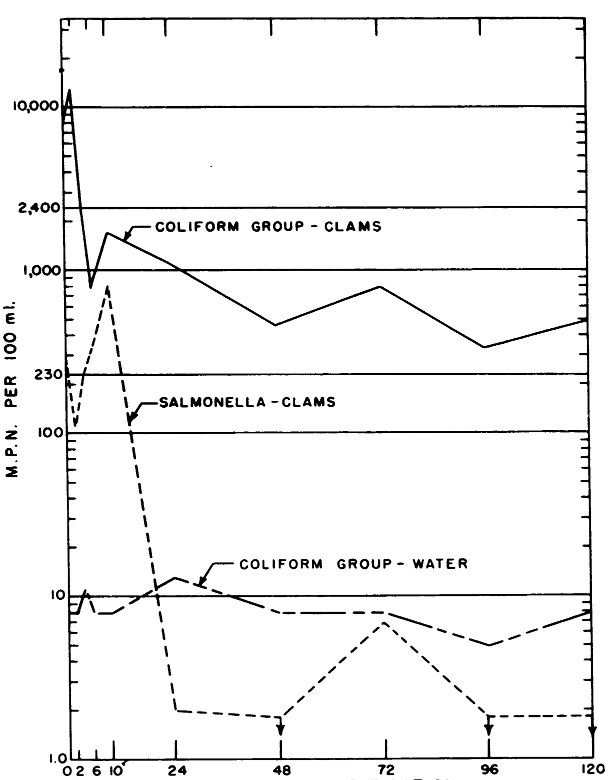
Results of Experiments

The results of these experiments are presented in a series of six figures.

Figures 3 and 4 show the results of experiments conducted at water temperature ranges of 2.5°–4.0° C. (36.5°–39.2° F.) and 3.5°–4.5° C. (38.3°–40.1° F.).

Figures 5, 6, 7, and 8 give the results at temperatures of 13° C. (54.5° F.), 15° C. (59.0° F.), 18° C. (64.4° F.), and 20° C. (68.0° F.), respectively.

Figure 4. Purification of soft clams—Experiment 2. Water temperature range 3.5–4.5° C.



Figures 3 and 4, illustrating the reaction of clams to purification at low temperatures, indicate that the reduction of coliforms in both experiments is similar. There is a similarity in the rapid initial drop and the subsequent leveling off. Although the initial concentration of *S. schottmuelleri* is roughly 10 times less in experiment 1 than in experiment 2, the time required for complete purging of this organism is 3 and 4 days, respectively.

Figure 5. Purification of soft clams—Experiment 3. Water temperature 13° C.

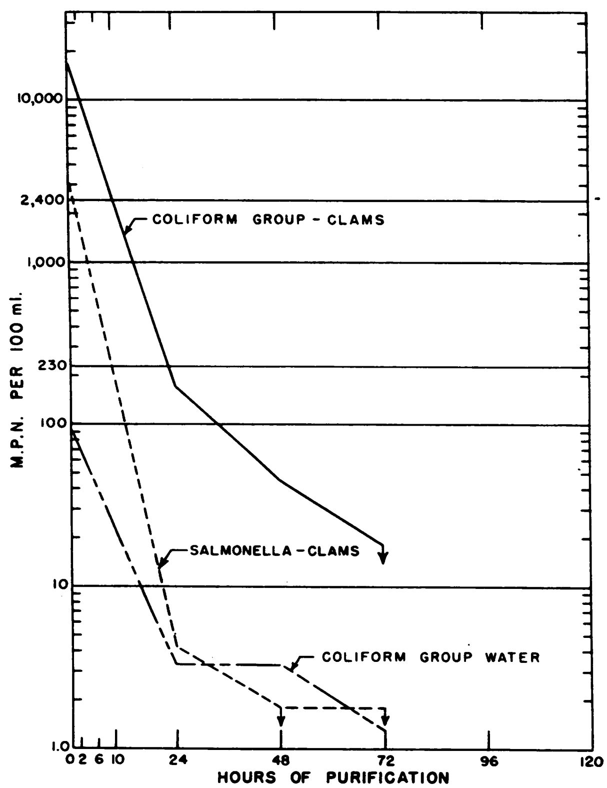
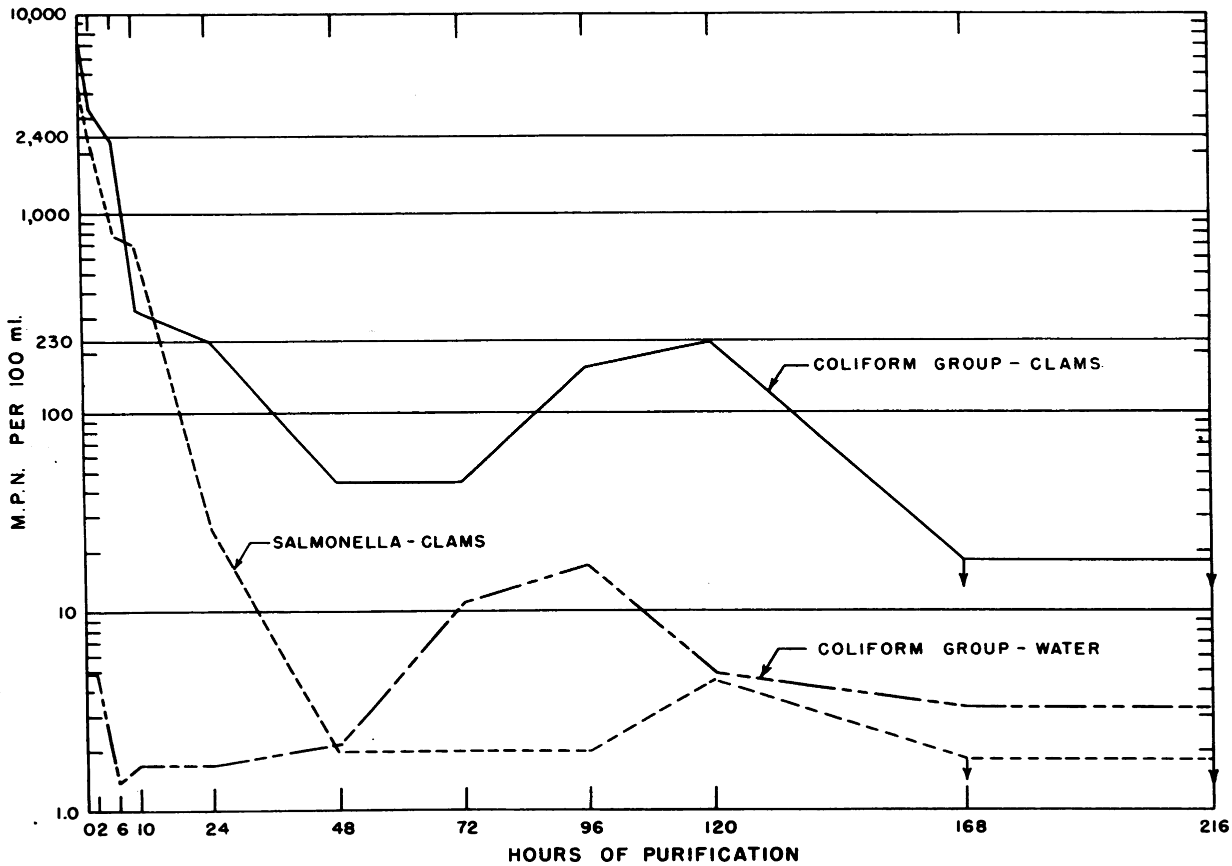


Figure 5 shows that at 13° C. clams containing an initial concentration of 17,000 coliforms and 3,300 *S. schottmuelleri* were purged of the latter in 2 days. No explanation for the indeterminate level of less than 18 coliforms per 100 milliliters which was effected in 3 days can be made, in view of other experiments in which the coliform content of the water was generally low, other than perhaps the clams were more active during this experiment.

Figure 6 shows the results of an experiment in which there were no apparent differences in the physical or biological quality of the water from that illustrated in figure 5, other than a 2-degree rise in temperature. Animals containing an initial concentration of 7,900 coliforms

Figure 6. Purification of soft clams—Experiment 4. Water temperature 15° C.



and 4,600 salmonellae per 100 milliliters showed a rapid decrease of both organisms. However, the clams showed presence of salmonellae for 5 days. Complete purging occurred between the 5th and 7th days.

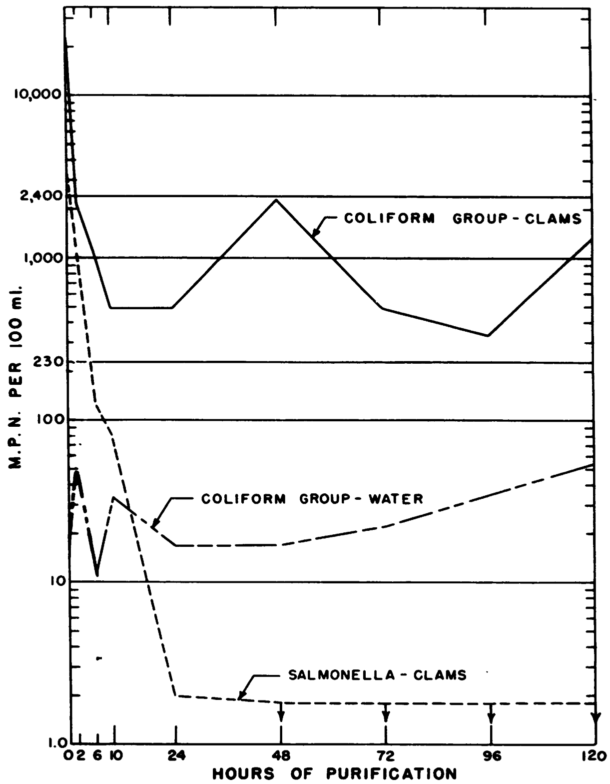
Figure 7 shows that clams having an initial concentration of 22,500 coliforms and 3,300 salmonellae were purged of salmonellae in 48 hours. The coliform content decreased but fluctuated with the water coliform content.

Figure 8 illustrates the effect of occasional pollution of an otherwise satisfactory water supply. Clams containing an initial concentration of 33,000 coliforms and 6.1 salmonellae per 100 milliliters were rid of the salmonellae in 24 hours. Although a reduction of coliforms in the clams did occur, it is not as rapid or as great in magnitude as that occurring in experiments in which the coliform load of the purifying water was lower.

Discussion

The data which have been presented in this report demonstrate that contaminated clams can be purified by exposure to a continuous flow of clean sea water. There is a suggestion that the activity of the clams may play a part in the length of time required for purification. However, even the least active animals studied showed significant decreases in bacterial loads within the purification time employed in the usual clam treatment processes. It is also apparent that the clam can purify itself as effectively at 2.5° C. (34.5° F.) as it can at 20° C. (68° F.). The initial concentrations of polluting organisms used appear to have no influence so far as the length of time necessary for purification is concerned. That enteric pathogens, as represented by *S. schottmuelleri*, can be purged from contaminated clams has been adequately demonstrated. However, although these

Figure 7. Purification of soft clams—Experiment 5. Water temperature 18° C.



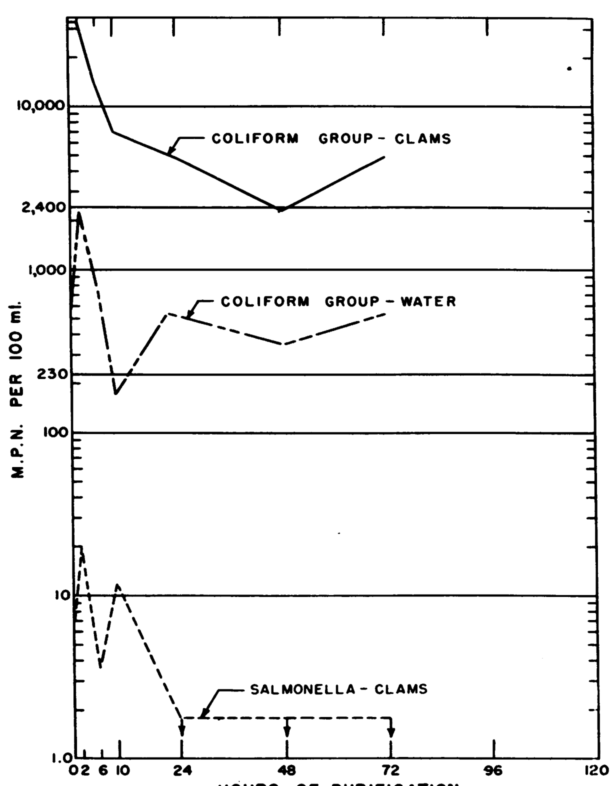
data indicate that purification is feasible, a discussion of certain regulatory, economic, and esthetic aspects of clam purification is indicated.

The use of water containing a chlorine residual of 0.05 p.p.m., or more, for purification of shellfish (*23*) is not supported by the findings of Dodgson (*5*), Galtsoff (*8*), Sandholzer (*9*), nor of the Massachusetts Special Commission Investigating Shellfish Purification (*10*), which demonstrated that chlorine, even in small amounts, can interfere with or inhibit molluscan physiological processes.

During our experiments, the coliform content of polluted clams usually was reduced to, or below, the recommended limiting coliform MPN of 2,400 per 100 milliliters (*23*) in 24 hours or less. Because this level of purification was accomplished with water of low coliform content, there is little doubt that using a water of drinking water quality, as recommended in the Public Health Service manual (*23*), a coliform MPN considerably less than 2,400 could be attained. *S. schottmuelleri* was usually present in the clams in substantial numbers at the time the limiting coliform value was attained. However, at 24 hours and thereafter, *S. schottmuelleri* was irregularly present and only in small numbers at low and medium temperature purifications. Whether the demonstration of these salmonellae at irregular times after 24 hours' purification was due to recontamination of the clams with organisms retained in the experimental apparatus or whether the salmonellae were continuously resident in the animals cannot be determined at this time, and therefore the sanitary significance of their presence is in question.

The economic aspects of shellfish purification are a limiting factor. Finding a source of pollution-free water near areas where polluted clams are found is somewhat of a problem. In most instances, natural waters close to areas where polluted clams are found are not suitable for purification purposes without preliminary

Figure 8. Purification of soft clams—Experiment 6. Water temperature 20° C.



sterilization. This is true in Massachusetts, where clam purification is being practiced at this time. Even if pollution-free waters are found, sporadic pollution of these waters makes the use of naturally clean waters unfeasible for purification purposes. Data gathered at Woods Hole have shown that waters of excellent bacterial quality are on occasion subject to sporadic pollution which can only be related to aquatic birds or runoff from terrestrial sources. However, the problem of finding a pollution-free source of water has been remedied at Conway, England, where water sterilized by chlorine and then dechlorinated has been used with considerable success for purifying mussels.

The efficacy of purification has been questioned from an esthetic viewpoint. It has been compared with dirty milk, containing large numbers of bacteria, which has been pasteurized.

Referring to mussel purification, Dodgson (*5*) states:

"The analogy between purification of polluted shellfish with the pasteurization of dirty milk would appear to be unsound. In the case of dirty milk, although pathogenic bacteria are, or should be killed by the process of pasteurization, nothing is actually abstracted from the milk, the 'dirt,' of whatever nature, e. g., faecal matter, and so forth—remaining therein. In other words, the milk remains a dirty food. In the case of mussels, however, the whole of the solid matter which they may contain in the intestines or elsewhere, e. g., faecal matter of sewage origin, etc., is eliminated by the shellfish, and got rid of by hosing."

Summary and Conclusions

Polluted clams can be purified by exposure to running sea water of low coliform content, according to experiments conducted at the Public Health Service Shellfish Sanitation Laboratory, when it was located at Woods Hole, Mass.

Activity of the clam may play a part in the length of time required for purification. However, even the least active animals studied showed significant decreases in bacterial loads within the purification time employed in the usual clam treatment processes.

The clam is able to function and purify itself at water temperatures of 2.5° C. (34.5° F.) to 20° C. (68° F.).

The recommended coliform MPN of 2,400 per 100 milliliters for cleansed clams can usually be attained in 24 hours or less.

It has not been determined whether the few *Salmonella schottmuelleri* irregularly observed after 24 hours' purification were derived from organisms in the experimental apparatus and water or from those retained in the animal bodies.

Purification time was not materially influenced by the initial pollution loads in the clams used in these studies.

REFERENCES

(*1*) Woods Hole Oceanographic Institution: Report on investigation of the propagation of the soft-shell clam, *Mya arenaria*. Woods Hole Oceanographic Institution Contribution No. 462. Woods Hole, Mass., The Institution, 1948.

(*2*) Shellfish [Report of the Committee of the Public Health Engineering Section of the American Public Health Association, L. M. Fisher, Chairman]. Am. J. Pub. Health 27: 180–196, Supp. March 1937.

(*3*) Fabre-Domergue, M: Bacterial purification of oysters in filtered sea water. Compt. rend. Acad. d. sc. Paris 154: 1257–1259 (1912).

(*4*) Wells, W. F.: Artificial purification of oysters. Pub. Health Rep. 31: 1848–1852 (1916).

(*5*) Dodgson, R. W.: Report on mussel purification. Ministry of Agriculture and Fisheries. Fishery Investigation Series 2, vol. 10, No. 1. London, The Ministry, 1928.

(*6*) Zobell, C. E., and Landon, W. A.: Bacterial nutrition of the California mussel. Proc. Soc. Exper. Biol. and Med. 36: 607–609 (1937).

(*7*) Fox, L.: Shellfish sanitation program of Massachusetts. Modern San. 6: 17 (1953).

(*8*) Galtsoff, P. S.: Reaction of oysters to chlorination. Research Report 11. Washington, D. C., U. S. Fish and Wildlife Service, 1946.

(*9*) Sandholzer, L. A., and Buckner, C. R. Bacteriological studies of oyster conditioning. Commercial Fisheries Review 9: 7–11 (1947).

(*10*) Commonwealth of Massachusetts: Report of the special commission established to make an investigation and study relative to edible shellfish and shellfish chlorinating plants. House Document No. 1770. Boston, The Commonwealth of Massachusetts, 1948.

(*11*) Galtsoff, P. S.: Experimental study of the functions of the oyster gills and its bearing on the problem of oyster culture and sanitary control. U. S. Bureau of Fisheries Bull. No. 46. Wash-

ington, D. C., U. S. Fish and Wildlife Service, 1928, pp. 1–39.
(12) Loosanoff, V. L: Rate of water pumping and shell movement of oysters in relation to temperature (abstract). Anat. Rec. 108: 620 (1950).
(13) Galtsoff, P. S.: Biology of the oyster in relation to sanitation. Am. J. Pub. Health 26: 245–247 (1936).
(14) Loosanoff, V. L.: Effect of temperature upon shell movement of clams, *Venus mercenaria* (L). Biol. Bull. 76: 171–182 (1939).
(15) Belding, D. L.: The soft-shelled clam fishery of Massachusetts. Marine Fisheries Series No. 1. Boston, Commonwealth of Massachusetts, Dept. of Conservation, Div. of Fish and Game, Marine Fisheries Section, 1930.
(16) Marston, A. T.: Preliminary experiments on the effect of temperature upon the ingestion of bacteria by the clam (*Mya arenaria*). Marine Fisheries Series No. 4. Boston, Commonwealth of Massachusetts, Dept. of Conservation, Div. Fish and Game, Marine Fisheries Section, 1931.
(17) Galtsoff, P. S.: New methods to measure the rate of flow produced by the gills of oysters and other molluscs. Science 63: 233–234 (1926).
(18) Loosanoff, V. L., and Engle, J. B.: Effect of different concentrations of micro-organisms in the feeding of oysters (*O. virginica*). U. S. Bureau of Fisheries Bull. 42. Washington, D. C., U. S. Fish and Wildlife Service, 1947.
(19) Nelson, T. C.: Water filtration by the oyster and a new hormone effect upon the rate of flow. Proc. Soc. Exper. Biol. and Med. 34: 189–190 (1936).
(20) Recommended procedure for the bacteriological examination of shellfish and shellfish waters. [Revision of recommended methods of procedure. Report of the Standard Methods Committee for the Examination of Shellfish of the American Public Health Association] Am. J. Pub. Health 37: 1121-1127 (1947).
(21) Galton, M. M., Hardy, A. V., and Mitchell, R. B.: The public health laboratory diagnosis of enteric infections. Am. J. Trop. Med. 30: 77, January 1950.
(22) Hoskins, J. K.: Most probable numbers for evaluation of coli-aerogenes tests by fermentation tube method. Pub. Health Rep. 49: 393–405 (1934).
(23) U. S. Public Health Service: Manual of recommended practice for the sanitary control of the shellfish industry. Public Health Service Pub. No. 33 (formerly Pub. Health Bull. No. 295). Washington, D. C., U. S. Government Printing Office, 1950.

PHS films

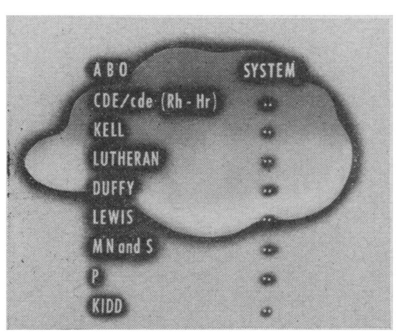
Fundamentals of the Human Blood Groups

35 mm. filmstrip, sound, color, 15 minutes, 70 frames. 1954.

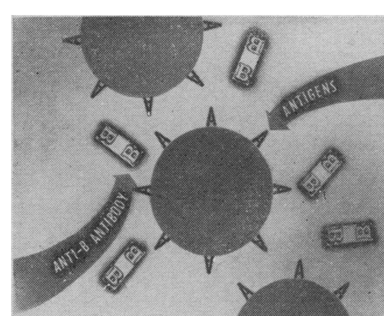
Audience: Pathologists, laboratory technicians, nurses, medical students, and physicians.

Available: Loan—Public Health Service, Communicable Disease Center, 50 7th St., NE., Atlanta 5, Ga. Purchase—United World Films, Inc., 1445 Park Ave., New York 29, N. Y.

The fundamentals of blood typing are explained by symbols and stylized drawings in this filmstrip The genetics of blood groups and the incompatibility of the various groups together with a description of "sensitization" are features depicted. Precautions in giving transfusions are emphasized.



All these blood group systems are inherited in a simple Mendelian manner.



The serum of the B group individual always contains anti-A antibodies.

technical publications

Comprehensive Dental Care in a Group Practice

Public Health Service Publication No. 395. 1954. 48 pages. 25 cents.

Presented is a study of time and service requirements for giving complete dental care on a fee-for-service basis to patients who were members of Group Health Association, Inc., a prepayment medical care program in Washington, D. C.

In the study group were 1,925 persons of all age groups, including approximately equal numbers of males and females. Participation of individual patients during the 5-year period of the study averaged approximately 25 months. Initially each participant received treatment for all accrued needs and was subsequently sustained in a state of good dental health by periodic maintenance care.

United States Participation in International Health

Public Health Service Publication No. 416. 1954. 24 pages; illustrated.

Through charts and explanatory notes, this pamphlet illustrates the role of the United States in the improvement of world health conditions. The United States has been concerned with health problems in other countries since 1902, when it participated in the development of the Pan American Sanitary Bureau. In 1942, the United States embarked upon its first bilateral technical assistance programs through the Institute of Inter-American Affairs. These programs are now conducted by the Foreign Operations Administration with the Public Health Service, through its Division of International Health, providing active support to the health components of the program.

The FOA-PHS health program is active in 38 countries in underdeveloped areas, and its activities cover a wide spectrum. Primary emphasis is placed on training nationals and on controlling malaria, smallpox, yaws, and gastroenteric and parasitic diseases.

The pamphlet also describes the activities of the World Health Organization and the relationship of the Public Health Service to the participation of the United States in this international organization.

State Mental Health Programs Planned for Fiscal 1954 and 1955

Public Health Service Publication No. 374. 1954. 37 pages. 30 cents.

Presented is a cross-section view of how the national health program is being advanced in the States. In addition to abstracts of State mental health program plans, it summarizes major needs and administrative problems pertinent to such programs. Included is a State by State listing which identifies the responsible administrative unit designated by each State as its mental health authority. The text is based on information supplied by the States.

It's Good Business to Know Your Men

Public Health Service Publication No. 379. 1954. 12 pages; illustrated. 10 cents.

Mental health in industry is the subject of this new publication, which suggests how the foreman or supervisor can help to foster a healthy job environment for his workmen by understanding and applying basic mental health principles. It also suggests that he, as a key person, can best help the worker who has emotional problems by using tact and understanding rather than playing the role of "amateur psychiatrist." Since the mental health of a person depends to a great extent on how he gets along in the work situation, the booklet is designed for both management and labor.

An Industrial Waste Guide to the Meat Industry

Public Health Service Publication No. 386. 1954. Prepared by the Committee on Meat Packing Plant Waste Disposal of the American Meat Institute in cooperation with the National Technical Task Committee on Industrial Wastes and the Public Health Service. 12 pages. 15 cents.

Industrial wastes which cannot be eliminated must be disposed of in a suitable manner to protect the Nation's water resources. This pamphlet discusses the sources, quantity, and character of meat industry wastes, the water pollution these wastes can cause, and remedial measures for the control of meat industry pollutants. It is designed primarily as a practical guide for operating and design personnel within the industry itself.

This publication is a revision of the original guide prepared in 1943 by the Public Health Service and published in supplement D of the report, Ohio River Pollution Control. It is the second of a series of industrial waste guides prepared by the National Technical Task Committee in cooperation with the Public Health Service, as a part of the joint government-industry program to reduce water pollution through control of industrial wastes.

How to Study Nursing Activities in a Patient Unit

Public Health Service Publication No. 370. 1954. 48 pages. 25 cents.

How much nurses' time is being diverted from patients to details that other personnel can do? This manual gives a method hospitals can use to study the time distribution of all nursing personnel assigned

technical publications

to inpatient units. The method is similar to that described in the published manual dealing with the head nurse, entitled "The Head Nurse Looks at Her Job." The new manual is intended to help hospital administrators with the next logical step — gathering the information needed to plan better staffing of inpatient units—with the hope that it will save them the time required to devise their own study methods.

The method provides for a sampling of the activities of personnel every 15 minutes. It will provide reliable information on the activities that take the most time and a general picture of the kinds of activities performed by each category of personnel.

Prenatal Health Examination Legislation—Analysis and Compilation of State Laws

Public Health Service Publication No. 369. 1954. 55 pages. 25 cents.

The Venereal Disease Program of the Public Health Service has compiled the laws requiring prenatal blood tests for syphilis which are now in effect in 42 States and 3 Territories. This publication reproduces these laws from the various legal reference sources of the States and Territories and includes citations for these sources.

In addition, the pamphlet contains a table showing the approval and effective dates of prenatal laws for each of the included States and Territories. It also reprints a paper entitled "Prenatal Health Examination Legislation—History and Analysis," by Laura M. Halse and Dominic V. Liberti. The original of the paper appeared in the February 1954 issue of *Public Health Reports*, pp. 105–110.

At the time the publication went to press, Alabama, the District of Columbia, Maryland, Minnesota, Mississippi, Tennessee, Wisconsin, and Puerto Rico did not have prenatal laws requiring blood tests for syphilis.

Handbook on Sanitation of Vessel Construction

Public Health Service Publication No. 393. 1954. 70 pages; illustrated. 30 cents.

Superseding "Principles of Sanitation Applicable to the Construction of New Vessels" dated June 1949, this handbook contains the minimum public health standards relating to the general sanitation and ratproofing of new vessels and vessels undergoing major reconstruction.

Included in the text are standards for the construction of potable water systems, wash water systems, overboard water systems, pressure water connections, food service spaces, plumbing, swimming pools, and crew and passenger accommodations.

The publication is prepared especially for the use of naval architects, shipbuilders, vessel-operating companies, the industries supplying materials and equipment for vessels, and others interested in sanitation aboard ship.

Occupational Health and Safety Legislation

Public Health Service Publication No. 357. 315 pages. $1.25.

Intended as a source of legislative reference, this compilation consists of citations and excerpts or digests of laws and regulations dealing with occupational health and safety. It represents a comprehensive revision of a multilithed publication entitled, "Industrial Health Legislation—a Compilation of State Laws and Regulations," which was issued in limited quantity in 1950.

The present publication includes laws enacted up to and during the first half of 1953. Information on safety inspection and prevention of accidents has been included because lack of uniformity in the usage, coverage, and interpretation of such general terms as "health," "safety," and "sanitation" made it impossible to draw a sharp line of demarcation. No attempt has been made to evaluate the adequacy or effectiveness of the various provisions.

Pertinent information is given for all 48 States, the District of Columbia, Alaska, and Hawaii.

Laws dealing with selected aspects of worker health and safety were examined for the following State agencies: departments of health, labor, industrial relations, agriculture, and education; industrial accident commissions; bureaus and inspectors of mines; public utilities commissions; and a few others, such as State fire marshals for laws regulating health and safety in dry-cleaning establishments.

Selected subjects covered in the provisions include the following: authority and functions of agencies, general provisions relating to occupational health and safety, employment of women and minors, mines and mining, reporting of occupational diseases and injuries, workmen's compensation, vocational rehabilitation, and air pollution and nuisance control.

This section carries announcements of all new Public Health Service publications and of selected new publications on health topics prepared by other Federal Government agencies.

Publications for which prices are quoted are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Orders should be accompanied by cash, check, or money order and should fully identify the publication. Public Health Service publications which do not carry price quotations, as well as single sample copies of those for which prices are shown, can be obtained without charge from the Public Inquiries Branch, Public Health Service, Washington 25, D. C.

The Public Health Service does not supply publications issued by other agencies.