Public Health Reports

Vol. 55 • MARCH 8, 1940 • *No. 10*

THE PLACE OF AN INDEX IN HEALTH DEPARTMENT RECORD KEEPING[1]

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For some time the United States Public Health Service has pursued a series of studies concerning the practices that are followed in selected small health departments serving rural counties. Among the devices found in use is a record system of conventional type, the main elements of which may be enumerated as follows: (1) The daily report, designed to provide a consecutive list of activities by workers; (2) the case record, a form which summarizes service rendered for separate conditions; (3) the family folder, a composite record of household members served by the department; and (4) the periodic report of the department to the sponsoring agencies.

The foregoing terms of common usage are not truly descriptive of actual recording and reporting practice. Departures and omissions disclosed by the study probably are no different from those which might be found in the performance of a large number of similar organizations. A few, however, may be cited for illustrative purposes. The daily report was completed with relative faithfulness by nurses, to a lesser degree by sanitation officers, and seldom or not at all by health officers. A rough check of recording practice showed that personnel tended to disregard casual and administrative contacts; hence, it is reasonable to suppose that even the entries made by nurses accounted for much less than the total service they actually rendered.

The above observations are in line with the experience of Randall[2] who, at the beginning of a survey of public health nursing services in Cattaraugus County, N. Y., found it necessary to emphasize "the importance of the nurse recording for *every* visit 'why she visited, what she did, and what happened.' " Special stress upon this procedure was necessary because prior to the survey period it had been common

[1] From the Division of Public Health Methods, National Institute of Health, in cooperation with the Division of Domestic Quarantine.

[2] Randall, Marian G.: Public Health Nursing Service in Rural Families. The Milbank Memorial Fund Quarterly Bulletin, 9:147 (October 1931).

practice not to record "single visits," "casual calls," or "inconsequential visits," which later were shown to represent all the service received by about half of the nursing clients.

In the three counties primarily under consideration, case records were used almost exclusively for persons admitted to clinic and home nursing service. Furthermore, the so-called family folder was little more than a filing device for case records opened in connection with the field nursing service. Upon tracing the origin of the monthly report, it was found to be a list of items prepared by the State health authorities for local enumeration.

After supplementing the local clerical force, the Public Health Service was able to improve the consistency of record keeping without affecting the extent or character of actual health department service. Special attention was given to the daily report in order that a complete account of all contacts made by the several professional employees might be obtained. Early in the course of the study a preliminary inspection of the data was made for the purpose of determining types of analysis that might be both feasible and revealing. An obvious defect in the prevailing record system from the standpoint of analysis, and one that immediately became apparent, was the absence of an arrangement for isolating in unduplicated form the recipient of service. Thus it was not possible to determine for individuals or situations the items of service rendered by the several staff members. The limitations which such a record keeping system places on analysis can readily be appreciated. In an effort to compensate for the deficiency referred to, a very simple index card which will be described later was devised.

A more extensive and meticulous analysis of the entire body of recorded data furnished objective and quantitative evidence which supported earlier impressions concerning the variance between service rendered and the way it was recorded. These points have been discussed in the series of papers [3] bearing on this aspect of health administration. Bean and Hankla,[4] for example, found that it was the actual practice of these health departments to enter on the appropriate case records home services for only about two-thirds of their patients seen for maternity, tuberculosis, acute communicable diseases, or health supervision. Omission of a case record for each person served

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[3] (*a*) Bean, Helen, and Hankla, Emily: Case Records as an Index of the Public Health Nurse's Work. Pub. Health Rep., 52:1077 (August 6, 1937).

(*b*) Derryberry, Mayhew: Do Case Records Guide the Nursing Service? Pub. Health Rep., 54:66 (January 20, 1939).

(*c*) Derryberry, Mayhew: Nursing Accomplishments as Revealed by Case Records. Pub. Health Rep., 54:2035 (November 17, 1939).

(*d*) Dean, J. O., and Flook, Evelyn: Neglected Opportunities for Teamwork in County Health Department Practice. To be published in Public Health Reports.

(*e*) Mountin, Joseph W., and Flook, Evelyn: The Scope of Personal Service Given by Representative County Health Departments. The Health Officer, 4:42 (November 1939).

[4] See footnote 3 (*a*).

by these departments may be ascribed in part to the fact that, varying with the counties studied, between one-third and two-thirds of the nurses' clients received only one visit. Return visits were even less frequently reported by health officers and sanitation officers. Obviously, under such practice, the maximum need for case records as a guide to future service could not have been far reaching.

The findings of Derryberry [5] raise extreme doubt as to the purposeful usage of even those case records which were completed, for there was little evidence that they influenced the nurse either in selection of patients for revisiting or in deciding upon the type of service to be rendered. No consistency in selection of cases for subsequent visits was noted, either among the several areas or between workers within each separate county. An item recorded as unsatisfactory on the first visit was followed up for some persons and not for others. Furthermore, Derryberry [6] found that a substantial proportion of the items designated as unsatisfactory on the first call were given no grading whatever on subsequent visits even when a return to the case had been recorded. It is assumed that the nurse either failed to observe the condition on the repeat visit or forgot to record the change which had taken place during the interim between her calls. No matter which circumstance prevailed, the value of the record as a guide to future service was lowered by the omission which caused a break in continuity of the case history.

According to Dean and Flook,[7] the extent to which records were used for administrative purposes in these organizations was also limited. In no instance was an occasion discernible which would show that case records were used for checking and increasing the proficiency of personnel under health officer direction. Neither was there any indication that the county supervising nurse or the State nursing consultant utilized these records for conducting their conferences with staff members.

Such discrepancies between service and the recording thereof raised doubt concerning the value of elaborate record systems adopted indiscriminately by health departments, regardless of their needs. That the experience of the health units studied does not represent isolated peculiarities is indicated by the fact that both the Committee on Records and Reports to State and Territorial Health Officers and the United States Public Health Service,[8] and the Committee on Administrative Practice [9] now recognize service entries made on an index

[5] See footnote 3 (*b*).

[6] See footnote 3 (*c*).

[7] See footnote 3 (*d*).

[8] Committee on Records and Reports to State and Territorial Health Officers and the United States Public Health Service: Tabulation of Health Department Services. Pub. Health Rep., 51:1236 (September 4, 1936).

[9] Committee on Administrative Practice: Appraisal Form for Local Health Work. American Public Health Association. New York City, 1938.

card or other special form as well as those made on case records, particularly if further service is not contemplated. These modifications of record keeping requirements, together with the afore-mentioned situations found in the three counties receiving special consideration, stimulated the interest of this office in the possibility of finding some device for supplying the data actually used.

Inclusion for experimental purposes of an index card (see below) proved to be a most satisfactory method of providing essential information for the three areas studied. Index cards are not new to record systems; as a matter of fact, an index is a part of most plans but the index usually serves either as a lead to the case record file,[10] or as an integrating device for the general record system.[11] Inasmuch as a high proportion of services are not described by entries on case cards, it was decided to expand the purpose of the index to identify all persons contacted, to describe briefly the service rendered, and to allocate services to specific workers. Even with this expansion, the form represents a rudimentary type of record which was designed primarily to supply the types of needed information not otherwise available because of the incompleteness of the case record file.

No. ------

-- W C ------ M F ------
(Family name) (First name)
H. H. Head ---------------------------- Dist. ---------------
Date of birth ------------------------- Open country -------
Address ------------------------------- Village ------------

Date	Place	Purpose of contact	Worker

Individual index card.

In many instances the completion of periodic summary reports represents the main use made of records. For this purpose the daily reports of individual workers offer the most usable source of information. There are, however, certain analyses of health department practices which need to be made at least annually if the program is to be guided intelligently. These analyses may relate to performance of the health department staff as a whole or to service to individuals.

[10] Walker, W. F., and Randolph, Carolina R.: Recording of Local Health Work. The Commonwealth Fund, New York City, 1935.

[11] Bellows, Marjorie T., and Ramsey, Geo. H.: Integration of Health Department Records. Am. J. Pub. Health, Vol. 29, No. 26, June 1939.

Such evaluations are facilitated by the inclusion of a record form which is characterized by simplicity, yet which offers maximum possibilities for the types of analysis that are of distinct administrative value. The extent to which the index might be used in supplying information that seems most important in routine health administration was given particular attention. An index record that may be prepared from entries made by staff workers on their daily reports is well equipped to furnish the kind of source material required by most health officers for study of the activities of the department as a whole. Likewise, it would furnish such basic data as commonly appear in annual reports of local health organizations.

A brief description of the items provided for and of the method of recording such information on the index form might be given at this point. The first section of the card is devoted to descriptive and identifying data which are as essential to analysis of service as are the service entries themselves. Name of the client and of the head of the household (H. Head) should be entered in full, as should the location of his residence. For sanitation services the two latter items will serve to identify the premises. The recorded date of birth will reveal whether a client is an adult, a school child, one of preschool age, or an infant. Other information for this section of the card can be indicated by the use of a check mark in the appropriate space. Correctly placed checks will indicate whether the person served is white or colored (W C), and whether a male or female (M F). They will also designate the type of community in which his home is located (open country or village). The section of the card which constitutes a history of services is completed by making the following entries for each separate contact: Date of service, place of service (home, school, office, clinic), purpose of contact (immunization, physical examination, health supervision, sanitary survey, promotion of clinic attendance, instruction regarding control of communicable disease, arrangement for admission to sanatorium, etc.), and identification of the health department worker (health off., A. B., San. insp., C. D., nurse, E. F., etc.). Initials of the person rendering service, in addition to his title, are especially important in larger health departments where more than one worker of each professional class is employed.

The index is the only device which permits a record of total service to unduplicated individuals, for in no other system is the recipient the basis of consideration.

A client's card becomes a part of the index file with his first health department contact, and all subsequent contacts are recorded thereon. Index records may be filed alphabetically according to name of the individual served or of the household head, depending on whether the department chooses to handle its clients singly or in family groups. The alphabetic guide cards might be replaced by a phonetic system, thus facilitating filing and location of records; such a system is especially useful where the department has a large clientele.

From an index record such as the one suggested it is possible to obtain a description of every person served by the health department. Thus the administrator may procure an actual count of infants, preschool children, school children, and adults who are reached by his organization during any chosen period of time. He can tell how many of these persons are white and how many are colored, as well as the sex of each. By comparing the count of clients in the separate categories with the total number of each in the population, a health officer can calculate the distribution of health department services. In addition, he can decide whether lack of balance exists in the selection of clients from particular sections of his jurisdiction.

The index record is a means of determining the total amount and the various types of service received by every person brought within the range of health department activity. Likewise, it is possible to identify those seen for a single purpose or for any given number of purposes and to compute the aggregate number of contacts made by the complete staff. No other record pattern permits these two types of analysis.

Not only does the index provide a history of services rendered by the entire staff, but each item of activity can be assigned to the individual worker responsible for its performance. Only the index tells a story of the related service of various workers to each client. From a record of this kind, the health officer can learn the degree to which his personnel cooperate in their handling of specific conditions, and whether the home, office, or clinic is apt to be the place of contact; he can also compare the proportion of the population served by the several staff members. Finally, the index lends itself to analysis of seasonal variation in health department activities, both from the standpoint of number of individuals served during specified periods and from the aspect of types of work emphasized at particular times. These suggested analyses are based on the types of data called for by the very simple index card described. The analysis made by Mountin and Flook [11] of the scope of personal service rendered by the health departments already referred to was based entirely upon information provided by this elementary index form. Items designed to describe in further detail either the individual or the service might readily be included, although each additional item makes record keeping more burdensome and complicates the analysis.

Limitations inherent in the index as a major element of a record system must be fully understood. Especially do these limitations apply to its use in large health departments where the roster of clients attains considerable magnitude and record files are decentralized.

[11] See footnote 3 (*e*).

The apparent simplicity of the sample index card, as judged by its size and the small number of items, may mislead the uninitiated into believing that the clerical problems of an office are automatically solved with its adoption. At most, an index can only simplify record keeping and facilitate the completion of uninvolved reports and analyses. The form is of limited value unless each staff worker faithfully records every service rendered to individuals and to premises. Furthermore, even the primary analyses described in this paper necessitate a large amount of sorting of cards and tabulating of data recorded thereon. The quantitative data required by administrators of small departments for completion of reports could be extracted by hand sorting with relative ease. One method of handling the card file which would partially mechanize the procedure is the use of the marginal punch system. Experience has shown, however, that this device is adaptable only to relatively small numbers of cards. Access to card punching and mechanical tabulating equipment naturally expedites the task of analysis. In the larger departments where the record system is completely mechanized, the items necessary for index purposes could be entered on the control portion of a punchcard, while the remaining columns are reserved for a description of the service. By the use of mechanical equipment it would be possible to allocate the various services to unduplicated recipients who can be described in any way that the analyst might desire.

Characteristics of the index as described in the foregoing discussion lead to the opinion that there are several noteworthy advantages to its adoption as an element in a record keeping system. The index offers a record of total service to unduplicated individuals, thereby forming a basis for computing the aggregate volume of work performed by the health department; it furnishes a description of every person with whom the organization made contact; it provides a history of the related service of various workers; and it permits consideration of seasonal variation in health department activities. It must be emphasized that the index is not recommended as a substitute for the case record in departments that are disposed to maintain and use the more elaborate system. It is conceivable, however, that under certain conditions the index may be the primary reference file.

STUDIES OF SEWAGE PURIFICATION

XI. THE REMOVAL OF GLUCOSE FROM SUBSTRATES BY ACTIVATED SLUDGE [1]

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In a previous paper (*1*) of this series, the sewage organic matter adsorption, removal, and oxidation characteristics of activated sludge

[1] From the Stream Pollution Investigations Station, Cincinnati, Ohio.

were studied. The very high rate of removal of the organic matter of sewage by the sludge and the portion of this removal which could be accounted for by biochemical oxidation was determined. From 2.5 to 30 percent reduction of the total carbonaceous oxygen demand (L value) of the substrate was accomplished by biochemical oxidation in the first 30 minutes of the process. The remarkable similarity between the purification accomplished by the biologically simple pure culture zoogleal sludge and the normal activated sludge was noted.

In these studies synthetic sewage containing true colloidal and soluble organic material only, and domestic sewage containing organic material in all states of dispersion were used. It has been shown that only about 6 to 10 percent of the organic material contained in domestic sewage is present in true colloidal form and that roughly 33 to 44 percent may be present in true solution (*2*, *3*, *4*).

Because of the large portion of organic material present in true solution in sewage it is pertinent to study the rates of removal of such material by activated sludge. The rates of removal of non-electrolyte solutes from substrates by the activated sludge process have not been extensively studied under controlled conditions. It was, therefore, decided to study this phenomenon and to use the simple carbohydrate glucose as a test material. Glucose was selected because of interest in it as a cause of sludge bulking, because its removal can readily be followed directly, and because of the ease with which it can be used for energy by bacteria. Kendall (*5*) states that no case has been recorded of a bacterium which can utilize any carbohydrate that will not utilize glucose also, and there are organisms which do not utilize any carbohydrate except glucose for energy requirements.

In the present study the rates of removal of glucose obtained with normal activated sludge as taken from an experimental plant and pure culture zoogleal sludge have been compared. The pure culture zoogleal sludge consists of the flocs formed by a strain of bacteria isolated from normal activated sludge. The isolation of these bacteria and the development of the pure culture sludge have been described by Butterfield (*6*). The rates of removal of glucose and sewage organic matter by activated sludges have also been compared. The influence of sludge concentration, temperature, and pH upon the glucose removal rate has been studied. The effect of other factors such as agitation without oxygen, prolonged reaeration, supplemental feeding, and chlorination of activated sludge upon the glucose removal rate has also been determined.

REVIEW OF LITERATURE

The theory of removal of dispersates of larger than colloidal size by coagulation or condensation on the surface of the sludge particles is readily acceptable. This suggests that the mutual coagulation theory proposed by Baly (*7*) and frequently reviewed in the literature (*8*, *9*, *10*, *11*) may be necessary only to explain the removal of the rather small proportion of colloidal organic matter present in the sewage. Baly concluded that lowering the pH of the system to 6.5 to 6 should promote the efficiency of the process. Lumb (*8*) cited experiments to show the advantage of lowering the pH, but Nesmehanoff's (*12*) experiments in which the pH was lowered to slightly under 6 resulted in a decrease in the activity of the sludge, and Mohlman (*11*) states that Baly's suggestion has not been put to practical use.

In any case, the organic materials in solution which include electrolytes and nonelectrolytes are not removed from the dispersions medium by the above coagulation or electro-adsorption mechanisms. Theriault (*13*, *14*, *15*) proposed a biozeolytic theory for the removal of ions of solutes and stated that adsorption of ammonia, amino acids, lignoproteins, and related organic constituents could be explained in terms of base exchange.

Theoretically, this leaves the nonelectrolyte solutes as the only organic components of sewage, the removal of which could not be explained upon the basis of one of the several rapid physiochemical mechanisms conceivably present and active in the activated sludge process. To remove the nonelectrolytic solute it is necessary to fall back upon a biophysical-chemical mechanism such as direct cell action or, as Buswell (*16*) has termed it, bioprecipitation.

The flocs of activated sludge consisting of zoogleal bacteria described by Butterfield (*6*) and Dienert (*17*) are heterogenous systems involving enzymic colloids and solutions of cellular materials. Consequently the reactions of these systems upon substrate are also biophysical-chemical. In this case the reaction velocity would seem to be dependent upon the quantities of the biological agents present to activate the reaction. Butterfield and Wattie (*18*) have shown that the immediate rate of biochemical oxidation of a substrate is proportional to the initial bacterial population. The maximum hourly rate of oxidation for a given substrate was obtained with the maximum number of organisms (10,000,000 per ml. in their experiments) present at the start. This maximum hourly rate became lower and required a longer time to attain as the initial number of bacteria that were present to activate the reaction became smaller.

The bacterial dissimilation of glucose has been extensively studied. Thaysen and Galloway (*19*) have ably reviewed the work in this field and their views are briefly summarized here. The mechanism of glucose dissimilation is generally accepted to depend upon the activation of hydrogen atoms in the glucose molecules and their subsequent removal by hydrogen acceptors according to the theory of Wieland

(*20*). The molecule containing the activated hydrogen (glucose, in this case) is termed the hydrogen donator and the oxygen or other hydrogen absorbing molecule or molecule radical, the hydrogen acceptor. The living plasma, or enzymes produced by the plasma, act upon the molecule of glucose in the substrate in which the plasma is suspended. This makes a transfer of hydrogen possible. According to this theory the function of oxygen has been reduced to that of the hydrogen acceptor. This function it shares with numerous other substances such as methylene blue, litmus, nitrates, etc. The reaction between the hydrogen donator and the hydrogen acceptor is considered an oxidation-reduction reaction. Although the oxygen may function as a hydrogen acceptor without preliminary activation, some authorities favor the view that an activation is necessary before oxygen becomes capable of combining with activated hydrogen.

Glucose is first esterified into monophosphoric esters, after which it is decomposed by the living cell, according to the mechanism described, into compounds containing less than six carbon atoms. The course of the decomposition and the final products formed depend upon the hydrogen activating properties of the organisms involved in the system. Kluyver and Donker (*21*) have reduced the fermentation activities of micro-organisms to eight types.

The type of glucose fermentation or dissimilation that takes place in activated sludge has not been adequately studied. Butterfield (*6*) reported that the zoogleal bacterium isolated from activated sludge grew well in the presence of glucose in nutrient broth but that no gas was formed and, as evidenced by changes in pH, no acid was produced. Heukelekian (*22*) added 1,000 p. p. m. of glucose to activated sludge suspensions under mechanical agitation and found that less than 10 percent of the glucose was removed in an hour. He concluded that, as biological action could not be precluded, this removal could not be ascribed to adsorption. Seiser (*23*) experimented with glucose as a nutrient for activated sludge and concluded that, when glucose was fed with asparagin, twice as much glucose was removed by adsorption as was removed by biological decomposition.

A very serious case of sludge bulking occurred at the Des Plaines River activated sludge plant in 1927, and Morgan and Beck (*24*) found a large quantity of glucose (10,400 p. p. m.) in a portion of the sewage. The glucose tripled the B. O. D. load upon the plant and resulted in a breakdown in plant operation. Ruchhoft and Watkins (*25*) tentatively identified the predominant infesting organism in the diseased activated sludge at this plant as the filamentous organism *Sphaerotilus natans* and showed that the organism could be cultured upon a dextrose peptone phosphate agar. Pearse (*26*) reviewed the literature upon excessive carbohydrates in relation to sludge bulking. Agersborg and Hatfield (*27*) found a rather poor activated sludge at

Decatur and stated that the presence of 8 p. p. m. of dextrose probably encouraged the abundant growth of *Sphaerotilus natans* in the aeration tanks. Scott (*28*) observed great increases in the volume of activated sludge to which dextrose had been added. He showed that once the quantity of sludge had been increased, long periods of aeration decreased the volume very little. Eldridge and Robinson (*29*) and Eldridge, Mallman, and Robinson (*30*) reported that up to 400 p. p. m. of lactose were removed from solution by aeration with activated sludge in 6 to 8 hours. They noted an increase in pH of from 7.2 to 8.1 after carbohydrate feeding and suggested that the carbohydrate was completely oxidized in the above period. They obtained decreases in the quantities of suspended solids in their aeration tanks following lactose feeding and did not obtain any appreciable bulking until the sludge had been aerated 3 days without being fed. Infection of the sludge by *Sphaerotilus* was not mentioned by these observers.

Smit (*31*, *32*) found that carbohydrates such as glucose, sucrose, lactose, and starch in quantities up to 1,000 p. p. m. were all rapidly removed from sewage and that the prolonged addition to activated sludge of sewage containing carbohydrates in such quantities in time produced poor sludge infested with the filamentous organism *Sphaerotilus natans*. He concluded that the average sugar content of about 25 p. p. m. found in the strong Amsterdam sewage (8 to 18 gallons per capita) was far below the limit of harmfulness to activated sludge. Smit also stated that the products of glucose metabolism were not found, that, contrary to his expectations, acids could not be traced, that the pH changed very little and further experiments were needed to decide whether all of the sugar had been oxidized to carbon dioxide or whether other products had been formed. Schmiedt (*33*, *34*) has denied the deleterious effect of carbohydrate on activated sludge and has reverted to the Willstätter theory of ferments adhering to the colloids to explain the oxidation phenomenon in activated sludge. He agrees, however, that wastes consisting mainly of carbohydrates are more difficult to treat than sewage containing colloidal albuminoid material.

From the above brief review it may be surmised that our knowledge regarding the removal of glucose from solution by activated sludge, the nature and relative quantities of dissimilation products formed from glucose by the reaction with activated sludge, and the effect of this reaction upon the sludge is fragmentary.

GENERAL EXPERIMENTAL PROCEDURE

In these experiments 3 liters of the activated sludge mixed liquor chosen for study were transferred to a 4-liter pyrex serum bottle and the suspended sludge solids were allowed to settle for about 30 minutes. After settling, most of the supernatant liquor was siphoned off, a volume of solution containing from 2 to 3 grams of glucose was added, and the volume was made up to 3 liters with distilled water. A small portion, about 50 to 60 ml. of the initial activated sludge glucose mixture, was immediately removed from the aeration bottle for determination of the suspended solids, ash, pH, and glucose content. The mixture was aerated continuously for definite periods, after which samples were withdrawn for analysis.

ANALYTICAL METHODS

The suspended solids and ash were determined according to Standard Methods (*35*). The pH determinations in all experiments were made electrometrically employing a glass electrode.

An adaption of the method recommended by Hassid (*36*, *37*) for the determination of glucose in plant saps was used for the glucose determination. This method involves the reduction of potassium ferricyanide to ferrocyanide by the glucose in slightly alkaline media and the subsequent volumetric estimation of the ferrocyanide by oxidation with dilute standard ceric sulfate solution using Setopaline C as an internal indicator. The method is very simple and it is possible to make 90 to 100 glucose determinations in 5 hours with it.[2] Hassid states that the method has an accuracy compared with the Munson-Walker method of within 2 to 3 percent. Our results with it indicate reproducibility within 3 percent.

Preliminary tests indicated that our Cincinnati sewage and the supernatant liquor from the experimental activated sludge plant at the station contained only negligible quantities of materials capable of reducing ferricyanide (equivalent to 6 p. p. m. of glucose or less). Consequently, it was unnecessary to make blank glucose determinations upon sludge liquor or sewage to which glucose was to be added or to use and analyze an unfed sludge control.

EXPERIMENTAL RESULTS

Typical results obtained in four experiments on glucose removal by activated sludge are tabulated in table 1 and plotted in figure 1. These data confirm Smit's (*31*) results indicating that normal activated sludge sometimes removes glucose from solution very rapidly. In these experiments about 25 percent of the glucose was removed in

[2] For this determination the sample of activated sludge liquor is withdrawn from the aeration bottle, filtered through No. 1 Whatman paper (further clarification is unnecessary) and a volume of filtered solution containing approximately 1 mg. of glucose is pipetted from a 2-ml. pipette (graduated in 0.1 ml.) into a 28×145 mm. test tube. Five ml. of alkaline ferricyanide are added and the tube is put into a wire basket which is placed in a 2-liter container of boiling water and heated for 15 to 17 minutes. Generally 8 to 13 tubes are heated at one time. Immediately following the heating period the tubes are cooled for 3 to 5 minutes in running water, acidified with 5 ml. of 5 N. H_2SO_4 and 7 drops of the 0.1 percent aqueous Setopaline C indicator solution are added. The sample solutions are then rinsed from the tubes into 125 ml. Erlenmeyer flasks and titrated with approximately 0.01 N. standard ceric sulfate from a 5-ml. microburette. The ceric sulfate is standardized against a carefully prepared 1,000 p. p. m. solution of glucose in distilled water.

30 minutes, after which the percentage removal increased rapidly until glucose was depleted in 5 to 10 hours.

TABLE 1.—*Typical glucose removal results obtained with activated sludges, at room temperature*

	Normal activated sludge				Pure culture zoogleal sludge No. 83			
Experiment number	G 7		G 8		G 26		G 42	
Sludge solids, p. p. m.	2,011		1,884		526		2,264	
Volatile solids, p. p. m.	1,432		1,328		518		2,124	
Glucose feed, p. p. m.	699		979		965		716	
Time	Glucose removed p. p. m.	Percentage removed	Glucose removed p. p. m.	Percentage removed	Glucose removed p. p. m.	Percentage removed	Glucose removed p. p. m.	Percentage removed
Initial after mixing	33	4.72	59	6.03	--------	0	0	0
10 minutes	101	14.4	150	15.3	--------	--------	--------	--------
15 minutes	--------	--------	--------	--------	20	2.07	16.0	2.23
20 minutes	155	22.2	199	20.3	--------	--------	42.0	5.87
30 minutes	205	29.3	242	24.7	0	0	61.0	8.52
45 minutes	255	36.5	[1] 297	30.3	27	2.80	113.0	15.8
60 minutes	275	39.3	344	35.1	45	4.66	157.0	21.9
75 minutes	--------	--------	392	40.0	38	3.94	--------	--------
90 minutes	355	50.8	370	37.8	11	1.14	163.0	22.7
2 hours	446	63.8	474	48.4	86	8.91	210.0	29.3
3 hours	556	79.5	664	67.4	51	5.28	[2] 260.0	36.3
3½ hours	--------	--------	--------	--------	--------	--------	304.0	42.5
4 hours	--------	--------	--------	--------	118	12.2	--------	--------
4½ hours	--------	--------	--------	--------	--------	--------	423.0	59.1
5 hours	690	98.7	894	91.3	--------	--------	--------	--------
23 hours	695	99.4	977	99.8	822	85.2	687.0	95.9

[1] 40 minutes. [2] 2¾ hours.

Pure culture zoogleal sludge removed glucose at a considerably lower rate than did normal activated sludge. The quantity of bacteria present very decidedly influenced the rate of glucose removal. With 526 p. p. m. of zoogleal bacteria (Exp. G 26) only 12.2 percent of glucose was removed in 4 hours, while with 2,264 p. p. m. of bacteria (Exp. G 42) 21.9 percent was removed in 1 hour and 59.1 percent in 4½ hours. On the basis of these removal performances it may be assumed that activated sludge contains organisms and enzymes more efficient in their glucose removal powers than these pure zoogleal cultures.

A comparison was made of the glucose removal rate obtained with activated sludge, with sewage, and with several of the biological agents common to sewage. These data are given in table 2 and indicate that about 2,000 p. p. m. of good activated sludge removes glucose at a much higher rate during the first 3-hour aeration period than any of the other agents tried. There is a lag of 5 hours before appreciable quantities of glucose are removed by Cincinnati domestic sewage. With cultures of *Bacterium aerogenes* and *Bacterium coli* containing about 21.6 and 32.6 million viable cells per ml., respectively, a lag of 3 hours was observed before appreciable quantities of glucose were removed. The much greater and earlier rate of glucose removal obtained with activated sludge gives evidence of the tremendous bacterial populations present in this sludge. It has been estimated (*18*) that activated sludge contains about 10,000 million bacteria per ml.

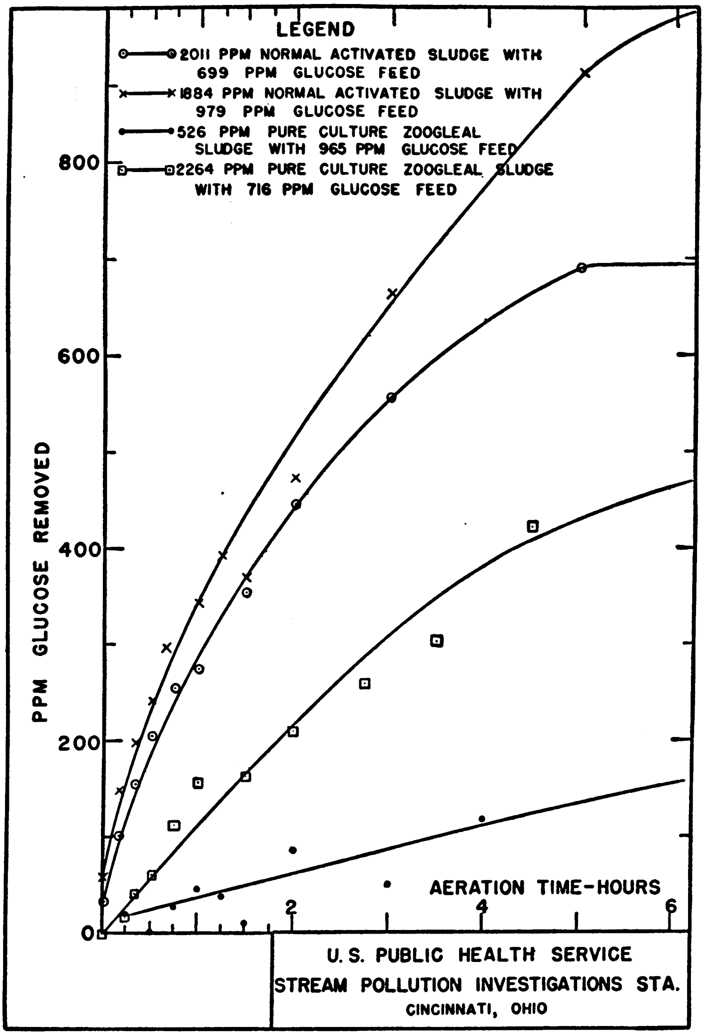

FIGURE 1.—Typical glucose removal curves for activated sludges.

The *Sphaerotilus natans* culture containing 422 p. p. m. of these organisms removed glucose at a considerably lower rate than the activated sludge.[3]

[3] When *Sphaerotilus natans* cultures are tested for glucose removal, the substrate must be properly balanced with nitrogenous and mineral constituents or glucose is removed very slowly. In this experiment glucose was fed with synthetic sewage under conditions in which maximum rates of removal are obtained.

TABLE 2.—*Comparison of various biological agents in removing glucose from solution under aeration, at room temperature*

Aeration time, hours	Glucose removed, p. p. m.					Percentage of glucose removed				
	Activated sludge [1]	*Bact. aerogenes* culture [2]	*Bact. coli* culture [3]	Domestic sewage	*Sphaerotilus natans* culture [4]	Activated sludge	*Bact. aerogenes* culture	*Bact. coli* culture	Domestic sewage	*Sphaerotilus natans* culture
½	172			0		17.2				
1	306	27	0	0		30.6	2.7	0		
3	660	46	13	0		66.0	4.6	1.3		
5	895	577	195	7	181	89.5	57.7	19.5	0.7	36.2
6½				350					35.0	
10½	(5)	660	424			100	66.0	42.4		
13				920					92.0	
24		704	771	(5)	480		70.4	77.1	100	96.0

[1] Activated sludge of 1,940 p. p. m. suspended solids dosed with 1,000 p. p. m. of glucose.
[2] A 48-hour 20° C. culture in standard nutrient broth was dosed with 1,000 p. p. m. of glucose. Initial count in mixture was 21.6 million per ml.
[3] A 48-hour 20° C. culture in standard nutrient broth was dosed with 1,000 p. p. m. of glucose. Initial count in mixture was 32.6 million per ml.
[4] A 24-hour culture in synthetic sewage containing 422 p. p. m. of organisms was dosed with synthetic sewage containing 500 p. p. m. of glucose.
[5] Complete.

It is interesting to compare the rate of glucose removal of these sludges and the removal of B. O. D. of sewages reported previously (*1*). It may be assumed, for the purpose of this comparison, that the B. O. D. of glucose is removed at the same rate as its disappearance from solution. Using typical experiments, this comparison for normal activated sludge is as follows:

Experiment number	Quantity of sludge, p. p. m.	Feed	L value [1]	Percentage reduction of L value after indicated time in hours				
				½	1½	3	5	10
7	2268	Settled sewage	334	55.1	74.6	81.7	88.5	92.8
G 7	2011	Glucose	745	29.2	50.9	79.5	98.7	99+
5	2812	Synthetic sewage	385	29.1	35.8	44.2	52.2	76.4

[1] Total carbonaceous B. O. D.

This suggests that for the first 2 hours the rate of glucose removal by normal activated sludge is lower than the rate of removal of sewage organic matter which is largely suspended and colloidal material. Glucose, however, seems to be removed more completely in a shorter time than the nitrogenous organic matter (peptone and meat extract) in synthetic sewage.

A similar comparison of the B. O. D. removal obtained by pure culture zoogleal sludge follows:

Experiment number	Quantity of sludge, p. p. m.	Feed	L value [1]	Percentage reduction of L value after indicated time in hours			
				½	1½	3	5
9	2,112	Settled sewage	414	68.4	81.3	89.3	91.7
G 42	2,268	Glucose	764	8.52	22.9	39.8	63.8
2	1,632	Synthetic sewage	384	39.8	55.7	81.5	86.8

[1] Total carbonaceous B. O. D.

This comparison indicates that the ability of the zoogleal culture to remove B. O. D. of sterile or synthetic sewage is much superior to its ability to remove glucose from solution.

Several experiments to determine the rate of glucose removal with increasing quantities of sludge have been completed. All of these have indicated that the rate of removal is directly related to the quantity of sludge under aeration. The data of a typical experiment are given in table 3 and the results for glucose removal are plotted in figure 2. The glucose removal results with the three lower sludge concentrations, A, B, and C, show irregularities during the first hour. Thereafter, however, the glucose removal is quite regular with all concentrations of sludge. As table 3 shows, the quantities of sludge solids present after 3 and 5 hours of aeration were definitely increased with the removal of glucose. The volatile matter content of these sludges also increased during the 5-hour aeration period. The mean volatile matter content of the sludges in this experiment was 50.95 percent at the start, increasing to 54.84 percent after 3 hours and to 56.44 percent after 5 hours.

TABLE 3.—*Glucose removal with increasing quantities of activated sludge, at room temperature*

Experiment G 17	A	B	C	D	E	F
Initial pH	7.2	7.2	7.2	7.2	7.2	7.2
Sludge solids p. p. m.:						
Initial	331	653	1,253	1,973	2,621	3,136
After 3 hours	308	716	1,336	2,052	2,652	3,188
After 5 hours	368	752	1,384	2,100	3,008	3,552
Glucose feed p. p. m	515	515	515	515	515	515
Time	Glucose removed, p. p. m.					
Immediately after mixing	1.8	−6	−8	−5	25	48
15 minutes	3.2	15	42	27	54	64
30 minutes	46	43	29	51	80	82
60 minutes	23	21	60	75	103	142
2 hours	47	60	105	157	201	256
3 hours	52	78	141	216	284	356
5 hours	67	117	223	306	415	485
24 hours	199	365	(1)	(1)	(1)	(1)

[1] Complete.

The increasing rates of glucose removal for increasing quantities of sludge, after the first hour, suggest that the Freundlich adsorption law may apply. If this is true the removal data obtained after any time for all sludge concentrations should satisfy the expression:

$$\frac{X}{M}=a\,C^b$$

or

$$\log\frac{X}{M}=b\log C+\log a$$

where

X=quantity of glucose removed
M=quantity of sludge used
C=concentration of glucose remaining in solution
a and b are constants.

The data obtained in the above experiment from the first to the fifth hour, inclusive, have been arranged in table 4 for plotting. In this computation the sludge solids results have been adjusted so that each higher concentration is an exact multiple of the lowest concentration.

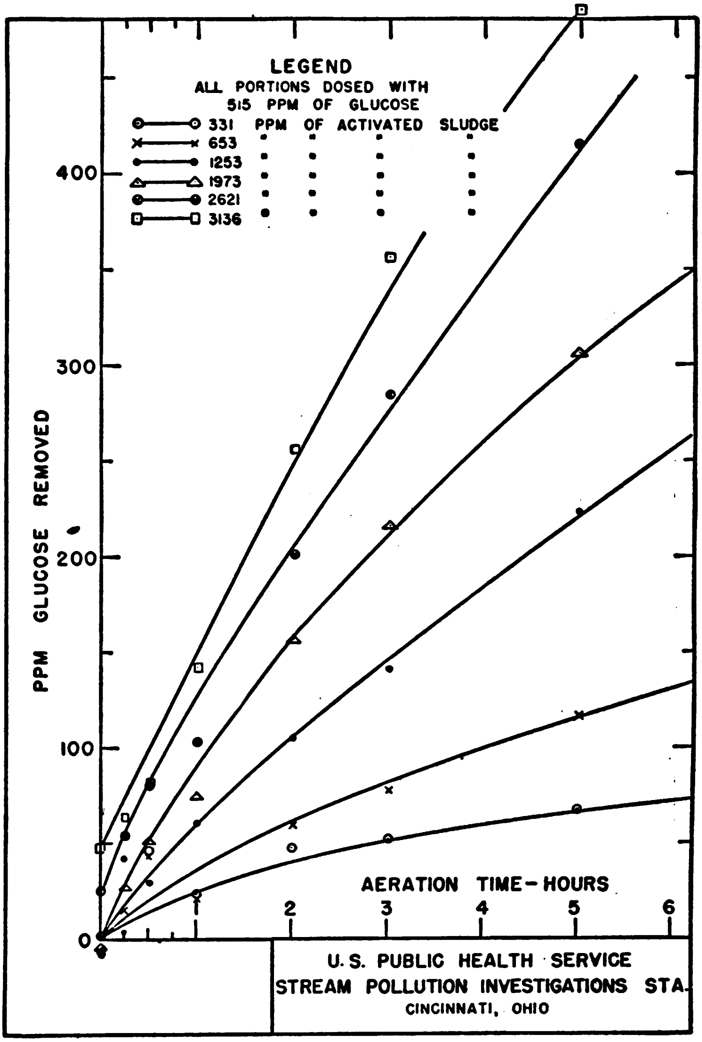

FIGURE 2.—Glucose removal with increasing quantities of activated sludge.

The initial suspended solids results were used with 1- and 2-hour glucose removal observations and the 3- and 5-hour suspended solids results were used with the removal observations at the corresponding times. These data have been plotted on a log-log scale, as shown in figure 3, with interesting results.

Table 4.—*Data of experiment G 17 arranged for plotting to determine the application of the Freundlich adsorption expression*

Sludge mixture	Initial sludge solids (*M*) p. p. m.	Aeration time—hour at which observations were made							
		1		2		3		5	
		$\frac{X}{M}$	*C*	$\frac{X}{M}$	*C*	$\frac{X}{M}$	*C*	$\frac{X}{M}$	*C*
A	825	0.07[illegible]	492	0.145	468	0.157	463	0.191	448
B	650	.032	494	.092	455	.117	437	.167	398
C	1,300	.046	455	.081	410	.106	374	.159	292
D	1,950	.038	440	.081	358	.108	299	.146	209
E	2,600	.040	412	.077	314	.107	231	.148	100
F	3,250	.044	372	.079	258	.107	159	.138	80

$\frac{X}{M} = \frac{\text{p. p. m. of glucose removed}}{\text{p. p. m. of sludge solids}}$

C = p. p. m. of glucose remaining in solution.

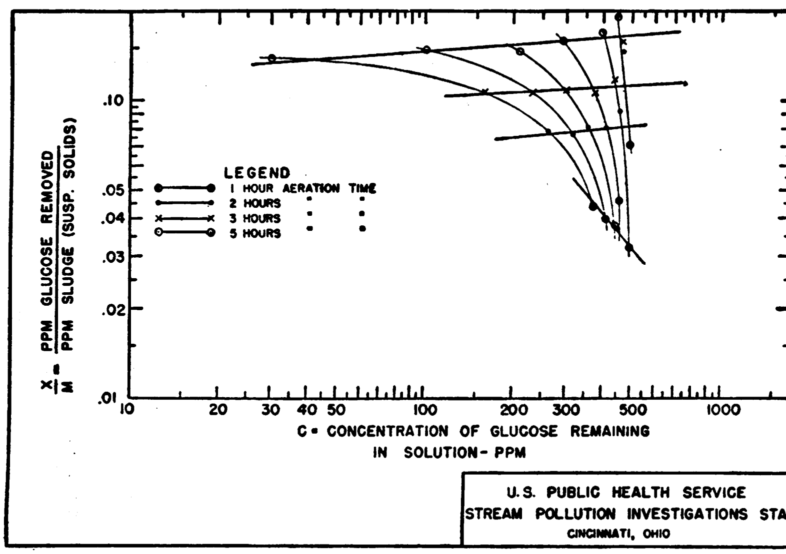

Figure 3.—Relation between the ratio of glucose removed to the sludge solids and the concentration of glucose remaining in solution.

This figure shows that all points except those representing the lowest concentration of sludge fall within a reasonable distance of a straight line for the 2-, 3-, and 5-hour observations. A straight line may also be drawn through 4 of the 5 points for the 1-hour observation, neglecting the point for the lowest sludge concentration. Considering the relatively small quantities of glucose removed in 1 hour and the possibility of error in the glucose determinations, it is not surprising to find one of these observations with the lower sludge concentrations in disagreement. The observation points for each sludge concentration from the first to the fifth hour have been connected with a light curved line simply for convenience in following the movement of the point for a given sludge concentration with increasing aeration time. The straight line obtained at each observation time indicates that this reaction follows the expression $\log \frac{X}{M} = b \log C + \log a$. Consequently, it may be concluded that with normal activated sludge concentrations of 650 to 3,250 p. p. m. and a glucose concentration of about 500 p. p. m. the Freundlich expression applies between the first and fifth hour. Agreement with this expression was not obtained when sludge concentrations below 650 p. p. m. were used.

The results of one experiment, in which 478, 906, and 1,088 p. p. m. of pure culture zoogleal sludge were tested for glucose removal ability, were similar to the above results with normal activated sludge. These results are given in table 5. The removal obtained with all zoogleal sludge concentrations were irregular during the first hour. Thereafter the removal results were fairly regular. Additional work with a larger number of concentrations of sludge is necessary to determine whether glucose removal by pure culture sludge also follows the Freundlich expression.

TABLE 5.—*Glucose removal with increasing quantities of pure culture zoogleal sludge*

Experiment G 16	D	E	F
Sludge solids, p. p. m	478	906	1,088
Glucose feed	631	631	631
Time	**Glucose removed, p. p. m.**		
Initial after mixing	0	0	17
15 minutes	22	54	84
30 minutes	41	76	123
45 minutes	24	63	109
60 minutes	35	70	105
90 minutes	9	55	91
2 hours	16	76	101
3 hours	21	120	115
5 hours	74	225	239
23½ hours	365	603	608

OTHER FACTORS AFFECTING GLUCOSE REMOVAL BY ACTIVATED SLUDGE

Temperature is one of the most important factors affecting glucose removal by activated sludge. In one experiment, to determine the effect of heat on the general removal mechanism, three portions of normal activated sludge were heated to 35°, 45°, and 55° C., respectively, for 10 minutes and cooled to room temperature. Then 1,000 p. p. m. of glucose were added to these three portions and to an untreated portion and all four portions were aerated at room temperature. The glucose removal results obtained are given in table 6 and plotted in figure 4. This experiment showed that warming to 35° C. had no measurable effect upon the rate of glucose removal by activated sludge. Warming for 10 minutes at 45° C., however, had a very definite retarding effect upon the glucose removal rate, and for 10 minutes at 55° C. practically destroyed the ability of activated sludge to remove glucose during the first 4-hour aeration period. The glucose removal ability of this sludge was recovered, however, within the first 24-hour aeration period. This experiment suggests that the glucose removal rate by activated sludge depends upon an enzymic bacterial reaction which is very sensitive to temperatures over about 45° C. for even a short time.

TABLE 6.—*Effect of warming normal activated sludge to various temperatures for 10 minutes upon its glucose removal ability*

[Sludge solids 3,200, volatile sludge solids 1,955; pH=7.3, glucose feed 1,000 p. p. m.]

Sludge portion treatment	A Untreated	B 10 min. at 35° C.	C 10 min. at 45° C.	D 10 min. at 55° C.
Aeration time	Glucose removed, p. p. m.			
Initial after mixing	67	53	22	34
15 minutes	179	180	73	19
30 minutes	247	225	149	71
45 minutes	282	297	197	10
60 minutes	367	338	216	−2
75 minutes	446	414	282	56
90 minutes	474	471	306	50
2 hours	552	540	354	58
3 hours	758	767	527	50
4 hours	928	907	638	82

In two experiments the effect of aeration temperature upon glucose removal by normal activated sludge was studied. In the first test, aeration temperatures of from 2° to 28° C. were used, and in the second trial, temperatures from 18° to 44° C. were maintained. In these experiments, portions of activated sludge which had been aerated at room temperature were heated or cooled to the desired temperatures. Each portion was dosed with 1,000 p. p. m. of glucose solution at the temperature at which the sludge was to be aerated and aeration was started. The results obtained are given in tables 7 and 8 and are plotted in figures 5 and 6. These figures show that the rate of glucose removal increased very decidedly as the aeration temperature was increased from 2° to 33°–35.2° C. At the lower temperature only about 289 p. p. m. of glucose had been removed in 5½ hours, while at the higher temperature the entire 1,000 p. p. m. had been removed in 2 hours. At the highest aeration temperatures of these experiments, 41° to 44.3° C., the initial removal obtained immediately after mixing was greater than that obtained at any of the lower temperatures. The rate of removal through the first hour after the initial mixing was lower, however, than for the sludge portions aerated at about 30° and 35° C. After the first hour the removal rate fell considerably. Between the third and twenty-third hour (not tabulated) only 222 p. p. m. of glucose were removed. This indicates that an aeration temperature of 41° to 44.3° C. is detrimental to the glucose removal mechanism of the sludge. In another experiment, activated sludge was conditioned by sewage feeding and aeration at

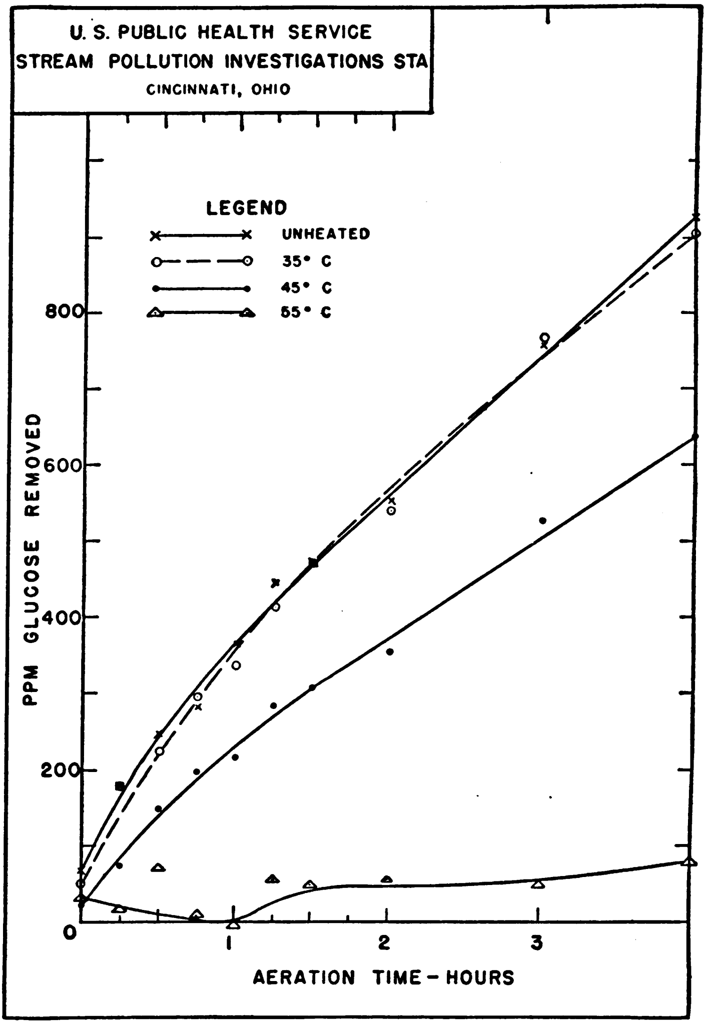

FIGURE 4.—Effect of warming activated sludge for 10 minutes to various temperatures upon its glucose removal ability.

42.6° to 43° C. for 44 hours before the glucose removal test was made. The conditioning at this temperature proved ineffective, as the glucose removal capacity was completely destroyed, thus indicating that this temperature is inimical to the enzymic glucose removal mechanism of the sludge.

TABLE 7.—*Effect of aeration temperatures upon rate of glucose removal by activated sludge, temperatures 2.0° to 28.0° C.*

[Sludge solids 2,672 p. p. m., volatile sludge solids 1,924 p. p. m., glucose feed 1,000 p. p. m.]

Sludge portion / Aeration temperature range °C	A 2.0 to 8.2	B 10.0 to 13.0	C 19.3 to 19.6	D 27.0 to 28.0
Aeration time	Glucose removed, p. p. m.			
Initial after mixing	39	43	62	44
15 minutes	71	58	126	154
30 minutes	76	118	177	255
45 minutes	103	168	250	344
60 minutes	107	221	330	415
80 minutes	138	255	370	482
100 minutes	149	268	416	584
2 hours	173	313	480	663
3 hours	213	403	636	904
4 hours	228	499	783	(1)
5½ hours	289	591	988	----------

1 Completely removed.

TABLE 8.—*Effect of aeration temperatures upon rate of glucose removal by activated sludge, temperatures 18.8 to 44.1° C.*

[Sludge solids 2,824 p. p. m., glucose feed 1,000 p. p. m.]

Sludge portion / Aeration temperature range °C	A 18.8 to 20.0	B 24.1	C 29.8 to 31.0	D 33.2 to 35.2	E 41.0 to 44.1
Aeration time	Glucose removed, p. p. m.				
Initial after mixing	66	61	118	157	199
15 minutes	148	168	213	415	295
30 minutes	204	257	448	505	356
45 minutes	265	355	518	636	455
60 minutes	360	454	604	741	509
80 minutes	418	540	690	771	500
100 minutes	500	647	842	835	506
2 hours	559	747	971	(1)	620
3 hours	697	(1)	(1)	----------	606
4 hours	856	----------	----------	----------	674
5½ hours	(1)	----------	----------	----------	743

1 Complete removal.

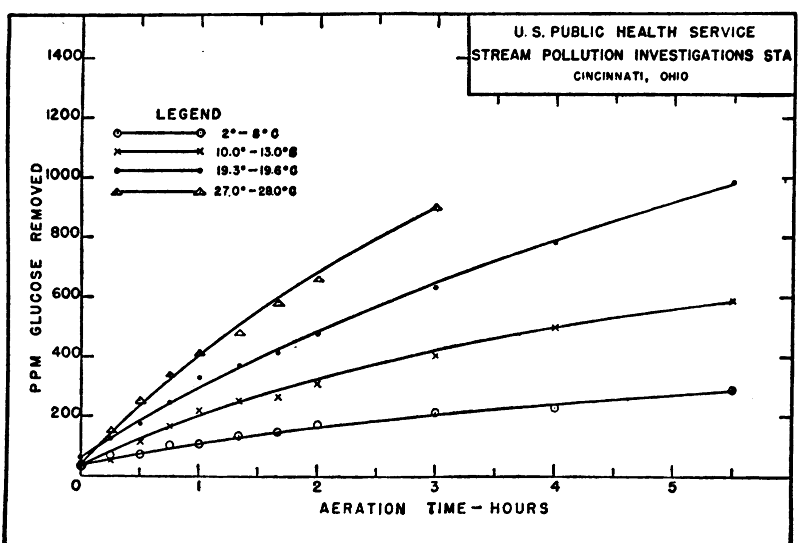

FIGURE 5—Effect of aeration temperatures upon the rate of glucose removal by activated sludge.

In another experiment, simultaneous tests were made upon a normal laboratory sludge of good quality developed at about 25° C. and a sludge from the station experimental plant that had been operated at aeration temperatures of from about 1° to 10° C.[4] In this experi-

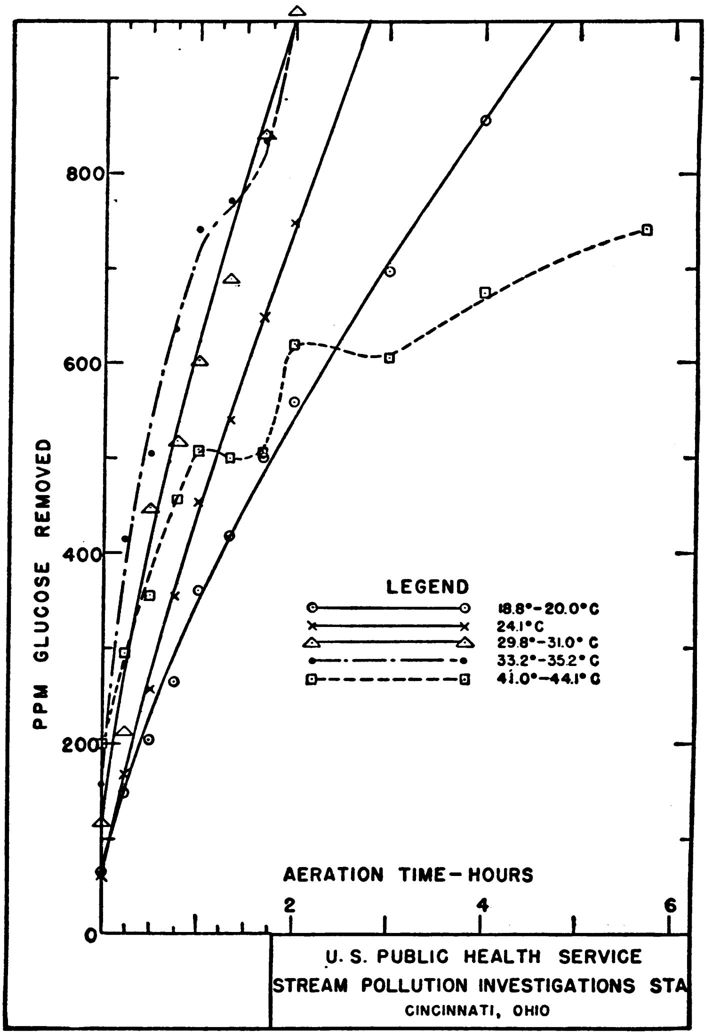

FIGURE 6.—Effect of aeration temperatures upon the rate of glucose removal by activated sludge.

ment samples of both sludges were divided into two portions, one portion of each sludge was brought to 27° C., dosed with a glucose solution at this temperature and aerated at the same temperature, while the second portion of each was brought to 1° C., dosed with

[4] This temperature range is rather broad because this small plant is located in an unheated, glass-covered building, without temperature control, subjected to winter temperatures. Consequently, the lower temperatures were obtained during the night and early morning and the maximum temperatures were reached during sunshine in the afternoon.

glucose adjusted to this temperature and aerated at the same temperature. The results of glucose removal obtained in this experiment, as given in table 9, are instructive. This experiment shows that the glucose removal depends not only upon the aeration temperature during the period of glucose removal but also upon the previous history of the sludge. The laboratory-developed sludge removed glucose at the customary rate for 27° C. when aerated at 27° C. When this sludge was cooled and aerated at 1° C. its glucose removal rate fell, but this rate was considerably higher for the first 90-minute aeration period than the removal rate for the winter temperature plant sludge aerated at 1° C. The plant sludge aerated at 1° C. removed glucose at a very low rate. At 27° C., however, this sludge did not reach the removal rate of the laboratory sludge aerated at 1° C. during the first 90-minute aeration period. This experiment suggests, therefore, that any preliminary treatment of a sludge which may affect its "quality" also affects the glucose removal rate that may be expected at any temperature.

TABLE 9.—*Comparison of glucose removal ability of activated sludge developed at winter and summer temperatures*

	Laboratory sludge, temperature 27° C. Solids=2,170 p. p. m.		Experimental plant sludge, winter temperature 1°-10° C. Solids=3,935 p. p. m.	
Aeration temperature	27.4° C.	1.0° C.	27.4° C.	1.0° C.
Aeration time	**Glucose removed, p. p. m.**			
Initial after mixing	115	55	13	0
15 minutes	203	128	11	5
30 minutes	309	193	25	19
45 minutes	341	200	72	25
60 minutes	384	218	75	52
75 minutes	434	243	119	36
90 minutes	478	256	149	28
2 hours	414	200	108	0
3 hours	544	216	189	35
4 hours	689	226	260	40
5 hours	832	263	349	39
6 hours	936	270	404	70

A final experiment upon the temperature factor in glucose removal was carried out with samples of the same laboratory and plant sludge used previously, but after preliminary conditioning. The laboratory sludge was dosed regularly with sewage (twice a day) and aerated at winter temperatures, 1° to 10° C., for 5 days. The plant sludge was conditioned by similar dosing and aeration at 25° to 28° C. for 3 days. Each sludge was then divided into two portions and the previous experiment was repeated. The results obtained are given in table 10. The 5-day period of cold temperature conditioning had a remarkable effect upon the glucose removal rates obtained from the laboratory sludge. This effect can be illustrated by comparing the rates of glucose removal in milligrams per gram of sludge per liter for the first hour as follows:

Aeration temperature, °C.	*Before conditioning*	*After conditioning at 1° to 10° C. for 5 days*
25° to 27° C.	177	57
1° to 4° C.	100	43

With winter plant activated sludge the following rates expressed similarly were obtained in these experiments:

Aeration temperature	*Before conditioning*	*After conditioning for 3 days at 27° C.*
25° to 27° C.	29	123
1° to 4° C.	20	55

TABLE 10.—*Comparison of glucose removal ability of laboratory sludge conditioned at winter temperature and winter (plant) sludge conditioned at summer temperatures*

	Laboratory sludge conditioned at 1.0 to 10° C. Solids=3,010 p. p. m.		Experimental plant sludge conditioned at about 27° C. Solids=5,170 p. p. m.	
Aeration temperature	25° C.	4.0° C.	25° C.	4.0° C.[1]
Aeration time	Glucose removed, p. p. m.			
Initial after mixing	0	33	182	100
15 minutes	72	75	272	176
30 minutes	113	111	404	224
45 minutes	143	129	580	274
60 minutes	171	148	638	286
75 minutes	187	159	688	256
90 minutes	189	131	721	265
2 hours	194	139	790	323
3 hours	323	127	837	359
4 hours	515	183	894	450
5½ hours	654	288	([2])	458

[1] The aeration temperature in this portion slowly increased and reached 10° C. at the end of the 5½-hour period.
[2] Complete.

The above comparison shows that the first hour glucose removal rates for laboratory sludge were reduced almost to the rate for winter plant sludge after 5 days of winter temperature conditioning. The winter plant sludge, on the other hand, had its first hour glucose removal rate raised from 20 percent to 55 percent of the laboratory sludge rates at the low temperature and from 17 to 70 percent at 27° C. after 3 days' conditioning at laboratory temperatures. These experiments indicate the great influence of aeration temperature as a factor on the biological enzymic activity of the sludge.

EFFECT OF pH

The effect of pH upon glucose removal rates was determined by subjecting the activated sludge to the desired pH for a short time and then readjusting the sludge to about 7.2, adding 1,000 p. p. m. of glucose and completing the removal test as before. In one experiment four portions of sludge were taken, three of which were adjusted to pH 6, 5.1, and 2.8±0.2, respectively, with N/10 phosphoric acid and allowed to stand for 20 minutes. Then all portions were readjusted to the neutral point with N/10 sodium hydroxide, the glucose was added, and the test was run. The results are given in table 11. Lowering of the pH of the sludge to 5.1 for 20 minutes had practically no effect upon its glucose removal rate, while exposure to a pH of 2.8 for 20 minutes had a most destructive effect upon the glucose removal mechanism for the first 90 minutes. Thereafter this latter sludge began to recover. In 4 hours it had not removed as much glucose as the other sludges had in 30 minutes. After 23 hours, however, this sludge had apparently recovered for the glucose removal was complete.

TABLE 11.—*Effect of lowering the pH for 20 minutes upon glucose removal by activated sludge, at room temperature*

Sludge portion	A	B	C	D
pH to which sludge was subjected for 20 minutes	7.2	6.0	5.2	2.8
pH at start	7.2	7.2	7.2	7.0
Aeration time	**Glucose removed, p. p. m.**			
Initial after mixing	65	60	56	0
15 minutes	126	151	139	2
30 minutes	205	219	208	44
45 minutes	275	263	265	23
60 minutes	329	357	363	63
75 minutes	380	366	393	39
90 minutes	428	410	374	51
2 hours	510	490	471	95
3 hours	694	683	661	136
4 hours	836	817	796	183
23 hours	(1)	(1)	(1)	(1)

[1] Complete.

The effect of pH above the neutral point was determined in a similar experiment, the results of which are given in table 12. In this experiment N/10 sodium hydroxide was used to make the desired pH adjustment and after 30 minutes the pH of each sludge was readjusted to 7.1 with phosphoric acid. The results indicate that holding the sludge at a pH of 8.1 to 9.2 for 30 minutes stimulated rather than hindered glucose removal by the sludge. When the sludge was subjected to a pH of 11 for this period, however, the glucose removal rate was reduced.

In two additional experiments the pH of a number of portions of two activated sludges was adjusted to desired points, glucose was added, and the effect of aeration at various hydrogen ion concentrations upon glucose removal was determined. The results for points below neutral are given in table 13 and for points above neutral in table 14. The data indicated very little difference in glucose removal rates for the first 3 hours in the pH range from 5.8 to 7.2. After the first 3-hour period the sludge at a pH of 6.6 maintained the maximum removal rate, with the neutral sludge portion second and the sludge at pH 5.8 next. There was not much difference, however, in the rate obtained at any of the above pH values even after 3 hours. Portion D was aerated at pH 5.6 for 1½ hours and then readjusted to pH 5 and the aeration was continued. The data indicated that there was a decided reduction in glucose removal rates as the pH is decreased from 5.8 to 5 or lower. While 63 percent of the glucose had been removed in 9 hours at pH 5.8, only about 17 percent was removed at pH 5 during this time. At a pH of 3.9 there was apparently some glucose removal (about 126 p. p. m.) during the first 2 hours, but thereafter the glucose was apparently returned to solution. After 9 hours of aeration more than 97 percent of the glucose remained in solution and after 22½ hours about 80 percent still remained in solution. It must be concluded that at a pH of 5 the glucose removal mechanism of activated sludge is greatly impaired and at 3.9 it is practically destroyed.

TABLE 12.—*Effect of raising the pH for 30 minutes upon glucose removal by activated sludge, at room temperature*

Sludge portion	A	B	C	D
pH to which sludge was subjected for 30 minutes	7.2	8.1	9.2	11.0
pH at start	7.2	7.1	7.1	7.1
Aeration time	Glucose removed, p. p. m.			
Initial after mixing				
15 minutes	51	79	73	18
30 minutes	134	152	149	79
45 minutes	181	163	212	127
60 minutes	237	221	282	200
75 minutes	214	232	309	196
90 minutes	254	270	308	233
2 hours	323	331	372	278
3 hours	434	463	474	366
4 hours	507	514	541	423
21½ hours	995	987	991	991

TABLE 13.—*The effect of aeration of activated sludge at pH values below neutral upon glucose removal, at room temperature*

[Sludge solids 1,810 p. p. m.]

Sludge portion	A	B	C	D	E
pH at which sludge was aerated	7.2	6.6	5.8	5.0 [1]	3.9
Aeration time	Glucose removed, p. p. m.				
30 minutes	106	92	111	74	77
60 minutes	126	140	154	122	65
90 minutes	118	155	177	105	48
2 hours	246	231	226	173	126
3¼ hours	308	340	298	192	98
4 hours	369	404	328	116	45
5 hours	405	441	382	116	0
9 hours	733	806	626	167	28
22½ hours	([2])	([2])	([2])	412	200

[1] pH 5.6 for first 90 minutes.
[2] Complete.

TABLE 14.—*The effect of aeration of activated sludge at pH values above neutral upon glucose removal, at room temperature*

[Sludge solids 2,320 p. p. m.]

Sludge portion	A	B	C	D
pH at which sludge was aerated	7.0	8.1	9.6	11.5+
Aeration time	Glucose removed, p. p. m.			
30 minutes	3	31	63	69
60 minutes	123	117	66	134
90 minutes	171	168	133	152
2 hours	231	188	185	177
3½ hours	386	371	333	326
4¼ hours	433	408	362	311
5 hours	545	530	497	469
8 hours	831	808	804	715
22½ hours	[1]	[1]	[1]	[1]

[1] Complete.

The data in table 14 for pH values above 7 are not as conclusive as the low pH data. The glucose removal at pH values of 7, 8.1, 9.6, and 11.5+ are remarkably similar for the first 2-hour period. Beyond this aeration time there seems to be some slight reduction in the glucose removal values as the pH was increased. At the end of 8 hours the percentage of glucose removal was 83.1, 80.8, 80.4, and 71.5 at pH 7, 8.1, 9.6, and 11.5, respectively. As it seems reasonable to suppose that autocatalytic oxidation of glucose took place at the higher pH values, it is impossible to estimate without further investigation the extent of the damage to the common glucose removal mechanism of the sludge at these high pH values.

GLUCOSE REMOVAL RATES IN ABSENCE OF OXYGEN

The rate of glucose removal during intimate mixing of activated sludge and glucose substrate in the absence of dissolved oxygen was studied in several experiments. In one test, four equal portions of activated sludge were each given 1,000 p. p. m. of glucose using different methods of keeping the sludge particles and glucose substrate in intimate contact. One portion, A, was aerated in the ordinary way using about 4 to 5 cu. ft. of air per hour for 3 liters of aeration mixture. This method kept the mixture aerobic at all times and also intimately mixed the sludge particles with the substrate. The second portion, B, was stirred with a paddle sufficiently to keep the sludge particles in complete suspension and about as intimately mixed as the particles in portion A. Although a layer of oil was placed on the surface of the liquor, this layer tended to gather in the center of the rotating liquid surface so that there undoubtedly was some surface aeration in this portion. However, the surface aeration obtained in this way was very limited and was insufficient in view of the high oxygen demand of the sludge mixture to maintain aerobic conditions throughout the liquid. Portion C was agitated with nitrogen gas using about 4 to 5 cu. ft. per hour for a 3-liter volume of sludge mixture in the same way that air was used in portion A. The sludge particles were as intimately mixed with the substrate as in portion A, but in this case there was no opportunity for reaeration and the sludge liquor became devoid of oxygen within a few minutes after the start of the experiment. Portion D, which was rotated continuously end over end in a number of completely filled glass-stoppered bottles, also became devoid of oxygen within a few minutes after the start, but the sludge particles may not have been kept in such intimate contact with the glucose substrate because of the slow rotation employed (1 r..p. m).

The results given in table 15 show a very decided difference in the rate of glucose removal obtained with aeration and with other means of agitation in the absence of oxygen. In portion A, with dissolved oxygen maintained by aeration, all of the glucose was removed from solution in 2 hours. Without oxygen the rate of glucose removal was reduced within 15 minutes. After about 2 hours the rate of removal was further reduced to such an extent that about 141, 343, and 360 p. p. m. of glucose remained in solution after 22½ hours of agitation in portions B, C, and D, respectively. It is also interesting to note that in portions C and D, in which all possibility of obtaining dissolved oxygen by reaeration during the agitation was removed, the lowest rates of glucose removal were obtained, while in portion B, where some slight reoxygenation was possible, slightly higher rates of glucose removal were obtained. A repetition of this experiment produced similar results. After 24 hours of mixing, one of the portions agitated without oxygen still contained 254 p. p. m. of glucose. This portion was agitated for an additional hour without any further loss of glucose. It was then aerated for 1 hour and 64 p. p. m. of glucose were removed. These experiments suggest that the organisms in the activated sludge process which are responsible for the glucose removal and dissimilation behave as obligate aerobes. From this it may be inferred that the hydrogen activation in the glucose molecule in this reaction is such that only oxygen will act as a hydrogen acceptor. Or, if the theory holds that the oxygen is also activated, the predominant organisms in activated sludge require and activate oxygen for the completion of this reaction. In any case, the velocity of the glucose removal reaction under aeration and the reduction in velocity of the reaction in the absence of air indicate the importance of oxygen to the predominant organisms in this process and confirm both Smit's (*31*) and Heukelekian's (*22*) glucose removal data.

EFFECT OF PROLONGED REAERATION

The effect of prolonged reaeration, without feeding, of activated sludge upon glucose removal was investigated, and the results are given in table 16. These data indicate that prolonged reaeration, which is, in effect, starvation, steadily reduced the ability of the sludge to remove glucose at a rapid rate. The sludge of this experiment after 18 hours of reaeration removed 40 percent of the glucose feed in 5 hours, but after about 13 days of reaeration it removed only about 11 percent of the same glucose dose in the same time.

TABLE 15.—*Comparison of glucose removal by activated sludge using various methods for keeping the sludge particles and substrate in intimate contact*

Sludge portion	A	B	C	D
Means of keeping sludge and substrate in contact	Aeration with air	Stirring with paddle [1]	Agitation with nitrogen gas [2]	By mechanical rotation of completely [3] filled bottle
Aeration time				
Initial after mixing	48	82	68	24
15 minutes	300	179	121	87
30 minutes	439	221	150	134
45 minutes	552	303	211	239
60 minutes	635	336	283	314
90 minutes	868	374	355	392
2 hours	(4)	466	418	426
3 hours	----------	557	380	461
4 hours	----------	601	469	----------
4¾ hours	----------	614	----------	----------
22½ hours	----------	859	657	640

[1] The surface of this portion was covered with an oil film. Each sample was removed by siphoning to prevent reaeration during sampling.
[2] Nitrogen gas at the same rate as air in portion A was bubbled through an aerator ball.
[3] 1-liter bottles completely filled were turned over endwise continuously once each minute. A, B, and C were held at room temperature of about 24° C., while D was held at 20° C.
[4] Complete.

TABLE 16.—*Effect of reaeration upon the glucose removal ability of activated sludge*

Reaeration period without feed, hours	18	42	162	306
Sludge solids at start of glucose removal test	2,036	2,054	----------	1,832
Glucose feed, p. p. m.	750	750	750	750
Aeration time, glucose removal test	**Glucose removed, p. p. m.**			
30 minutes	58	33	21	22
60 minutes	80	46	13	11
90 minutes	----------	55	22	22
2 hours	95	12	39	23
3 hours	----------	47	93	30
3½ hours	198	----------	----------	----------
4 hours	----------	----------	105	63
4½ hours	----------	114	----------	----------
5 hours	297	----------	132	87
6 hours	----------	----------	----------	78
6½ hours	----------	283	211	----------

SUPPLEMENTAL FEEDING

Two experiments were carried out to determine the effect of feeding other materials with glucose, upon the glucose removal rate by activated sludge. The results obtained are presented in table 17. The first experiment indicates that the feeding of sewage with glucose increases slightly the rate of glucose removal by activated sludge. The results obtained when peptone was used as a supplemental feed were not as definite as the results with sewage, but this experiment seems to indicate that peptone certainly does not reduce the glucose removal rate and may increase it very slightly.

TABLE 17.—*Effect of supplemental feeding upon glucose removal by activated sludge*

Experiment	G 13		G 14	
Portion	Control	Supplemental feed	Control	Supplemental feed
Glucose feed, p. p. m.	440	470	445	475
Supplemental feed	0	Domestic sewage	0	Peptone solution (750 p. p. m.)
Aeration time	**Glucose removed, p. p. m.**			
Initial after mixing	51	110		
10 minutes	56	114	78	107
20 minutes	57	115	95	137
30 minutes	82	132	104	99
40 minutes	91	141	114	137
50 minutes	95	144	103	133
60 minutes	116	166	153	173
75 minutes	123	189	159	188
90 minutes	138	206	168	173
2 hours	166	253	202	232
3 hours	208	333	241	256
5 hours	352	430	348	365
23 hours	[1]	[1]	[1]	[1]

[1] Complete.

EFFECT OF REPEATED GLUCOSE FEEDING

After determining the glucose removal rate on a sample of activated sludge, two 8-liter portions of this sludge were treated as follows: One portion was dosed with domestic sewage daily for 9 days and then the glucose removal test was repeated. The second portion was dosed daily with the same sewage as the above portion, but fortified with 500 p. p. m. of glucose. This was continued for 7 days and the glucose removal test was repeated. The results obtained in this experiment are presented in table 18. The glucose removal rate for this sludge was improved slightly after dosing it daily for 9 days with sewage. However, after 1 week of daily treatment with sewage plus 500 p. p. m. of glucose, the glucose removal rate was so accelerated that the time for complete removal was reduced from about 3 hours to 30 minutes. The increase in the suspended solids obtained with glucose fortified sewage in this experiment is quite remarkable. During 9 days of sewage feeding, the quantity of sludge under aeration in the portion fed only with sewage increased by 620 p. p. m. If the proportionate increase of solids due to sewage for 7 days is deducted from the total solids increase in the glucose fortified sewage fed sludge, C, an increase of 2,220 p. p. m. of sludge due to glucose feeding is obtained. As 3,500 p. p. m. of glucose were fed during this interval, the sludge increase due to glucose represents 63 percent of the glucose weight recovered as sludge.

In another experiment, 2,000 p. p. m. of glucose were fed to activated sludge daily for 3 days and the rate of glucose removal was followed each day. The results obtained are given in table 19 and indicate that in this experiment the sludge was overloaded with respect to glucose. The rate of glucose removal fell upon the second and third feeding. While 86 percent of the glucose was removed in 23 hours in the first day, only 46 percent was removed on the third day in the same time. In this case, additional nitrogenous material in the form of sewage or peptone was not given with the glucose. It is probable that a better performance of the sludge with this quantity of glucose would have been obtained had this been done.

TABLE 18.—*Effect of repeated glucose feeding upon glucose removal by activated sludge using 500 p. p. m. of glucose per day*

Sludge portion	A	B	C
Description	Control (initial sludge)	Same as A except that it was dosed daily with sewage for 9 days	Same as B except that it was dosed daily with same sewage fortified with 500 p. p. m. of glucose for 7 days
Sludge solids change during treatment, p. p. m.:			
From		2,640	2,640
To		3,260	5,340
Sludge solids used in glucose removal test:			
Total suspended p. p. m	2,640	2,608	2,196
Volatile suspended p. p. m	1,684	1,608	1,724
Aeration time	**Glucose removed, p. p. m.**		
Initial after mixing	47	100	206
10 minutes	99	168	414
20 minutes	147	221	462
30 minutes	175	261	(1)
45 minutes	209	316	
60 minutes	228	360	
75 minutes	265	387	
90 minutes	295	436	
2 hours	356	448	
3 hours	458	(1)	

[1] Complete.

TABLE 19.—*Effect of feeding 2,000 p. p. m. of glucose daily upon glucose removal by activated sludge*

Aeration time	First day	Second day	Third day
	Suspended solids, p. p. m.		
Initial	2, 376	3, 344	4, 135
1 hour	2, 744	3, 451	4, 063
3 hours	2, 608	3, 512	
5 hours	2, 764	3, 570	
23 hours	3, 480	4, 145	4, 477
	Glucose removal, p. p. m.		
Initial	0		0
15 minutes	44	28	0
30 minutes	79	74	0
45 minutes	99	91	0
60 minutes	111	117	41
90 minutes	205	113	61
2¼ hours	297	120	88
3 hours	340	205	111
4 hours	497	284	135
5 hours	618	373	138
23 hours	1, 720	1, 176	928

EFFECT OF CHLORINATION

As chlorination is often recommended as a method of controlling or curing the activated sludge process when difficulties are encountered, one experiment to determine the effect of chlorination upon the glucose removal reaction was completed. In this experiment, the desired doses of chlorine, as H. T. H. solution, were added and after 15 minutes of contact any residual chlorine was neutralized with sodium sulfite solution. The glucose solution was then added and the glucose removal tests completed in the ordinary way. The data for this experiment are presented in table 20. It will be seen at once that the 15-minute contact period with 16 p. p. m. of chlorine in portion D practically destroyed the glucose removal mechanism and prevented the removal of glucose for 4 hours. Between the fourth and twenty-first hour of aeration, however, the sludge regained its power to remove glucose. A 6.2 p. p. m. dose of chlorine for 15 minutes also injured the glucose removal mechanism. With this dose only about 109 p. p. m., or 15.6 percent, of the glucose had been removed after 4 hours of aeration. When the values for glucose removal for portions A and B of table 20 are calculated in terms of p. p. m. of glucose removed per gram of sludge, it is found that 1.6 p. p. m. of chlorine affected the glucose removal very slightly. This experiment indicates that the quantity of chlorine that has been suggested by Smith and Purdy (*38*) to correct sludge bulking caused by fungus growths is not great enough to interfere seriously with the ordinary enzymic reactions such as are indicated by the glucose removal mechanism. However, chlorination of activated sludge is attended by the serious danger of overchlorinating. This would destroy not only the plankton growths, as pointed out by the above authors, but also the normal bacterial reactions of the sludge as shown in portion D, in the above experiment.

TABLE 20.—*Effect of chlorination upon glucose removal by activated sludge*

Sludge portion	A	B	C	D
Amount of chlorine, p. p. m., given for 15 minutes and then neutralized	0	1.6	6.2	16.0
Sludge solids, p. p. m	1,684	1,480	1,412	1,376
Glucose dose, p. p. m	700	700	700	700
Aeration time	**Glucose removed, p. p. m.**			
Initial after mixing	48	66	8	5
15 minutes	91	98	23	19
30 minutes	152	142	32	0
45 minutes	182	158	44	0
60 minutes	238	192	38	0
75 minutes	270	183	65	0
90 minutes	321	247	31	0
2 hours	380	284	80	0
3 hours	513	404	147	41
4 hours	613	493	109	0
21 hours	(1)	605	606	606

1 Complete.

SUMMARY AND CONCLUSIONS

The rates of removal of glucose from substrates by activated sludge have been investigated. Experimental data are presented to illustrate the rates of removal of glucose from substrates by normal activated sludge and by pure cultures of certain bacterial species found in activated sludge or domestic sewage. The effect of various factors such as temperature, pH, dissolved oxygen, supplemental feeding and acclimatization on these removal rates has been determined. It has been shown that glucose is removed from solution much more rapidly by activated sludge than by domestic sewage, pure cultures of *Bact. coli*, *Bact. aerogenes*, *Sphaerotilus natans*, or zoogleal sludge. The rate of glucose removal by activated sludge is a function of the quantity of sludge present and, after the first hour, the removal rate follows the Freundlich adsorption equation. A comparison of the rates of removal by activated sludge of glucose and of settled or synthetic sewage indicated that glucose is removed more slowly than the carbonaceous organic matter of settled sewage and more rapidly than the nitrogenous material of synthetic sewage. The zoogleal sludge, however, removed synthetic sewage at a higher rate than glucose.

Temperature studies showed that heating the sludge for 10 minutes at 35° C. did not affect the removal rate, 10 minutes at 45° C. reduced the rate for a considerable time, and 10 minutes at 55° C. practically destroyed the glucose removing mechanism of the sludge. The glucose removal rate roughly doubled for each 10° C. increase in aeration temperature from 0° to 35° C. Aeration temperatures over 45° C. were inimical to glucose removal by activated sludge. Aeration temperatures of the sludge previous to the addition of glucose also affected the glucose removal rate. Winter sludge dosed with glucose and aerated at 27° C. did not remove glucose at as rapid a rate as the summer sludge at this temperature. Summer sludge, to which glucose was added and then aerated at 1° C., removed glucose at higher rates than winter sludge similarly treated. Acclimatization of the sludges at either temperature tended to bring the glucose removal rate to normal for the aeration temperature employed.

Lowering the pH of the sludge for 20 minutes to 5.2 before the addition of glucose retarded glucose removal slightly, and lowering to pH 2.8 for the same time practically destroyed the glucose removing mechanism for several hours. Subjection of the sludge to a pH up to 11 for 30 minutes followed by neutralization had very little effect upon the glucose removal reaction. When activated sludge was aerated below a pH of about 6, the rate of glucose removal was reduced, and at a pH of 3.9 it was practically stopped. The experiments above pH 7 were not conclusive but apparently there was little if any reduction in the glucose removal rate when sludge was aerated at pH values up to 9.6.

The results show definitely that aeration was required to maintain the glucose removal rate. In samples in which the activated sludge was maintained in contact with the glucose substrate by stirring with a paddle, by agitation with nitrogen, or by mechanical rotation of a completely filled bottle, the glucose removal rate was very much reduced within a few minutes. The experiments indicate, however, that while oxygen was needed, the ratio of oxygen used to glucose removed was low.

When glucose was added to sewage or peptone and fed to sludge, these nitrogenous materials did not retard the glucose removal rate and possibly increased it slightly. When glucose alone was fed in large doses, the glucose removal mechanism of the sludge failed after several treatments. This indicated the deficiency of certain nutritive elements, probably nitrogen and phosphorus, for the continued maintenance of the process. When sewage containing glucose was fed regularly to activated sludge for a period of about a week, the rate of glucose removal was very much accelerated. Sludge acclimated in this way can remove 1,000 p. p. m. of glucose from solution in about 90 minutes. This acclimatization phenomenon may be explained upon the basis of a multiplication of certain special glucose removing micro-organisms in the sludge or by the development of adaptive glucose enzymes of the predominant bacteria of the sludge.

Starvation of the sludge by reaeration without additions of food steadily reduced the glucose removal rate. The effect of chlorination on activated sludge depended entirely upon the chlorine dose used. When a mixed liquor containing about 1,500 p. p. m. of suspended sludge solids was dosed with 1.6 p. p. m. of chlorine, the glucose removal reaction was only slightly affected. When the chlorine dose was increased to 6.2 p. p. m. a 75 percent reduction in the glucose removal rate was obtained, and with 15 p. p. m. of chlorine the glucose removal reaction was completely stopped for 4 hours.

The results of this study, using glucose as a representative of the large fraction of organic material present in true solution in sewage, indicate the probability of the rapid removal of such constituents from sewage by the purely biochemical processes in activated sludge and demonstrate the sensitivity of such processes to temperature, proper pH, balanced nutrients, starvation, chlorination, acclimatization, and oxygen depletion. Under the maintenance of proper conditions, such constituents can be removed at rates which compare favorably with the removal of material in suspension from sewage by activated sludge. The metabolism of the glucose removed from solution by the sludge will be considered in a following paper.

ACKNOWLEDGMENTS

Acknowledgment is made of the cooperation of Principal Bacteriologist C. T. Butterfield and Assistant Bacteriologist Elsie Wattie in

preparing the pure cultures of zoogleal sludges and to Cytologist James B. Lackey for the cultures of *Sphaerotilus natans* used in these studies.

REFERENCES

(*1*) Ruchhoft, C. C., Butterfield, C. T., McNamee, P. D., and Wattie, Elsie: Studies of sewage purification. IX. Total purification, oxidation, adsorption, and synthesis of nutrient substrates by activated sludge. Sewage Works J., **11**: 195 (1939). Also Pub. Health Rep., **54**: 468 (1939).

(*2*) Mills, E. V.: The determination of organic carbon in sewage. J. Soc. Chem. Ind., **50**: 375 T (1931).

(*3*) Mills, E. V.: The ultimate analysis of sewage. J. Soc. Chem. Ind., **51**: 205 T (1932).

(*4*) Calvert, H. T.: Report of the Water Pollution Research Board for the Year Ending 30th June, 1932, pp. 45–51.

(*5*) Kendall, Arthur Isaac: The Utilization of Carbohydrates by Bacteria, in The Newer Knowledge of Bacteriology and Immunology by Jordan and Falk. University of Chicago Press, Chicago, Ill., 1928. Page 232.

(*6*) Butterfield, C. T.: Studies of sewage purification. II. Zoogleal forming bacterium isolated from activated sludge. Pub. Health Rep., **50**: 671 (1935).

(*7*) Baly, E. C. C.: The mechanism of the activated sludge process of sewage disposal. J. Soc. Chem. Ind., **50**: 22–26 T (1931).

(*8*) Lumb, L.: Some notes on the mechanism of the activated sludge process. J. Inst. Sewage Purification, part I, 21–32 (1933). Also The Surveyor, **83**: 229 (1933).

(*9*) Theriault, E. J.: Studies of sewage purification. III. The clarification of sewage—a review. Pub. Health Rep., **50**: 1581–95 (1935). Sewage Works J., **7**: 377–91 (1935).

(*10*) Edwards, G. P.: A review of activated sludge theory. Sewage Works J., **7**: 17–22 (1935).

(*11*) Mohlman, F. W.: Twenty-five Years of Activated Sludge—Modern Sewage Disposal, p. 79. Published by Federation of Sewage Works Associations, New York, N. Y., 1938.

(*12*) Nesmehanoff, Dr. Ing.: The effect of iron and aluminum salts on the activated sludge process. Gesundheits-Ingenieur, **58**: 471 (1935).

(*13*) Theriault, E. J.: Activated sludge as a biozeolite. Ind. and Eng. Chem., **27**: 683 (1935).

(*14*) Theriault, E. J., and McNamee, P. D.: Adsorption by activated sludge. Ind. and Eng. Chem., **28**: 79 (1936).

(*15*) Theriault, E. J.: A biozeolytic theory of sewage purification. Ind. and Eng. Chem., **28**: 83 (1936).

(*16*) Buswell, A. M.: The biology of activated sludge—An historical review. Sewage Works J., **3**: 362–368 (1931).

(*17*) Dienert, F.: The clarification of liquids by bacteria. C. R. Acad. Sci., **200**: 1253 (1935). Water Pollution Research Summary Current Literature, Vol. 8, No. 623 (1935).

(*18*) Butterfield, C. T., and Wattie, Elsie: Studies of sewage purification. VIII. Observations on the effect of variations in the initial numbers of bacteria and of the dispersion of sludge flocs on the course of oxidation of organic material by bacteria in pure culture. Sewage Works J., **10**: 815 (1938), also Pub. Health Rep., **53**: 1912 (1938). (Reprint No. 1999.)

(*19*) Thaysen, A. C., and Galloway, L. G.: The Microbiology of Starch and Sugars. Oxford University Press, London, 1930. Pp. 78–91.

(*20*) Wieland, Henrich: On the Mechanism of Oxidation. Yale University Press. New Haven, Conn., 1932.

(*21*) Kluyver, A. J., and Donker, H. J. L.: The uniformity of the chemical mechanism of fermentative sugar dissimilation processes of microbes. Verlag. Akad. Wetenschappen Amsterdam, **33**: 895–914 (1924). Zeits d. Zelle and Gewebe, **13**: 134 (1926).

(*22*) Heukelekian, H.: Studies on the clarification stage of the activated sludge process. Sewage Works J., **8**: 873–87 (1936).

(*23*) Seiser, Adolf: Research on the mechanisms of the activated sludge process. Gesundheits-Ingenieur, **51**: 253, 273 (1928). Sewage Works J., **1**: 265 (1928–29).

(24) Morgan, E. H., and Beck, A. J.: Carbohydrate wastes stimulate growth of undesirable organisms in activated sludge. Sewage Works J., 1: 46 (1928–29).
(25) Ruchhoft, C. C., and Watkins, J. H.: Bacteriological isolation and study of the filamentous organisms in the activated sludge of the Des Plaines River Sewage Treatment Works. Sewage Works J., 1: 52 (1928–29).
(26) Pearse, L. (American Public Health Association Committee Report): Bulking of sludge in the activated sludge process of sewage treatment. Am. Pub. Health Assoc. Year Book, Vol. 27, No. 3, p. 164 (1936–37).
(27) Agersborg, H. P. K., and Hatfield, W. D.: The biology of a sewage treatment plant. A preliminary survey. Sewage Works J., 1: 411 (1928–29).
(28) Scott, Walter: Bulking of activated sludges: An investigation as to its cause. The Surveyor, 73: 345 (1928).
(29) Eldridge, E. F., and Robinson, G. H.: Studies of the activated sludge process. Bull. No. 46, Michigan Engineering Experiment Station (1932).
(30) Eldridge, E. F., Mallman, W. L., and Robinson, G. H.: The utilization of carbohydrates and proteins by activated sludge organisms. Bull. No. 6, Michigan Engineering Experiment Station (1934).
(31) Smit, Jan.: A study of the conditions favoring "bulking" of activated sludge. Sewage Works J., 4: 960 (1932).
(32) Smit, Jan.: Bulking of activated sludge. II. On the causative organisms. Sewage Works J., 6: 1041 (1934).
(33) Schmiedt, F.: The bulking of activated sludge. Tech. Gemeindeblatt, 35: 169 (1932).
(34) Schmiedt, F.: The aeration of sewage with and without activated sludge. Tech. Gemeindeblatt, 37: 205 (1934), also The Surveyor (London), 86: 361 (1934).
(35) Standard Methods of Water Analysis. 8th ed. Am. Pub. Health Assoc., New York, N. Y., 1936.
(36) Hassid, W. Z.: Determination of reducing sugars and sucrose in plant materials. Ind. and Eng. Chem., Anal. Ed., 8: 138 (1936).
(37) Hassid, W. Z.: Determination of sugars in plants. Ind. and Eng. Chem., Anal. Ed., 9: 228 (1937).
(38) Smith, Russell S., and Purdy, W. C.: The use of chlorine for the correction of sludge bulking in the activated sludge process. Sewage Works J., 8: 223 (1936).

NOTIFIABLE DISEASES IN THE UNITED STATES, 1938

Morbidity and Mortality Summaries for Certain Important Communicable Diseases

The United States Public Health Service has recently issued a tabular morbidity and mortality compilation, by States and by months, for the notifiable diseases as reported by the State health officers in 1938.[1] A summary of this compilation for several important communicable diseases is presented here, together with case and death rates, case fatality rates, and, in some instances, the estimated expectancy based on figures for recent prior years.

For certain diseases, some States do not report cases, or their case reports are manifestly incomplete. In such instances, groups of States with the most satisfactory morbidity reports are treated separately in order to arrive at more nearly accurate case and case-fatality rates, while the totals for the larger group of States include the deaths as cases in States which reported fewer cases than deaths. Case fatality rates are not computed, however, on such totals.

[1] The Notifiable Diseases—Prevalence in States, 1938. Supplement No. 160 to the Public Health Reports. The publication of this information has been held up because of the delay in securing reports from a few States.

The mortality figures may be considered as approximately correct, although they will not agree in all instances with the final figures of the Bureau of the Census.

The estimated expectancy, given for some of the diseases, represents an attempt to ascertain from the experience of recent years the number of cases of a disease that might normally have been expected in 1938. In comparing the numbers of cases reported in 1938 with the estimated expectancy, or with figures for prior years, it should be borne in mind that there has been a gradual improvement in the reporting of notifiable diseases and that the population has increased. A large increase, however, especially in the case rate, is quite likely to represent an actual increase in the prevalence of the disease.

The populations given for groups of States, used in computing case and death rates, are totals of estimates made for the individual States by the Public Health Service as of July 1, 1938, while the total population of the United States is the estimate of the Bureau of the Census.

CHICKENPOX (44A)*

48 States:[1]	
Cases reported, 1938 (population 130,215,000)	286,848
Estimated expectancy based on years 1931–37	253,886
Cases per 1,000 inhabitants, 1938	2.203
Cases per 1,000 inhabitants, estimated expectancy	2.005
Deaths registered, 1938	104
Deaths per 1,000 inhabitants, 1938	0.001
Cases reported for each death registered, 1938	2,758

DIPHTHERIA (10)

48 States:[1]	
Cases reported, 1938 (population 130,215,000)	30,508
Estimated expectancy based on years 1931–37	42,309
Cases per 1,000 inhabitants, 1938	0.234
Cases per 1,000 inhabitants, estimated expectancy	0.334
Deaths registered, 1938	2,560
Deaths per 1,000 inhabitants, 1938	0.020
Cases reported for each death registered, 1938	12

DYSENTERY (AMOEBIC) (13A)

28 States:[1]	
Cases reported, 1938 (population 97,375,000)	2,490
Cases per 1,000 inhabitants, 1938	0.026
Deaths registered, 1938	224
Deaths per 1,000 inhabitants, 1938	0.002
Cases reported for each death registered, 1938	11
35 States:[1]	
Cases reported, 1938 (population 120,281,000)	[2] 2,538
Deaths registered, 1938	272
Deaths per 1,000 inhabitants, 1938	0.002
47 States:[1]	
Deaths registered, 1938 (population 129,978,000)	274
Deaths per 1,000 inhabitants, 1938	0.002

DYSENTERY (BACILLARY) (13B)

30 States:	
Cases reported, 1938 (population 101,926,000)	20,382
Cases per 1,000 inhabitants, 1938	0.200
Deaths registered, 1938	966
Deaths per 1,000 inhabitants, 1938	0.009
Cases reported for each death registered, 1938	21
42 States:[1]	
Cases reported, 1938 (population 126,668,000)	[2] 20,644
Deaths registered, 1938	1,228
Deaths per 1,000 inhabitants, 1938	0.010
46 States:[1]	
Deaths registered, 1938 (population 128,086,000)	1,263
Deaths per 1,000 inhabitants, 1938	0.010

* Figures in parentheses in the subheadings are disease title numbers from the International List of Causes of Death, 1929.

[1] The District of Columbia is also included but not counted as a State.

[2] Includes the numbers of deaths used as cases when no cases are reported, or when the reported numbers of cases are less than the numbers of deaths.

ENCEPHALITIS, EPIDEMIC OR LETHARGIC (17)

30 States:	
Cases reported, 1938 (population 80,048,000)	983
Cases per 1,000 inhabitants, 1938	0.012
Deaths registered, 1938	467
Deaths per 1,000 inhabitants, 1938	0.006
Cases reported for each death registered, 1938	2.105
45 States:[1]	
Cases reported, 1938 (population 129,338,000)	[2] 1,303
Deaths registered, 1938	787
Deaths per 1,000 inhabitants, 1938	0.006
48 States:[1]	
Deaths registered, 1938 (population 130,215,000)	787
Deaths per 1,000 inhabitants, 1938	0.006

GONORRHEA (35)

48 States:[1]	
Cases reported, 1938 (population 130,215,000)	181,845
Cases per 1,000 inhabitants, 1938	1.396

INFLUENZA (11)

35 States:[1]	
Cases reported, 1938 (population 81,053,000)	128,736
Cases per 1,000 inhabitants, 1938	1.588
Deaths registered, 1938	12,568
Deaths per 1,000 inhabitants, 1938	0.155
Cases reported for each death registered, 1938	10.243
48 States:[1]	
Cases reported, 1938 (population 130,215,000)	[2] 132,954
Deaths registered, 1938	16,778
Deaths per 1,000 inhabitants, 1938	0.129

MALARIA (38)

36 States:	
Cases reported, 1938 (population 120,024,000)	84,204
Cases per 1,000 inhabitants, 1938	0.702
Deaths registered, 1938	2,305
Deaths per 1,000 inhabitants, 1938	0.019
Cases reported for each death registered, 1938	37
38 States:	
Cases reported, 1938	[2] 84,206
48 States:[1]	
Deaths registered, 1938 (population 130,215,000)	2,307
Deaths per 1,000 inhabitants, 1938	0.018

MEASLES (7)

48 States:[1]	
Cases reported, 1938 (population 130,215,000)	822,811
Cases per 1,000 inhabitants, 1938	6.319
Deaths registered, 1938	3,227
Deaths per 1,000 inhabitants, 1938	0.025
Cases reported for each death registered, 1938	255

MENINGITIS, MENINGOCOCCUS (18)

44 States:[1]	
Cases reported, 1938 (population 122,749,000)	2,788
Estimated expectancy based on years 1931–37	4,095
Cases per 1,000 inhabitants, 1938	0.023
Cases per 1,000 inhabitants, estimated expectancy	0.034
Deaths registered, 1938	960
Deaths per 1,000 inhabitants, 1938	0.008
Cases reported for each death registered, 1938	2.904
47 States:[1]	
Cases reported, 1938 (population 128,323,000)	[2] 2,919
Deaths registered, 1938	1,091
Deaths per 1,000 inhabitants, 1938	0.009
48 States:[1]	
Deaths registered, 1938 (population 130,215,000)	1,106
Deaths per 1,000 inhabitants, 1938	0.008

MUMPS (PART 44C)

44 States:	
Cases reported, 1938 (population 108,492,000)	152,749
Estimated expectancy based on years 1931–37	109,904
Cases per 1,000 inhabitants, 1938	1.408
Cases per 1,000 inhabitants, estimated expectancy	1.043
Deaths registered, 1938	57
Deaths per 1,000 inhabitants, 1938	0.0005
Cases reported for each death registered, 1938	2,680
47 States:[1]	
Cases reported, 1938	[2] 153,967
Deaths registered, 1938 (population 128,323,000)	68
Deaths per 1,000 inhabitants, 1938	0.0005

[1] The District of Columbia is also included but not counted as a State.

[2] Includes the numbers of deaths used as cases when no cases are reported, or when the reported numbers of cases are less than the numbers of deaths.

PELLAGRA (62)

21 States: [1]	
Cases reported, 1938 (population 55,325,000)	14,676
Cases per 1,000 inhabitants, 1938	0.265
Deaths registered, 1938	3,053
Deaths per 1,000 inhabitants, 1938	0.055
Cases reported for each death registered, 1938	4.807
37 States: [1]	
Cases reported, 1938 (population 124,731,000)	[2] 14,799
Deaths registered, 1938	3,176
Deaths per 1,000 inhabitants, 1938	0.025
48 States: [1]	
Deaths registered, 1938 (population 130,215,000)	3,176
Deaths per 1,000 inhabitants, 1938	0.024

PNEUMONIA (ALL FORMS) (107-109)

22 States: [1]	
Cases reported, 1938 (population 61,621,000)	96,927
Cases per 1,000 inhabitants, 1938	1.573
Deaths registered, 1938	41,885
Deaths per 1,000 inhabitants, 1938	0.680
Cases reported for each death registered, 1938	2.314
48 States: [1]	
Cases reported, 1938 (population 130,215,000)	[2] [3] 143,997
Deaths registered, 1938	87,867
Deaths per 1,000 inhabitants, 1938	0.675

POLIOMYELITIS (16)

47 States: [1]	
Cases reported, 1938 (population 130,113,000)	1,705
Estimated expectancy based on years 1931-37	4,553
Cases per 1,000 inhabitants, 1938	0.013
Cases per 1,000 inhabitants, estimated expectancy	0.036
Deaths registered, 1938	478
Deaths per 1,000 inhabitants, 1938	0.004
Cases reported for each death registered, 1938	3.567
48 States: [1]	
Deaths registered, 1938 (population 130,215,000)	478
Deaths per 1,000 inhabitants, 1938	0.004

SCARLET FEVER (8)

48 States: [1]	
Cases reported, 1938 (population 130,215,000)	189,631
Estimated expectancy based on years 1931-37	211,057
Cases per 1,000 inhabitants, 1938	1.456
Cases per 1,000 inhabitants, estimated expectancy	1.667
Deaths registered, 1938	1,216
Deaths per 1,000 inhabitants, 1938	0.009
Cases reported for each death registered, 1938	156

SEPTIC SORE THROAT (115A)

31 States:	
Cases reported, 1938 (population 79,007,000)	7,205
Cases per 1,000 inhabitants, 1938	0.091
Deaths registered, 1938	1,009
Deaths per 1,000 inhabitants, 1938	0.013
Cases reported for each death registered, 1938	7.141
46 States: [1]	
Cases reported, 1938	[2] 9,445
44 States: [1]	
Deaths registered, 1938 (population 112,586,000)	1,927
Deaths per 1,000 inhabitants, 1938	0.014

SMALLPOX (6)

48 States: [1]	
Cases reported, 1938 (population 130,215,000)	49,319
Estimated expectancy based on years 1931-37	7,300
Cases per 1,000 inhabitants, 1938	0.115
Cases per 1,000 inhabitants, estimated expectancy	0.058
Deaths registered, 1938	46
Deaths per 1,000 inhabitants, 1938	0.0004
Cases reported for each death registered, 1938	325

SYPHILIS (34)

48 States: [1]	
Cases reported, 1938 (population 130,215,000)	476,702
Cases per 1,000 inhabitants, 1938	3.661

TUBERCULOSIS (ALL FORMS) (23-32)

37 States:	
Cases reported, 1938 (population 106,136,000)	95,383
Cases per 1,000 inhabitants, 1938	0.899
Deaths registered, 1938	49,696
Deaths per 1,000 inhabitants, 1938	0.468
Cases reported for each death registered, 1938	1.919
44 States: [1]	
Cases reported, 1938	[2] 104,964
48 States: [1]	
Deaths registered, 1938 (population 130,215,000)	63,155
Deaths per 1,000 inhabitants, 1938	0.485

[1] The District of Columbia is also included but not counted as a State.

[2] Includes the numbers of deaths used as cases when no cases are reported, or when the reported numbers of cases are less than the numbers of deaths.

[3] Includes 4,296 cases of lobar pneumonia only, reported in Massachusetts.

TUBERCULOSIS (RESPIRATORY SYSTEM) (23)

19 States:	
Cases reported, 1938 (population 51,673,000)	47,107
Cases per 1,000 inhabitants, 1938	0.912
Deaths registered, 1938	23,000
Deaths per 1,000 inhabitants, 1938	0.445
Cases reported for each death registered, 1938	2.048
47 States: [1]	
Cases reported, 1938 (population 129,797,000)	[2] 80,899
Deaths registered, 1938	56,792
Deaths per 1,000 inhabitants, 1938	0.438

TYPHOID FEVER (1) AND PARATYPHOID FEVER (2)

48 States: [1]	
Cases reported, 1938 (population 130,215,000)	14,903
Estimated expectancy based on years 1931-37	20,282
Cases per 1,000 inhabitants, 1938	0.114
Cases per 1,000 inhabitants, estimated expectancy	0.160
Deaths registered, 1938	2,397
Deaths per 1,000 inhabitants, 1938	0.018
Cases reported for each death registered, 1938	6.217

WHOOPING COUGH (9)

48 States: [1]	
Cases reported, 1938 (population 130,215,000)	227,319
Estimated expectancy based on years 1931-37	189,549
Cases per 1,000 inhabitants, 1938	1.746
Cases per 1,000 inhabitants, estimated expectancy	1.497
Deaths registered, 1938	4,729
Deaths per 1,000 inhabitants, 1938	0.036
Cases reported for each death registered, 1938	48

[1] The District of Columbia is also included but not counted as a state.
[2] Includes the numbers of deaths used as cases when no cases are reported, or when the reported number of cases are less than the number of deaths.

Cases reported, 1938, by months

Disease	Number of States [1]	January	February	March	April	May	June	July	August	September	October	November	December	Total
Anthrax in man (20)	20	7	4	3	2	3	2	6	5	8	5	4	5	[2] 54
Chickenpox (44a)	48	44,133	39,840	44,793	34,205	25,522	19,425	6,015	1,954	2,448	11,726	24,852	31,935	286,848
Dengue (part 44c)	8	39	42	13	15	12	34	35	14	12	24	9	11	[2] 260
Diphtheria (10)	48	3,032	2,491	2,198	1,713	1,427	1,312	1,343	1,752	2,847	4,980	4,061	3,352	30,508
Dysentery (amoebic) (13a)	35	98	136	147	185	237	294	295	284	217	229	201	185	[2] 2,538
Dysentery (bacillary) (13b)	42	501	410	426	1,028	3,168	4,631	3,388	2,733	1,847	1,033	848	631	[2] 20,644
Dysentery (unspecified)	5	45	32	37	55	32	49	82	78	108	48	57	50	[3] 674
Encephalitis, epidemic or lethargic (17)	45	73	84	84	83	74	83	93	181	271	113	73	91	[2] 1,303
Influenza (11)	48	26,848	26,480	16,724	10,318	5,318	3,525	3,101	3,233	4,333	7,227	8,991	16,790	[2] [3] 132,954
Malaria (38)	38	1,863	1,917	2,490	4,008	6,014	8,898	11,704	14,663	14,521	10,957	4,734	2,437	[2] 84,206
Measles (7)	48	89,459	142,318	196,351	156,717	106,969	66,961	17,320	4,764	2,824	5,386	11,138	22,595	[3] 822,811
Meningitis meningococcus (18)	47	403	384	366	312	250	216	160	162	140	170	146	210	[2] 2,919
Mumps (part 44c)	47	18,549	20,462	28,141	23,186	17,821	12,805	4,998	2,867	2,574	4,569	7,538	10,457	[2] 153,967
Pellagra (62)	37	578	639	1,016	1,288	1,956	2,478	2,210	1,403	1,051	892	696	592	[2] 14,799
Pneumonia (all forms) (107-109)	48	21,104	19,173	18,569	14,599	10,416	8,854	5,533	4,857	5,640	8,780	10,366	15,723	[2] [3] [4] 143,997
Poliomyelitis (16)	47	102	87	90	69	66	129	199	334	261	178	91	99	1,705
Rabies in animals	28	620	532	676	629	620	584	470	439	366	457	520	512	[5] 6,425
Rabies in man (deaths) (21)	48	5	7	5	8	9	2	4	9	3	9	4	6	71
Rocky Mountain spotted fever (part 44c)	32	2	....	4	26	63	88	118	71	26	14	6	6	[3] 434
Scarlet fever (8)	48	26,054	24,970	28,433	22,829	17,596	10,932	4,634	3,375	5,541	12,010	14,640	18,617	189,631
Septic sore throat (115a)	46	1,002	861	1,150	1,019	828	629	580	615	514	638	735	874	[2] 9,445
Smallpox (6)	48	2,707	2,324	2,184	2,174	1,546	1,320	689	224	187	234	438	912	14,939
Tuberculosis (all forms) (23-32)	44	8,072	7,773	9,623	9,556	9,316	9,685	9,406	8,885	8,278	8,346	7,728	8,296	[2] 104,964
Tuberculosis (respiratory system) (23)	47	6,692	6,120	7,470	7,334	7,166	7,611	6,750	6,861	6,262	6,373	6,118	6,142	[2] 80,899
Tularaemia (part 44c)	40	140	51	66	72	70	91	96	65	55	42	203	1,137	2,088
Typhoid fever and paratyphoid fever (1) (2)	48	524	526	563	623	814	1,465	2,351	2,678	2,288	1,529	902	638	[3] 14,903
Typhus fever (3)	21	129	76	65	64	110	152	270	290	296	313	237	231	[3] 2,294
Undulant fever (5)	47	252	310	328	340	357	386	458	392	418	488	320	330	4,379
Venereal diseases:														
Gonorrhea (35)	48	14,829	14,534	15,435	14,672	12,886	14,847	15,555	16,769	16,926	16,922	14,653	13,817	181,845
Syphilis (34)	48	32,903	35,444	42,871	46,492	35,956	40,120	39,225	41,014	40,170	45,155	40,104	37,248	476,702
Whooping cough (9)	48	18,457	17,498	21,272	21,668	21,311	21,414	21,654	19,866	14,823	14,128	17,268	17,960	227,319

[1] The District of Columbia is also included but not counted as a State.
[2] Includes the numbers of deaths used as cases when no cases are reported, or when the reported numbers of cases are less than the numbers of deaths.
[3] The following numbers of cases of certain diseases are not distributed by months but are included in the totals of the above table: Dysentery (unspecified) 1; influenza, 66; measles, 6; pneumonia (all forms), 383; Rocky Mountain spotted fever, 10; typhoid and paratyphoid fever, 2; typhus fever, 61.
[4] Includes 4,296 cases of lobar pneumonia only reported in Massachusetts.
[5] Exclusive of New York City.

NOTE.—Figures in parentheses are disease title numbers from the International List of Causes of Death, 1929.

Deaths registered, 1938, by months

Disease	Number of States [1]	January	February	March	April	May	June	July	August	September	October	November	December	Total
Anthrax in man (20)	48			1	1	2		2	1	1			2	10
Chickenpox (44a)	48	13	10	18	11	6	9	2	3	2	6	14	10	104
Dengue (part 44c)	48	1	1			1	3	3	1	1				11
Diphtheria (10)	48	275	210	172	125	116	87	111	129	239	367	399	326	[2] 2,560
Dysentery (amoebic) (13a)	47	23	12	20	15	25	28	34	37	25	18	16	21	[3] 274
Dysentery (bacillary) (13b)	46	30	23	27	60	140	265	179	171	151	108	70	39	[3] 1,263
Encephalitis, epidemic or lethargic (17)	48	64	61	63	60	73	61	60	81	102	59	49	54	787
Influenza (11)	48	3,035	2,683	2,515	1,471	1,005	525	438	435	495	922	1,173	2,015	[2] 16,778
Malaria (38)	48	79	54	82	100	135	182	304	389	367	332	172	111	2,307
Measles (7)	48	250	436	716	666	521	279	140	52	32	21	35	75	[2] 3,227
Meningitis, meningococcus (18)	48	162	145	130	104	87	73	59	57	52	74	82	80	[2] 1,106
Mumps (part 44c)	47	7	9	6	9	7	6	7	3	6	1	3	3	[2] 68
Pellagra (62)	48	223	222	241	259	302	372	342	273	235	234	227	246	3,176
Pneumonia (all forms) (107-109)	48	12,742	10,894	10,855	8,433	6,248	4,457	3,481	3,447	4,070	5,754	6,844	10,259	[2] 87,867
Poliomyelitis (16)	48	44	34	37	37	34	38	44	45	51	32	41	41	478
Rabies in man (21)	48	5	7	5	8	9	2	4	9	3	9	4	6	71
Rocky Mountain spotted fever (part 44c)	48			1	8	14	21	28	23	7	1	1		104
Scarlet fever (8)	48	184	160	169	140	95	61	42	48	48	76	84	104	[2] 1,216
Septic sore throat (115a)	45	181	175	183	183	190	141	137	132	127	138	152	185	1,924
Smallpox (6)	48	9	3	5	5	8	8	4			2		2	46
Tuberculosis (all forms) (23-32)	48	5,595	5,158	5,757	5,772	5,736	5,243	5,307	4,970	4,790	4,964	4,725	4,990	[2] 63,155
Tuberculosis (respiratory system) (23)	47	5,069	4,647	5,210	5,147	5,111	4,784	4,704	4,441	4,280	4,491	4,302	4,476	[2] 56,792
Tularaemia (part 44c)	48	11	4	1	5	7	7	6	3	3	2	24	66	139
Typhoid fever and paratyphoid fever (1) (2)	48	129	101	119	107	157	227	323	367	316	267	144	135	[2] 2,397
Typhus fever (3)	48	6	3	6	5	12	12	28	10	16	20	10	9	137
Undulant fever (5)	48	12	5	9	5	13	4	11	16	13	15	5	10	118
Whooping cough (9)	48	324	425	485	504	533	481	485	347	331	276	261	264	[2] 4,729

[1] The District of Columbia is also included but not counted as a State.

[2] The following numbers of deaths from certain diseases are not distributed by months but are included in the totals of the above table: Diphtheria, 4; influenza, 66; measles, 4; meningitis, meningococcus, 1; mumps, 1; pneumonia (all forms), 383; scarlet fever, 5; tuberculosis (all forms), 148; tuberculosis (respiratory system), 130; typhoid fever and paratyphoid fever, 5; whooping cough, 13.

[3] Exclusive of 25 deaths from dysentery, unspecified, reported as follows: New Hampshire, 1; Pennsylvania, 23; Wyoming, 1.

NOTE.—Figures in parentheses are disease title numbers from the International List of Causes of Death, 1929.

THE FIRST UNITED STATES CENSUS OF HOUSING

The first comprehensive data on housing in the United States will be secured in conjunction with the 1940 census which is to be conducted by the United States Bureau of the Census in April of this year.

In view of the intimate relationship between housing conditions and health, the information covering the entire country that will be made available by this part of the coming census will be of great value to health departments and social workers as well as to housing authorities, other governmental agencies, and commercial interests. By correlating the data secured in this census with information regarding sickness and death and with the incidence of specific diseases, the relationship between conditions of housing and health can be better established and the housing program more definitely determined with respect to human needs.

There are 31 questions on housing to be asked by the enumerators. These questions fall under 4 general headings, as follows:

1. Characteristics of structures in which the dwelling unit is located.
2. Characteristics of dwelling units.
3. Characteristics of occupied dwelling unit.
4. Mortgage characteristics of owner-occupied nonfarm 1- to 4-family structures.

The first three of these headings will contain questions which will provide information of especial interest to health and social workers, such as physical condition of structure and number of dwelling units contained, number of rooms, number of persons in household, water supply, toilet and bathing facilities, lighting, heating, and refrigeration.

The Senate Committee on Education and Labor of the United States Housing Act sums up the estimated extent of the housing problem in the United States by the following statement:

> It is now a matter of general agreement that even before the depression commenced over 10,000,000 families in America, or more than 40,000,000 people, were subjected to housing conditions that did not adequately protect their health and safety.

This quest for information that will be most helpful in disease prevention as well as in all human betterment programs deserves the unqualified support of all health and social agencies as well as of all individuals. Health departments and housing authorities may help in securing this aid and cooperation through educational publicity. The concerns and programs of these agencies meet on a common basis in the need for full information regarding housing conditions that affect adversely the health, lives, and comfort of the people of the United States.

DEATHS DURING WEEK ENDED FEBRUARY 17, 1940

[From the Weekly Health Index, issued by the Bureau of the Census, Department of Commerce]

	Week ended Feb. 17, 1940	Corresponding week, 1939
Data from 88 large cities of the United States:		
Total deaths	9,751	9,939
Average for 3 prior years	9,744	
Total deaths, first 7 weeks of year	67,941	65,444
Deaths under 1 year of age	534	580
Average for 3 prior years	587	
Deaths under 1 year of age, first 7 weeks of year	3,843	3,844
Data from industrial insurance companies:		
Policies in force	66,256,632	68,049,622
Number of death claims	12,586	11,890
Death claims per 1,000 policies in force, annual rate	9.9	9.1
Death claims per 1,000 policies, first 7 weeks of year, annual rate	10.4	10.1

PREVALENCE OF DISEASE

No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

UNITED STATES

REPORTS FROM STATES FOR WEEK ENDED MARCH 2, 1940

Summary

The decline in influenza continued, with 11,533 cases reported for the current week as compared with 13,950 cases for the preceding week. The figures for the current week do not include a cumulative delayed report of 10,035 cases which the State health officer of Indiana reported to have occurred in Madison County since the first of the year and not previously recorded. It was stated that there had been an outbreak in that county, during which the schools in some localities had been temporarily closed. The distribution of these cases by weeks is not available.

All geographic areas which have been reporting a considerable number of cases, except the East North Central States, showed a decline. The increase of 208 cases in that group of States was accounted for entirely by the increase in Ohio, which reported 253 cases for the current week.

All the other 8 important communicable diseases included in the weekly telegraphic reports were below the median expectancy, based on reports for the 5-year period 1935–39. For the first time in 1940 the weekly number of cases of poliomyelitis dropped below the 5-year median. The cumulated totals for the first 9 weeks of this year are well below the median 5-year totals for the corresponding period for all 9 diseases except influenza and poliomyelitis. The current 8 weeks' total for measles is less than half, for meningitis about one-third, for smallpox about one-fourth, and for typhoid fever a little more than half the 5-year median.

For the current week, 23 cases of endemic typhus fever were reported, 9 of which occurred in Georgia.

Telegraphic morbidity reports from State health officers for the week ended March 2, 1940, and comparison with corresponding week of 1939 and 5-year median

In these tables a zero indicates a definite report, while leaders imply that, although none were reported, cases may have occurred.

Division and State	Diphtheria			Influenza			Measles			Meningitis, meningococcus		
	Week ended		Median, 1935–39	Week ended		Median, 1935–39	Week ended		Median, 1935–39	Week ended		Median, 1935–39
	Mar. 2, 1940	Mar. 4, 1939		Mar. 2, 1940	Mar. 4, 1939		Mar. 2, 1940	Mar. 4, 1939		Mar. 2, 1940	Mar. 4, 1939	
NEW ENG.												
Maine	1	6	2	3	46	15	336	10	165	0	0	0
New Hampshire	0	0	0				23	9	13	0	0	0
Vermont	0	0	1	------	------	------	11	23	23	0	0	0
Massachusetts	3	5	5	------	------	------	329	1,061	916	4	2	3
Rhode Island	0	0	1	------	------	------	183	14	43	0	0	0
Connecticut	4	0	4	7	30	21	150	490	490	0	0	1
MID. ATL.												
New York	18	23	34	[1] 68	[1] 91	[1] 56	468	1,224	1,848	1	6	13
New Jersey	7	10	14	29	24	29	73	45	842	1	0	3
Pennsylvania	28	38	41	------	------	------	254	182	797	12	6	6
E. NO. CEN.												
Ohio	12	48	35	253	------	103	28	31	421	3	3	9
Indiana [2]	12	17	27	52	607	89	23	23	40	1	0	1
Illinois	18	32	41	52	1,241	71	30	23	32	2	1	7
Michigan [3]	1	12	12	20	429	10	213	320	320	1	0	2
Wisconsin	5	0	2	173	584	120	233	1,086	1,086	0	0	2
W. NO. CEN.												
Minnesota	8	3	3	3	12	5	253	1,120	289	0	0	2
Iowa	3	4	5	65	1,083	27	309	192	54	0	0	1
Missouri	19	25	20	32	644	382	54	14	20	1	2	3
North Dakota	2	0	1	44	364	12	11	215	8	0	0	0
South Dakota	1	4	2	1	77	2	0	280	3	0	0	1
Nebraska	0	0	8	------	2	------	49	42	29	0	1	2
Kansas	5	1	13	41	116	32	639	10	12	0	1	2
SO. ATL.												
Delaware	0	2	2	------	------	------	1	0	26	0	0	0
Maryland [3]	4	5	9	55	124	72	2	1,077	146	1	0	4
Dist. of Col	7	7	7	4	25	3	2	19	19	0	2	2
Virginia	12	16	16	1,696	1,509	------	30	252	252	0	0	5
West Virginia [3]	8	7	12	1,500	271	236	9	13	38	1	0	2
North Carolina [4]	13	14	19	52	97	174	183	1,563	787	2	2	5
South Carolina	5	12	6	945	1,181	1,181	6	27	33	0	1	1
Georgia [4]	13	2	6	590	140	304	94	153	------	3	0	1
Florida	10	5	5	9	9	33	68	188	102	0	0	2
E. SO. CEN.												
Kentucky	8	7	15	107	1,348	117	32	56	121	1	3	6
Tennessee [4]	4	8	10	231	146	175	78	80	52	2	1	6
Alabama [5]	6	8	15	528	599	889	224	228	228	1	1	2
Mississippi [3]	8	4	4	------	------	------	------	------	------	0	0	0
W. SO. CEN.												
Arkansas	2	7	3	838	1,473	184	17	76	58	0	0	0
Louisiana [4]	3	8	14	194	30	37	12	183	51	3	0	1
Oklahoma	6	9	10	443	334	256	3	148	54	0	0	2
Texas [4]	23	40	45	2,547	965	897	465	330	418	1	4	5
MOUNTAIN												
Montana	0	0	1	4	126	45	22	363	62	0	0	1
Idaho	0	1	0	1	1	3	96	79	28	0	0	0
Wyoming	0	6	0	------	1	------	57	119	17	1	0	0
Colorado	7	3	8	25	150	------	25	98	98	0	1	1
New Mexico	0	1	5	2	57	30	4	38	38	0	0	1
Arizona	3	5	5	280	144	144	25	31	31	0	2	1
Utah [3]	3	1	1	17	53	------	341	130	24	0	0	0
PACIFIC												
Washington	0	4	4	4	8	4	776	352	132	1	0	1
Oregon	8	1	1	38	97	109	446	60	60	0	0	0
California	21	45	33	680	50	202	462	3,845	564	1	5	5
Total	321	456	548	11,533	14,288	11,515	7,149	15,922	15,922	44	44	154
9 weeks	[6] 3,716	4,939	5,803	[6] 124,174	51,047	51,047	44,809	106,124	106,124	351	481	987

See footnotes at end of table.

Telegraphic morbidity reports from State health officers for the week ended March 2, 1940, and comparison with corresponding week of 1939 and 5-year median—Con.

Division and State	Poliomyelitis			Scarlet fever			Smallpox			Typhoid and paratyphoid fever		
	Week ended		Median, 1935–39	Week ended		Median, 1935–39	Week ended		Median, 1935–39	Week ended		Median, 1935–39
	Mar. 2, 1940	Mar. 4, 1939		Mar. 2, 1940	Mar. 4, 1939		Mar. 2, 1940	Mar. 4, 1939		Mar. 2, 1940	Mar. 4, 1939	
NEW ENG.												
Maine	0	0	0	3	27	21	0	0	0	0	1	1
New Hampshire	0	0	0	3	4	13	0	0	0	0	0	0
Vermont	0	0	0	2	9	13	0	0	0	0	0	1
Massachusetts	0	0	0	135	229	229	0	0	0	1	0	1
Rhode Island	0	0	0	15	12	18	0	0	0	0	0	0
Connecticut	0	0	0	82	98	90	0	0	0	1	0	0
MID. ATL.												
New York	2	1	1	835	638	948	0	0	0	1	5	5
New Jersey	0	0	0	425	196	196	0	0	0	0	2	2
Pennsylvania	0	1	1	389	404	608	0	0	0	9	4	3
E. NO. CEN.												
Ohio	1	0	0	436	646	491	1	22	3	3	2	2
Indiana [3]	0	1	1	168	204	246	1	86	4	1	2	3
Illinois	1	1	1	703	516	707	4	15	12	3	1	2
Michigan [3]	0	0	0	414	469	469	4	13	1	1	1	1
Wisconsin	3	0	0	136	293	333	13	5	9	0	0	0
W. NO. CEN.												
Minnesota	0	0	0	118	111	149	5	12	12	0	0	0
Iowa	0	0	0	65	126	126	4	37	20	1	0	0
Missouri	0	0	0	101	125	219	4	6	17	7	1	2
North Dakota	0	0	0	17	15	50	0	3	8	0	0	0
South Dakota	0	0	0	14	23	24	0	11	11	0	0	0
Nebraska	0	0	0	19	41	66	0	14	14	0	0	0
Kansas	0	0	0	83	154	217	2	4	28	0	0	0
SO. ATL.												
Delaware	0	0	0	7	0	10	0	0	0	0	0	0
Maryland [3]	0	0	0	43	47	73	0	0	0	2	0	2
Dist. of Col.	0	0	0	26	20	25	0	0	0	0	1	0
Virginia	0	0	1	32	40	40	0	0	0	1	8	2
West Virginia [3]	0	2	0	53	40	45	1	0	0	0	6	3
North Carolina [4]	0	0	1	45	32	37	1	0	0	0	3	1
South Carolina	1	0	0	1	5	5	1	0	0	1	1	1
Georgia [4]	0	0	0	25	13	7	0	0	1	1	4	3
Florida	0	0	0	13	18	5	0	0	0	1	6	2
E. SO. CEN.												
Kentucky	0	0	0	88	68	68	0	4	0	2	5	5
Tennessee [4]	0	0	0	77	53	28	4	7	0	4	0	1
Alabama [5]	0	1	1	18	21	15	0	0	0	1	1	2
Mississippi [3]	1	0	0	8	7	9	0	0	0	0	3	1
W. SO. CEN.												
Arkansas	0	0	0	6	9	9	2	1	1	0	1	1
Louisiana [4]	0	1	0	11	6	11	0	0	1	1	54	7
Oklahoma	0	0	0	13	45	39	1	55	8	1	1	2
Texas [4]	2	0	1	67	89	89	5	25	7	5	20	7
MOUNTAIN												
Montana	0	0	0	33	27	31	0	3	8	0	0	0
Idaho	0	1	1	20	18	18	0	16	4	0	1	0
Wyoming	0	0	0	6	2	37	0	0	1	1	1	0
Colorado	0	0	0	66	24	73	11	0	2	1	2	2
New Mexico		1	0	17	27	27	1	0	0	0	4	4
Arizona	0	0	0	14	10	10	1	6	0	1	0	0
Utah [3]	0	0	0	24	42	54	0	0	0	0	0	0
PACIFIC												
Washington	0	0	0	64	63	63	0	4	11	2	2	1
Oregon	0	0	0	32	47	47	1	9	9	0	0	0
California	4	2	3	175	285	285	0	38	12	0	3	8
Total	15	12	18	5,147	5,398	7,153	67	396	293	53	146	100
9 weeks	275	145	192	[5] 40,913	48,148	57,724	640	3,597	2,657	674	1,037	1,037

See footnotes at end of table.

Telegraphic morbidity reports from State health officers for the week ended March 2, 1940, and comparison with corresponding week of 1939 and 5-year median—Con.

Division and State	Whooping cough	
	Week ended	
	Mar. 2, 1940	Mar. 4, 1939
NEW ENG.		
Maine	46	64
New Hampshire	0	0
Vermont	70	35
Massachusetts	119	229
Rhode Island	19	96
Connecticut	63	77
MID. ATL.		
New York	492	491
New Jersey	84	578
Pennsylvania	341	282
E. NO. CEN.		
Ohio	156	159
Indiana	33	14
Illinois	110	269
Michigan [3]	153	206
Wisconsin	130	273
W. NO. CEN.		
Minnesota	28	35
Iowa	7	19
Missouri	11	48
North Dakota	13	13
South Dakota	1	6
Nebraska	4	3
Kansas	36	22
SO. ATL.		
Delaware	8	2
Maryland [3]	207	23
Dist. of Col	6	17
Virginia	45	67
West Virginia [3]	42	24
North Carolina [4]	138	211
SO. ATL.—continued		
South Carolina	22	106
Georgia [4]	11	12
Florida	4	31
E. SO. CEN.		
Kentucky	52	10
Tennessee [4]	31	41
Alabama [5]	12	51
Mississippi [3]		
W. SO. CEN.		
Arkansas	1	17
Louisiana [4]	28	1
Oklahoma	5	6
Texas [4]	154	96
MOUNTAIN		
Montana	10	7
Idaho	8	0
Wyoming	12	1
Colorado	11	35
New Mexico	71	45
Arizona	23	19
Utah [3]	117	51
PACIFIC		
Washington	24	32
Oregon	44	13
California	167	162
Total	3,174	3,999
9 weeks	25,267	38,184

[1] New York City only.
[2] An estimate has been reported of approximately 10,000 additional cases of influenza in Madison County since about the first of the year.
[3] Period ended earlier than Saturday.
[4] Typhus fever, week ended Mar. 2, 1940, 23 cases, as follows: North Carolina, 2; South Carolina, 1; Georgia, 9; Tennessee, 3; Louisiana, 1; Texas, 7.
[5] Later information increases to 8, 9[illegible]2, and 15, respectively, the reported cases of diphtheria, influenza, and scarlet fever in Alabama for the week ended Feb. 17, 1940. See PUBLIC HEALTH REPORTS, Feb. 23, 1940, pp. 335 and 336.

WEEKLY REPORTS FROM CITIES

City reports for week ended February 17, 1940

This table summarizes the reports received weekly from a selected list of 140 cities for the purpose of showing a cross section of the current urban incidence of the communicable diseases listed in the table.

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Data for 90 cities:											
5-year average	176	1,124	146	5,558	975	2,091	36	398	18	1,137	-------
Current week	96	1,090	135	1,245	769	1,584	1	360	13	667	-------
Maine:											
Portland	0	------	0	12	3	0	0	0	0	9	26
New Hampshire:											
Concord	0	------	0	0	1	0	0	0	0	0	9
Manchester	0	------	1	0	0	1	0	0	0	0	22
Nashua	0	------	0	54	0	1	0	0	0	0	5
Vermont:											
Barre	0	------	------	1	------	0	0	------	0	0	-------
Burlington	0	------	0	1	0	1	0	0	0	3	7
Rutland	0	------	0	0	1	0	0	0	0	0	8
Massachusetts:											
Boston	0	------	2	12	19	37	0	7	0	30	228
Fall River	.	------	0	14	3	1	0	1	0	9	37
Springfield	0	------	0	3	2	5	0	1	0	5	33
Worcester	1	------	0	2	19	18	0	1	0	0	58
Rhode Island:											
Pawtucket	0	------	0	1	0	0	0	0	0	0	13
Providence	0	------	0	91	0	8	0	1	0	8	51
Connecticut:											
Bridgeport	0	------	0	0	3	1	0	1	0	0	35
Hartford	0	2	0	1	3	6	0	0	0	9	43
New Haven	0	------	2	0	2	2	0	0	0	1	41
New York:											
Buffalo	1	------	0	1	13	25	0	5	0	10	133
New York	28	43	10	61	95	456	0	76	0	84	1,620
Rochester	0	3	0	1	3	8	0	0	0	3	69
Syracuse	0	------	0	0	3	6	0	1	0	8	49
New Jersey:											
Camden	1	1	1	0	5	9	0	0	0	0	37
Newark	0	7	0	10	10	15	0	2	0	17	102
Trenton	0	------	0	0	5	7	0	1	0	0	41
Pennsylvania:											
Philadelphia	4	18	8	15	44	69	0	28	2	69	617
Pittsburgh	3	14	10	1	33	38	0	9	0	9	222
Reading	0	------	0	1	5	1	0	0	0	4	36
Scranton	1	------	------	0	------	3	0	------	0	1	-------
Ohio:											
Cincinnati	2	2	6	1	8	14	0	4	0	10	146
Cleveland	1	98	0	5	8	40	0	9	1	19	195
Columbus	2	3	3	2	6	2	0	1	0	1	107
Toledo	0	1	1	1	3	13	0	4	0	6	81
Indiana:											
Anderson	0	------	1	0	2	0	0	0	0	3	11
Fort Wayne	0	------	2	0	2	4	0	0	0	1	31
Indianapolis	7	------	1	0	24	28	0	2	1	8	128
Muncie	0	------	0	0	1	3	0	0	1	1	14
South Bend	0	------	0	0	0	0	0	0	0	0	21
Terre Haute	0	------	0	0	4	0	0	0	0	0	37
Illinois:											
Alton	0	------	0	0	3	0	0	0	0	1	12
Chicago	8	38	4	10	62	302	0	41	0	29	802
Elgin	0	------	0	0	0	1	0	0	0	0	7
Moline	0	------	0	0	0	3	0	0	0	0	14
Springfield	0	2	1	0	6	12	0	0	0	2	35
Michigan:											
Detroit	4	2	0	29	14	84	0	15	0	39	294
Flint	0	------	------	1	------	13	0	------	0	25	-------
Grand Rapids	0	------	2	1	0	23	0	0	0	2	44
Wisconsin:											
Kenosha	0	------	0	1	0	0	0	1	0	1	18
Milwaukee	0	------	0	5	5	35	0	6	0	5	100
Racine	0	------	0	1	0	0	0	0	0	0	16
Superior	0	------	0	43	1	7	0	0	0	0	9
Minnesota:											
Duluth	0	------	1	245	3	2	0	1	0	1	19
Minneapolis	1	------	1	1	11	30	0	1	1	1	123
St. Paul	0	------	0	1	8	10	0	2	0	10	63

City reports for week ended February 17, 1940—Continued.

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Iowa:											
Cedar Rapids	1	------	------	12	------	0	0	------	0	0	------
Davenport	0	------	------	1	------	2	0	------	0	0	------
Des Moines	0	------	0	1	0	13	2	0	0	0	51
Sioux City	0	------	------	0	------	1	0	------	0	0	------
Waterloo	0	------	------	1	------	6	0	------	0	0	------
Missouri:											
Kansas City	0	------	3	0	3	18	0	3	0	1	96
St. Joseph	0	------	0	0	5	4	0	0	0	0	36
St. Louis	2	19	8	0	30	21	0	9	0	3	268
North Dakota:											
Fargo	0	------	0	0	0	0	0	0	0	0	4
Grand Forks	0	------	------	0	------	0	0	------	0	0	------
Minot	0	------	0	0	0	2	0	0	0	0	5
South Dakota:											
Aberdeen	0	------	------	0	------	1	0	------	0	1	------
Sioux Falls	0	------	0	0	0	0	0	0	0	0	7
Nebraska:											
Lincoln	1	------	------	3	------	2	0	------	0	2	------
Omaha	0	------	0	4	5	2	0	1	0	2	64
Kansas:											
Lawrence	0	5	0	0	0	0	0	0	0	0	4
Topeka	0	------	0	0	6	2	0	0	0	0	29
Wichita	1	1	0	240	7	0	0	0	0	2	22
Delaware:											
Wilmington	0	------	0	0	3	10	0	1	0	4	40
Maryland:											
Baltimore	1	42	4	1	34	21	0	17	0	107	289
Cumberland	0	1	1	0	0	0	0	0	0	0	21
Frederick	1	------	0	0	0	0	0	0	0	0	5
Dist. of Col.:											
Washington	5	19	6	2	20	24	0	13	1	18	211
Virginia:											
Lynchburg	0	------	1	0	4	0	0	0	0	3	20
Norfolk	0	143	0	0	4	0	0	2	0	1	31
Richmond	0	1	2	0	7	0	0	1	0	0	53
Roanoke	1	------	0	3	7	1	0	0	0	3	17
West Virginia:											
Charleston	0	3	0	0	0	0	0	0	0	0	6
Huntington	0	------	------	0	------	1	0	------	0	0	------
Wheeling	0	------	0	0	4	1	0	1	0	2	33
North Carolina:											
Gastonia	0	------	------	1	------	1	0	------	0	0	------
Raleigh	0	------	0	0	3	1	0	0	0	0	18
Wilmington	1	------	0	0	0	0	0	0	0	0	11
Winston-Salem	0	1	0	0	5	3	0	2	0	0	27
South Carolina:											
Charleston	0	95	1	0	3	0	0	1	0	0	20
Florence	0	2	0	0	2	0	0	0	0	0	11
Greenville	1	------	0	0	4	0	0	0		0	28
Georgia:											
Atlanta	0	39	1	19	5	5	0	1	0	2	84
Brunswick	0	------	0	0	0	0	0	1	0	0	5
Savannah	0	25	3	0	2	1	0	4	0	0	46
Florida:											
Miami	0	8	1	0	7	1	0	2	0	1	55
Tampa	0	2	1	27	5	1	0	0	0	1	35
Kentucky:											
Ashland	0	------	0	0	0	1	0	0	0	0	3
Covington	0	------	0	0	1	0	0	1	0	0	14
Lexington	2	------	0	0	0	0	0	0	0	5	16
Louisville	0	67	2	2	12	16	0	4	0	0	102
Tennessee:											
Knoxville	0	28	2	0	3	16	0	0	0	0	31
Memphis	0	54	9	1	7	35	0	6	0	6	99
Nashville	0	------	5	17	18	6	0	1	0	2	78
Alabama:											
Birmingham	0	31	2	1	10	1	0	6	0	1	88
Mobile	1	84	3	0	0	1	0	0	0	0	30
Montgomery	1	4	------	5	------	2	0	------	0	0	------
Arkansas:											
Fort Smith	0	37	------	0	------	0	0	------	0	0	------
Little Rock	0	120	1	1	10	0	0	2	0	0	15
Louisiana:											
Lake Charles	0	------	0	0	2	0	0	0	0	0	3
New Orleans	2	77	9	3	27	4	0	13	2	3	242
Shreveport	0	------	2	5	19	4	0	2	1	0	56

City reports for week ended February 17, 1940—Continued

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Smallpox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Oklahoma:											
Oklahoma City	1	------	0	0	9	1	0	1	0	0	55
Tulsa	0	------	------	1	------	1	0	------	0	8	------
Texas:											
Dallas	3	5	4	9	8	1	0	3	1	9	81
Fort Worth	0	------	0	0	8	0	0	0	0	20	59
Galveston	0	------	0	4	3	1	0	0	0	0	17
Houston	0	49	4	4	20	3	0	4	0	0	102
San Antonio	1	50	3	108	11	0	0	10	1	5	78
Montana:											
Billings	0	------	0	0	1	0	0	0	0	4	9
Great Falls	0	------	0	0	3	0	0	0	0	0	9
Helena	0	------	0	1	0	1	0	1	0	0	6
Missoula	0	1	0	1	0	0	0	0	0	0	1
Idaho:											
Boise	0	------	0	1	1	0	0	0	0	0	9
Colorado:											
Colorado Springs	0	------	0	0	2	1	0	0	0	0	17
Denver	9	------	0	2	7	9	0	3	0	3	76
Pueblo	0	------	0	6	2	4	0	1	0	0	14
New Mexico:											
Albuquerque	1	------	0	0	1	0	0	2	1	6	11
Utah:											
Salt Lake City	0	------	0	43	3	9	1	1	1	37	25
Washington:											
Seattle	0	------	3	113	2	5	0	3	0	5	102
Spokane	0	1	1	3	5	8	0	0	0	4	40
Tacoma	0	------	0	44	5	15	0	0	0	0	39
Oregon:											
Portland	0	9	0	134	11	2	0	0	0	3	98
Salem	0	------	------	23	------	0	0	------	0	0	------
California:											
Los Angeles	1	134	4	7	7	30	0	20	0	13	411
Sacramento	3	2	0	2	2	2	0	2	0	2	32
San Francisco	1	1	0	1	7	12	0	10	1	6	180

State and city	Meningococcus meningitis		Poliomyelitis cases	State and city	Meningococcus meningitis		Poliomyelitis cases
	Cases	Deaths			Cases	Deaths	
New York:				Kentucky:			
New York	2	0	0	Lexington	1	0	0
Pennsylvania:				Alabama:			
Philadelphia	1	0	1	Montgomery	0	0	1
Scranton	1	1	0	Louisiana:			
Minnesota:				New Orleans	0	0	1
Minneapolis	1	0	0	Texas:			
Kansas:				Houston	0	0	1
Wichita	1	0	0	San Antonio	1	0	0
Maryland:				California:			
Baltimore	2	0	0	Los Angeles	0	1	0
South Carolina:							
Charleston	1	0	0				

Encephalitis, epidemic or lethargic.—Cases: San Francisco, 1.
Pellagra.—Cases: Atlanta, 1; Birmingham, 2.
Typhus fever.—Cases: Lake Charles, 1; Fort Worth, 2.

FOREIGN REPORTS

CUBA

Habana—Communicable diseases—4 weeks ended February 10, 1940.—During the 4 weeks ended February 10, 1940, certain communicable diseases were reported in Habana, Cuba, as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Diphtheria	14		Tuberculosis	5	1
Scarlet fever	1		Typhoid fever	32	5

FINLAND

Communicable diseases—November 1939.—During the month of November 1939, cases of certain communicable diseases were reported in Finland as follows:

Disease	Cases	Disease	Cases
Diphtheria	346	Scarlet fever	511
Influenza	1, 721	Typhoid fever	14
Paratyphoid fever	217	Undulant fever	1
Poliomyelitis	11		

REPORTS OF CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER RECEIVED DURING THE CURRENT WEEK

NOTE.—A cumulative table giving current information regarding the world prevalence of quarantinable diseases appeared in the PUBLIC HEALTH REPORTS of February 23, 1940, pages 342–345. A similar table will appear in future issues of the PUBLIC HEALTH REPORTS for the last Friday of each month.

Yellow Fever

Brazil.—For the period January 7–27, 1940, deaths from yellow fever (jungle type) have been reported in Brazil as follows: Espirito Santo State—Alfredo Chaves, 1; Cachoeiro Itapemirim, 2; Domingos Martins, 2; Itapemirim, 2; Joao Neiva, 3; Joao Pessoa, 1; Lauro Muller, 1; Santa Leopoldina, 4; Sao Felipe, 4; Serra, 2; Viana, 1; Rio de Janeiro State—Santo Eduardo, 1.

Colombia—Caldas Department—La Pradera.—On January 30, 1940, 1 death from yellow fever was reported in La Pradera, Caldas Department, Colombia.

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