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THE U. S. MARINE HOSPITAL (NATIONAL LEPROSARIUM), CARVILLE, LA.

Review of the More Important Activities for the Fiscal Year Ended June 30, 1938

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A smaller number of patients remained in the hospital at the end of the fiscal year than at the close of any of the past 7 years. This was due to a continued lower admission rate and a greater number of deaths. Thirty-nine percent of the deaths occurred in persons who had suffered from leprosy for more than 10 years. The number of patients conditionally discharged as arrested cases and the number absconding remained at practically the same level as in immediately preceding years.

The following table shows the changes in the hospital population during the year:

TABLE 1.—*Movement of population*

	Male	Female	Total
Patients in the hospital July 1, 1937.....			365
Admitted during year:			
New patients (never previously admitted).....	22	10	32
Returned absconded patients.....	10	7	17
Returned paroled patients (leprosy reactivated).....	2	1	3
Returned paroled patients (for observation).....	6	0	6
Relapsed paroled patient (from Louisiana Leper Home).....	0	1	1
Total admissions.....	40	19	59
To be accounted for.....			424
Discharged during year:			
Conditionally released previous year, left this year.....	1	0	1
Conditionally released and left hospital.....	11	6	17
Conditional release continued after observation.....	2	0	2
Absconded.....	8	9	17
Died:			
Active cases.....	27	8	35
Paroled cases.....	1	0	1
Discharged, deported by Immigration authorities.....	2	0	2
Total discharges.....	52	23	75
Remaining in hospital at end of year.....			349

The maximum number of patients in the hospital on any one day was 373. During the year 132,579 days of in-patient relief were furnished.

Three patients conditionally discharged from the hospital in previous years and one similarly discharged from the Louisiana Leper Home were readmitted because of reactivation of their leprosy. Six other paroled patients were readmitted for observation to determine

reactivation, or for other conditions, of whom two were again discharged, parole status being continued. One other died of pneumonia in the hospital, and three were in the hospital at the end of the year, their leprosy inactive but general disability resulting from sequelae of leprosy making it impossible for them to earn a living. Two patients who were granted parole during the year elected to remain here. One patient who was granted parole in the preceding year left the hospital in August 1937. Two patients with active leprosy and one paroled patient were discharged to the custody of the Immigration Service for deportation.

The nativity of new patients by States or countries, the State from which patients were admitted and the nativity of all patients in the hospital at the end of the year are shown in table 2.

TABLE 2.—Number of new patients by nativity (State or country), and State from which admitted, and nativity of all patients

State or country	Nativity of patients admitted	State from which admitted	Nativity of all patients in hospital
<i>United States</i>			
Alabama.....	1	1	-----
Arizona.....	-----	2	-----
Arkansas.....	-----	-----	1
California.....	1	10	7
Colorado.....	1	-----	1
Connecticut.....	-----	1	-----
District of Columbia.....	-----	1	-----
Florida.....	1	3	21
Georgia.....	1	-----	6
Illinois.....	-----	1	-----
Iowa.....	-----	-----	1
Kansas.....	-----	-----	1
Kentucky.....	2	-----	2
Louisiana.....	16	16	94
Maryland.....	-----	-----	2
Michigan.....	-----	2	-----
Mississippi.....	-----	-----	3
Missouri.....	-----	-----	2
Minnesota.....	-----	1	1
New Jersey.....	-----	1	-----
New York.....	-----	3	2
Ohio.....	2	-----	4
Pennsylvania.....	-----	-----	1
Rhode Island.....	-----	-----	1
South Carolina.....	-----	-----	3
Tennessee.....	-----	1	-----
Texas.....	9	16	56
Total.....	34	59	209
<i>Insular or Territorial Possessions</i>			
Territory of Hawaii.....	1	-----	8
Philippine Islands.....	3	-----	16
Puerto Rico.....	1	-----	8
Total.....	5	-----	32
<i>Foreign countries</i>			
Bahama Islands, British West Indies.....	1	-----	2
Bermuda, British West Indies.....	1	-----	1
Barbados, British West Indies.....	1	-----	2
Jamaica, British West Indies.....	-----	-----	4
Trinidad, British West Indies.....	-----	-----	1
Canada.....	-----	-----	3
China.....	2	-----	13
Cuba.....	1	-----	4
Dutch Guiana, South America.....	-----	-----	2
Finland.....	-----	-----	2

TABLE 2.—Number of new patients by nativity (State or country), and State from which admitted, and nativity of all patients—Continued

State or country	Nativity of patients admitted	State from which admitted	Nativity of all patients in hospital
<i>Foreign countries—Continued</i>			
France.....			1
Greece.....			10
Hungary.....			1
India.....			1
Italy.....	2		6
Japan.....			1
Mexico.....	12		43
Montenegro.....			1
Portugal.....			1
Russia.....			3
Spain.....			6
Total.....	20		108
Grand total.....	59	59	349

CLINICAL DIVISION

Of the 349 patients in the hospital at the close of the fiscal year, 106 were women and 243 were men.

Admissions to the infirmary in the men's ward numbered 259, there being 16 permanent resident cases owing to chronic infirmities. In the women's ward 129 were admitted and 10 were permanent residents. The average length of stay in the men's ward was 42 days and in the women's ward 39 days; the total number of infirmary days for both wards was 17,586. Progress records are kept for all patients under treatment.

With rare exceptions, all patients are taking some form of treatment. Two hundred and two patients are taking chaulmoogra oil orally, the dosage varying from 5 to 50 drops, three times daily; 157 are taking benzocaine-chaulmoogra oil twice weekly intramuscularly; 60 are taking weekly intramuscular injections of hydnocarpus esters. The total number of all injection treatments given during the year was as follows:

Benzocaine-chaulmoogra oil (intramuscularly).....	3,460
Hydnocarpus esters (intramuscularly).....	1,041
Nearsphenamine (intravenously).....	90
Gold sodium thiosulfate (intravenously).....	118

A general survey of all patients taking treatment shows a satisfactory amount of improvement, although a considerable number of the older advanced cases show retrogression. It is felt that some of this retrogression is the natural course of the disease; but in some cases it is probably the aftermath of the extended malaria outbreak of several years ago, which lowered the resistance of these patients considerably. A number of different experimental treatments were tried out, but nothing worthy of note has resulted.

There were 36 deaths during the year from the following causes:

Leprosy, mixed type (predominant).....	11	Cirrhosis of liver.....	1
Tuberculosis, pulmonary.....	7	Gangrene.....	2
Tubercular meningitis and pulmo- nary tuberculosis.....	1	Arteriosclerosis.....	1
Tuberculosis of femur.....	2	Parenchymatous nephritis.....	2
Pneumonia.....	7	Valvular cardiac disease.....	1
Carcinoma of lungs.....	1	Total	36

Surgical operations were performed as follows:

Amputations.....	6	Myringotomy.....	1
Aspirations.....	1	Nose operation.....	1
Appendectomies.....	3	Operations (miscellaneous).....	3
Biopsies.....	1	Paracentesis of abdomen.....	5
Cataract extractions.....	2	Plastic repairs.....	11
Cauterizations.....	22	Pterygium, operation for.....	4
Circumcisions.....	6	Spinal puncture.....	1
Curettements.....	2	Submucous resection.....	2
Dilation of lacrimal duct.....	26	Sutures.....	1
Enucleations.....	3	Tenotomy of eye muscle.....	1
Excisions.....	20	Thiersch graft.....	1
Eye operations (unclassified).....	15	Tonsillectomy.....	2
Incisions.....	2	Tracheotomy.....	4
Incisions and drainage.....	7	Total	165
Iridectomies.....	10		
Laryngoscopy, and cauterization.....	2		

In the out-patient clinic, which includes all Government personnel and their immediate families resident on the Station, exclusive of colony patients, there were 735 patients treated, 1,416 treatments being given.

LABORATORY DIVISION

The pathological laboratory reports the following routine procedures carried out during the fiscal year:

Blood Chemistry:		Hematology—Continued.	
Total lipids.....	78	Hemoglobin estimations.....	26
Fatty acids.....	78	Coagulation time.....	6
Lecithin.....	78	Blood typings.....	12
Cholesterol.....	78	Smears.....	202
Cholesterol esters.....	78	Bone marrow smears.....	2
Sugar.....	58	Urinalyses:	
N. P. N.....	37	Routine chemical and micro- scopic.....	574
Urea.....	4	Quantitative albumin.....	26
Von den Bergh.....	1	Quantitative sugar.....	16
Chlorides.....	2	Urobilinogen (quantitative).....	49
Sulfanilamide concentration.....	3	Feces: Parasites and occult blood.....	45
Basal metabolism.....	20	Bacteriological examinations:	
Hematology:		Water supply.....	52
White cell counts.....	94	Throat.....	14
Differential counts.....	94		
Red cell counts.....	33		

Bacteriological examinations—		Sputum.....	51
Continued.		Examination of patients for <i>M.</i>	
Feces.....	7	leprae.....	725
Blood Culture.....	6	Miscellaneous smears.....	203
Pneumococcus typing.....	5	Histological sections.....	487
Complement fixation:		Biopsies.....	49
Kolmer, Wassermann.....	320	Friedman pregnancy test.....	3
Kahn.....	181	Lantern slides prepared.....	163
Kline.....	277	Autogenous vaccines.....	1
Bacterial antigens.....	169	Ethyl esters of hydnocarpus pre-	
Colloidal gold.....	2	pared (cc).....	8,000
Autopsies:			
Human.....	27		
Animal.....	26		

Each patient is given a routine clinical laboratory examination on admission, consisting of skin examination for the verification of the diagnosis of leprosy, blood counts, sputum examination, urine examination, feces examinations, Kolmer, Wassermann, Kahn, and Kline tests. Laboratory procedures are done subsequently as indicated.

In addition to these routine procedures, the laboratory makes photographs of all patients on admission and subsequently when desired. The laboratory is also equipped to make lantern slides and photomicrographs for scientific papers, a number of which were made during the year.

During the past year, as in former years, one of the major duties of the laboratory has been the examination of the patients for *M. leprae* at monthly intervals, as one of the criteria for consideration for parole is the failure to find *M. leprae* at monthly examinations for a period of 1 year. Patients showing improvement are examined at monthly intervals, and those stationary or retrogressing, at longer intervals.

The occurrence of a few cases of pneumonia during the past year prompted the addition of the Neufeld technique of typing pneumococci to the laboratory procedure. In the few instances in which it was used, this procedure checked with the older mouse method; from the limited experience here and the reports given in the literature, it is felt that it should be the method of choice in typing pneumococci.

During the past year the Kline test was added to the routine serological examination for syphilis. This procedure checks in most instances with the Wassermann and Kahn tests, and gives approximately the same percentage of positive reactions in leprosy.

At present the laboratory is attempting to repeat the work of Lleras Acosta, of Colombia, in which he reported an extremely large percentage of patients giving a positive complement fixation test, using as an antigen an alcoholic extract of a bacillus isolated from the blood stream of a patient. The bacillus is now growing in our laboratory and the antigen is being prepared here. A detailed report of this

work will be made as soon as it is completed. The preliminary work is encouraging, but extensive control work must be done before any report of value can be made.

DENTAL SERVICE

Dental service consisted of examinations, prophylaxis, fillings, extractions, and X-rays; the construction of partial and full dentures, and the repair and adjustment of dentures; the treatment of pyorrhea alveolaris; the treatment of secondary lesions of leprosy, such as leprous granuloma, ulcerations, sensitiveness of teeth, the treatment of Vincent's angina, and other miscellaneous treatments; and alveolectomy and the removal of permanent leprous nodules by means of electric cauterization.

A few of the dental services rendered are as follows:

Examinations.....	58	Leprous ulcers treated.....	1, 127
X-rays.....	228	Sensitive gingivitis treated.....	784
Extractions.....	314	Total number of treatments	
Leprous granulomata treated...	922	given.....	5, 154

Special attention has been given to the study of dental and oral pathology of secondary lesions of leprosy and to the relief of pain and discomfort by routine treatment, which will be reported later in a separate article.

DERMATOLOGIC SERVICE

The routine treatments with the oral administration of chaulmoogra oil and intramuscular injections of the esters of hydnocarpus were continued, as was also the administration of strychnine, arsenic, and calcium by mouth. No material difference has been noted in results obtained from those noted in previous reports.

The number of consultations for diseases of the skin, including cutaneous manifestations of leprosy was 1,470. In addition to the consultations, 1,041 intramuscular injections of the ethyl esters of hydnocarpus were made.

In a recent communication (as yet unpublished) attention was called to the frequency of the occurrence of xanthoma (xanthelasma) in leprosy and the coexisting increase in certain of the lipid contents of the blood. In approximately 11 percent of the patients examined typical plaques of xanthoma were noted in the orbital region, while in an equal number of tuberculous patients in Charity Hospital in New Orleans no xanthoma was found.

The greatest variation from the normal in the lipid content of the blood in leprosy occurred in the cholesterol esters and was found to exist to a greater extent in those patients in whom xanthoma was found than in those in whom xanthoma did not occur. In active,

advanced cases of cutaneous leprosy the variance from the normal in the lipid content of the blood was more marked, and xanthoma occurred more frequently than it did in incipient and neural cases.

It is generally believed that the altered ratio of the fat-emulsifying agents in the serum of the blood is responsible for the occurrence of xanthoma in the nonleprous, and we believe that this altered ratio in our cases resulted from leprosy. Whether or not leprosy affects the lipid contents of the blood by causing dysfunction of the liver was not determined. It is true that disease of the liver has been found post-mortem in almost all autopsies at the leprosarium, but no evidence has been obtained during life of a dysfunction of the liver which might influence fat metabolism, nor have symptoms of disease of the liver been frequent in the hospital.

Nevertheless, the view that liver dysfunction is an important factor in the altered fat metabolism of lepers is interesting; for could this be established, it might be extended to explain certain acute and evanescent symptoms of leprosy for which an adequate explanation is now lacking. It does not seem impossible that changes in the lipid constituents of the blood resulting from greater or less dysfunction of the liver might be the cause of allergic cutaneous manifestations in lepers.

Acceptance of the view held by some that the pituitary gland, instead of the liver, is the primary cause of altered fat metabolism suggests an approach to the solution of the disproportionate incidence of leprosy in men and women because of a definite relation between that gland and the sex glands. Insofar as the etiology of leprosy is concerned, altered fat metabolism in leprosy depends on whether such alteration occurred prior or subsequent to the development of leprosy. Data to establish this sequence have not been obtained, but the effects of diet on the acute symptoms of leprosy is being observed.

ORTHOPEDIC SERVICE

During the year 444 consultations were held, the greatest number being in March 1938. Fifty new patients were examined during the year, and 29,792 treatments were given, the greatest number, 2,731, being given during August 1937. The monthly average was more than 2,483, and the daily average was above 95. Five operations were performed, three of which were emergency cases requiring extra or special trips from New Orleans.

Palliative rather than radical measures continue to prove advisable in the treatment of osseous and soft part necroses, contractions, and nerve conditions; and such procedure has often obviated the necessity of operation in many cases in which at first inspection operation appeared called for. Because of the insidious character of the onset of deformity in leprosy patients, it has been the aim of the department

to recognize and anticipate potential deformity so as to devise and advocate measures to correct or arrest such conditions. In those cases in which deformity had already been established before the patient was admitted to the institution, correction of, or decrease in, the deformity has been possible when cooperation of the individual has been obtained; however, certain individuals are noncooperative because they resent any retentive or corrective measures that may interfere or inhibit their social or recreational activities; and in such cases one may expect gradual increase in the deformity, possibly to a point where operation becomes imperative. Fortunately such instances are few, and the majority of patients are anxious to improve their condition and are cooperative. It is very gratifying, indeed, to prevent deformities in many, and to correct them in some, and to restore lost sensation and motion in the extremities so that when the leprosy is arrested, the patient is able to resume his former occupation or undertake a new one when discharged from the hospital instead of being handicapped by multiple contractions and lost digits.

There has been recently installed in the department a positive and negative pressure apparatus for the treatment of conditions produced by circulatory disturbances in the extremities; and though sufficient time has not yet elapsed to offer a definite report as to the results obtained, the improvement in those conditions now being treated with this method has been so decided that one is justified in the belief that a number of conditions which have resisted other forms of treatment will be controlled and finally eliminated.

It is again to be remarked that arthritis of the secondary infectious type still is not to be found among patients in this institution.

NEUROPSYCHIATRIC SERVICE

During the year, examinations were made of 28 new patients, 26 readmitted patients, and 15 paroled patients.

Two hundred and six consultations were held in the clinic for conditions of a neurologic nature. In the psychopathic division there have been 18 patients under observation, and 8 of these have shown little, if any, activity of their psychopathic disorder. Two psychopathic cases died during the year—one a widely known paranoiac whose trend ran in the line of publicity, the other a depressed type of dementia praecox.

At the close of the year there were 5 female psychopathic patients who required practically constant attention, 2 male patients who required constant seclusion on account of their noisy and filthy behavior, and one male patient who required close attention lest he wander off and become lost. The other 9 patients were able to be about the colony like other patients. One of this number, who seemed in a

very demented state slightly over a year ago, has improved mentally to an almost unbelievable degree.

EYE, EAR, NOSE, AND THROAT SERVICE

The following statistical table shows a summary of work of this department during the fiscal year:

Total number of visits.....	52	Total number of refractions.....	412
Total number of treatments.....	4, 104	Total number of operations.....	113

Classification of operations

Dilatation and irrigation of lacrimal duct.....	27	Incisions, abscess (lacrimal duct and peritonsillar).....	2
Cauterizations (eye and nasal passages).....	22	Plastic repair (mouth, eyelids) ..	11
Excisions of growth (nodules, leproma, cysts).....	15	Laryngoscopy.....	2
Injections (adrenal) of eye and intraorbital nerve.....	10	Myringotomy.....	1
Injections of lipoidol in bronchi..	1	Tracheotomy.....	1
Pterygium, operation for.....	2	Skin graft.....	2
Submucous resection.....	2	Diathermy, coagulation of nodule on face.....	1
Tonsillectomy.....	2	Enucleation of eyes.....	3
Curettement (nasal).....	2	Iridectomy.....	4
		Operation for squint.....	1
		Cataract extraction.....	2

In this list of operations it is worthy of note that skin grafting was attempted twice with excellent results on both occasions.

In this department, Dr. John J. Prendergast of St. Paul, Minn., was engaged to make a special study of eye lesions in leprosy, particularly from a pathologic viewpoint, with the hope that something might be learned that would lessen the high incidence of blindness among our patients. His work began in November 1937 and ended in April 1938. A report of his findings, without recommendations, was submitted in April 1938, and since that time he has submitted the following recommendations as to improvements in handling the eye conditions that arise in this hospital:

1. The ideal provision would be a full-time man to take care of all eye, ear, nose, and throat work. If this is not possible, a part-time man should serve at least 3 full days per week.

2. Protection of patients' eyes from glare and from dust or other irritants by the use of colored goggles is recommended.

3. The daily use of a good antiseptic eye wash as a hygienic prophylactic measure is recommended.

4. There should be increased nursing facilities for the care of eye cases, having two nurses who are specially instructed in the care of eye conditions.

5. Treatment along the lines following in the work already done should be continued, though it seems probable that complete success in these cases is rather improbable.

NURSING SERVICE

There exists a fine spirit of cooperation on the part of the nursing staff. In addition to the regular nursing service, members of the staff of nurses act as technicians in the X-ray and physiotherapy departments, both departments operating at peak activity during the year; X-rays of the chest have been made on all patients. The nursing staff also cooperated with Dr. Prendergast in his research work on the eyes. A summary of the work has been submitted by the medical staff and will give an adequate idea of the extent of the work.

The work in the male and female clinics is particularly heavy because of the extensive skin involvement. In the former, 34,824 dressings were done; and in the latter, 9,450. The eye, ear, nose, and throat clinic has been unusually busy, the number of treatments given being listed elsewhere.

We are handicapped because of a lack of efficiency on the part of our orderlies, who themselves are patients, their physical output being about 50 percent at most.

During the past year much comfort has been derived from the arrangement of employing two emergency orderlies. However, more satisfactory service could be rendered if we were granted an additional full-time night orderly. The tracheotomy cases (11 at the end of the fiscal year) are permanent infirmary patients and are unable to care for themselves; the majority of the other infirmary patients require as much care as infants.

DIETETIC SERVICE

To conduct an economic dietetic department, and at the same time give satisfaction, has always been the goal set for this department. It is a well-known fact that if satisfaction is given in food service, success and savings will follow. The result of this year's work proves the point. While endeavoring to keep well within budgetary limits, neither money nor labor has been spared in our efforts to serve the well-balanced and appetizing diet so necessary in the treatment of the type of patients cared for here. The per diem ration cost for the year was \$0.436, which was somewhat less than last year (\$0.454).

We have continued our special features for holidays, birthdays, and similar occasions, and the serving of refreshments following entertainments given for the patients, without any appreciable effect on the per diem cost. We believe this helps to a marked degree in maintaining the good will of the patients, a very important asset.

We are much pleased with the new equipment recently added—three well-constructed food conveyors. It has been a problem to transport hot foods to blind and helpless patients living in the cottages at some distance from the kitchen. The new carts have solved these difficulties, and the patients are delighted with the improvement.

The dietetic department owes no small measure of its success to the cordial cooperation of the other departments of the station, and to its chefs and employees, who have had to work long hours every day of the year.

PHARMACY

The pharmacy has been as busy as in previous years. There were 18,989 prescriptions dispensed, 138,400 capsules of various sizes filled with chaulmoogra oil or other drugs; 280 gallons of syrups, tinctures, elixirs, and the like manufactured; 1,889 pounds of ointments compounded; and liniments, lotions, dentifrices, and chaulmoogra oil mixtures for injection were made.

EQUIPMENT, BUILDINGS, AND GROUNDS

The new cottage for the care and treatment of psychiatric cases was completed and made ready for occupancy in September 1937.

The improvement of much of the swamp land that formerly was unfit for use has been carried out at times when other station work would permit. As a result there has been a considerable increase in acreage available for the production of forage for the dairy herd. The reestablished drainage canals have functioned well, though some work is now necessary to remove partial obstructions from caving of the banks. Mosquito-control work by use of oil, paris green dusting, and attention to drainage of small collections of water has been carried on during the mosquito season with gratifying results.

Additional equipment for the treatment of the station water supply has been installed.

MATÉRIEL SERVICE

The repair and preservation of 110 buildings, of 1¼ miles of covered screened walks, the upkeep of 13 miles of drainage ditches, and approximately 50 acres of lawns, have cost for material and labor \$30,970.63. The repairs to buildings include all necessary work by carpenters, plumbers, steam fitters, electricians, and painters. The above figure includes repairs to equipment and furniture. It also includes cost of material and a portion of the labor for painting the interior of the infirmary building. This might be said to be a completion of the original construction cost, as the walls were left unpainted to enable them to become thoroughly dry before painting. The plain white wall was so satisfactory that it was left for 3 years before painting was deemed necessary. As the building was occupied by very ill patients it was thought best to have the painting done by the station force at times when it would interfere least with the patients rather than to have the work done under contract. This work was partially completed at the end of the fiscal year, and thus far has

caused very little inconvenience to patients or medical and nursing staff.

The farm and dairy have shown an actual cash saving of \$14,028.13 for the year. The milk house has been remodeled, repaired, and enlarged according to modern plans furnished by the milk specialists of the Service. A new farm tractor and some new farm implements have been added late in the fiscal year.

New laundry machinery has been installed, and this has improved the laundry service. During the year 694,837 pieces were laundered, an increase of about 18,000 pieces over the preceding year.

The new machinery has brought to light one further needed improvement, namely, better ventilation of the laundry buildings owing to increased temperature within the building from the larger and more efficient machinery. This will be arranged for in the construction of the new building in the rebuilding program which is about to begin.

Patients' amusement facilities have been kept in good condition, including a golf course, tennis courts, baseball grounds, and volley ball court. The moving picture projecting and sound machines, as well as the screen, are rapidly approaching the end of their usefulness. They will have to be replaced when the new amusement hall is provided, if not before that time.

Each house that is designated for the use of blind patients now has a house radio which is kept in repair by the station. These radios have been acquired from deceased patients who have given their privately owned radios to the various houses for the benefit of all patients therein.

The powerhouse has been equipped with a new 500-horsepower boiler and a new ice machine has been provided, which adds much to the ease of supplying station power, heat, light, and refrigeration.

Two buildings have been moved by station labor to make way for beginning construction under the rehabilitation program.

At the end of the fiscal year a new dragline dredge was received and will be used in the maintenance of drainage ditches and similar work.

Generally speaking, the electrical, plumbing, painters, and carpenters departments, and the garage force have done most of the repair work and given better satisfaction than would be obtained from outside sources.

MISCELLANEOUS

The collecting, sterilizing, and sorting of patients' outgoing mail and the sorting and distributing of all incoming mail was handled by the office personnel. During the year there were approximately 135,624 pieces of mail handled. There were 383 outgoing letters registered; money orders were obtained in total amount of \$10,039.39; and 189 registered letters and 1,262 insured parcels were delivered.

Banking transactions in total amount of \$78,322.99 were handled for the patients at a Baton Rouge bank. These transactions consisted of cashing their salary, pension, and other checks, opening of individual checking and savings accounts, making deposits and withdrawals, obtaining United States savings bonds, and obtaining small bills and coins for the patients' canteen.

During the year subscriptions to 26 magazines and 9 daily newspapers were obtained for the patients' library through requisition to the Surgeon General's office.

One new radio for the blind patients, 39 books for the library, baseball supplies, softballs, and tennis balls were purchased for the patients from the patients' benefit fund. Radios in houses for blind patients and children were kept in repair, four pianos were tuned, and a dance orchestra and baseball teams playing an exhibition game were paid for their services from this same fund.

PROTOZOAN PLANKTON AS INDICATORS OF POLLUTION IN A FLOWING STREAM

By JAMES B. LACKEY, *Cytologist, U. S. Public Health Service, Stream Pollution Investigations, Cincinnati, Ohio*

Biological surveys of rivers have lagged far behind chemical and bacteriological studies of the same nature. This is surprising, for biological studies are more easily made. It is perhaps due to the fact that biologists have tried to study too great a variety of organisms, or perhaps have not themselves had a sufficient background for study of one selected group. The present day knowledge of the protozoa is certainly confined to a smaller group of investigators than is the knowledge of bacteria.

In this country the plankton of the Illinois River and its tributaries has been studied by Kofoid (1), Forbes and Richardson (2), Purdy (3), Galtsoff (4), Eddy (5) (6), and others, both before and after contamination by the sewage of Chicago. Purdy (7) (8) has also studied that of the Potomac and the Ohio Rivers, Allen (9) has given some information on the San Joaquin River, and the writer (10) has studied Raritan River plankton. These are almost the only American studies which give any specific information relative to algal or protozoan river plankton, although some general information may be derived from studies in Wisconsin by Turner (11) and Wiebe (12), and from the New York Conservation Commission studies. Fritsch (13) has given some attention to the plankton of English rivers, while Butcher, Longwell, and Pentelow (14) have recently published an excellent study of the Tees, but did not consider the animal plankton. The plankton of European and Russian rivers has been studied in

more detail although very little correlation of quantitative and qualitative studies with pollution has been made. Seiler (15) (16) has made some good quantitative studies of the Elbe and the Rhine, and the influence of sewage is well shown, but he considers four groups of organisms and has but little qualitative information on the protozoa. Bennin (17) studied the Warthe qualitatively for 4 years and noted the occurrence of 99 species of protozoa. He made counts also and gave the seasonal fluctuation. His work and identifications are accurate, but contain little reference to pollution. In a bibliography of 91 titles, he gives only 3 which are in English. Altogether, the general impression to be gained from many plankton surveys is that the subject has been approached too broadly and that sufficient consideration of a particular group, studied as to the quantitative relation of each species to pollution or the lack of it, is wanting.

This paper represents an attempt at such an approach. The studies were made on the Scioto River in Ohio, the entire watershed of which lies within the State and covers about 6,510 square miles. It is a stream which floods and subsides very quickly, and is generally shallow with a rocky or gravelly bottom and many riffles. Its principal tributary is the Olentangy which joins it just above the city of Columbus. This city uses large quantities of the river water, practically all of it at times of extreme low flow. The water is then returned to the river almost wholly as domestic sewage, about 31,000,000 gallons daily from a population of 322,000 people. Before discharge into the river it receives treatment in a sewage disposal plant just below the city.

Until November 1937 treatment had been carried out in an obsolete plant and the river was visibly grossly polluted downstream. Chemical and bacteriological studies of the river showed heavy and offensive pollution at Shadeville, gradually decreasing downstream, until at Circleville the river was a fairly clean stream, and became still better beyond this point. In November, however, the first stages of treatment in a new modern plant were begun and by the spring of 1938 complete treatment was expected. It was anticipated that by June 1938 the river would be getting a purified effluent rather than untreated or poorly treated sewage. These conditions offered an excellent study of a stream during pollution and subsequent to removal of that pollution so the Stream Pollution Investigations Laboratory of the United States Public Health Service undertook a 2- to 3-year study of the Scioto from Columbus to its mouth. The base laboratory is at Cincinnati, but a field laboratory was set up at Chillicothe.

PROCEDURE

For the plankton work covered by this paper, samples were collected once a week from certain stations indicated on the map in figure 1. In addition, such other samples as were desired could be obtained by

24 hours' notice to the sample collector. These were obtained with a specially designed sampling bottle. Fresh samples were studied biweekly in the laboratory at Chillicothe and 5 percent formalin preserved samples at the Cincinnati laboratory on the alternate weeks. Bottles holding 250 cc were used, but in practice only 100 cc were examined for it was shown that this amount represented an inclusive sample. The type of collecting bottle used did not secure the larger free swimming plankton such as Crustacea. The fresh samples were not more than 2 hours old when they reached the laboratory, but during the summer they were nevertheless put into an iced container, and kept cold until examined. As long as they were kept cold, not much change in the plankton content was found to occur in 24 hours unless the pollution was extreme. Samples from near Shadeville, however, could not be kept this long, and were like trickling filter or activated sludge samples in this respect.

At the beginning of the work a comparison of the Sedgwick-Rafter, sedimentation, and centrifuge methods of obtaining organisms in a sample was made, and the centrifuge method was adopted. Centrifuging does not always throw down 100 percent of all organisms in fresh samples, for example the small brown flagellate *Chrysococcus rufescens*. Possibly because of its lightness and small size from 10 to 20 percent of these organisms are not recovered. The speed and length of time of centrifuging vary somewhat with the nature of the sample, but in general there is almost a total recovery of all plankton forms in an uninjured, recognizable form, when this method is used. Counts were not made in a counting cell, but a single drop, spread under a cover, was used. Because the cover would ultimately squeeze out some organisms around the edge and because of the migration (in unkilld samples) of certain photosynthetic forms, no whole drop was ever counted, but two paths, right to left and front to rear, bisecting the drop, were quickly counted, then the whole drop looked over for rotifers, worms, Crustacea, and such large protozoa as *Stentor*. This necessitated the use of 10 to 20 drops, but by using No. 1 thickness cover glasses, and pipettes delivering 18 to 20 drops per ml, any squeezing out or migrating effects were eliminated, a very representative count was obtained, and uncertain identifications could be verified with the 44X objective.

All organisms were counted and identified, if possible, and a careful estimate of the number per ml or per liter was made. Thus far, less than 5 percent of the organisms have escaped identification as to genus and most of them as to species. For some genera, however, no attempt was made to classify as to species, viz, *Chlamydomonas* and *Scenedesmus*. A very large plankton population has been found at times, some new to this country, and a few new species. Most of the species of Ciliata and Flagellata that have been encountered in this

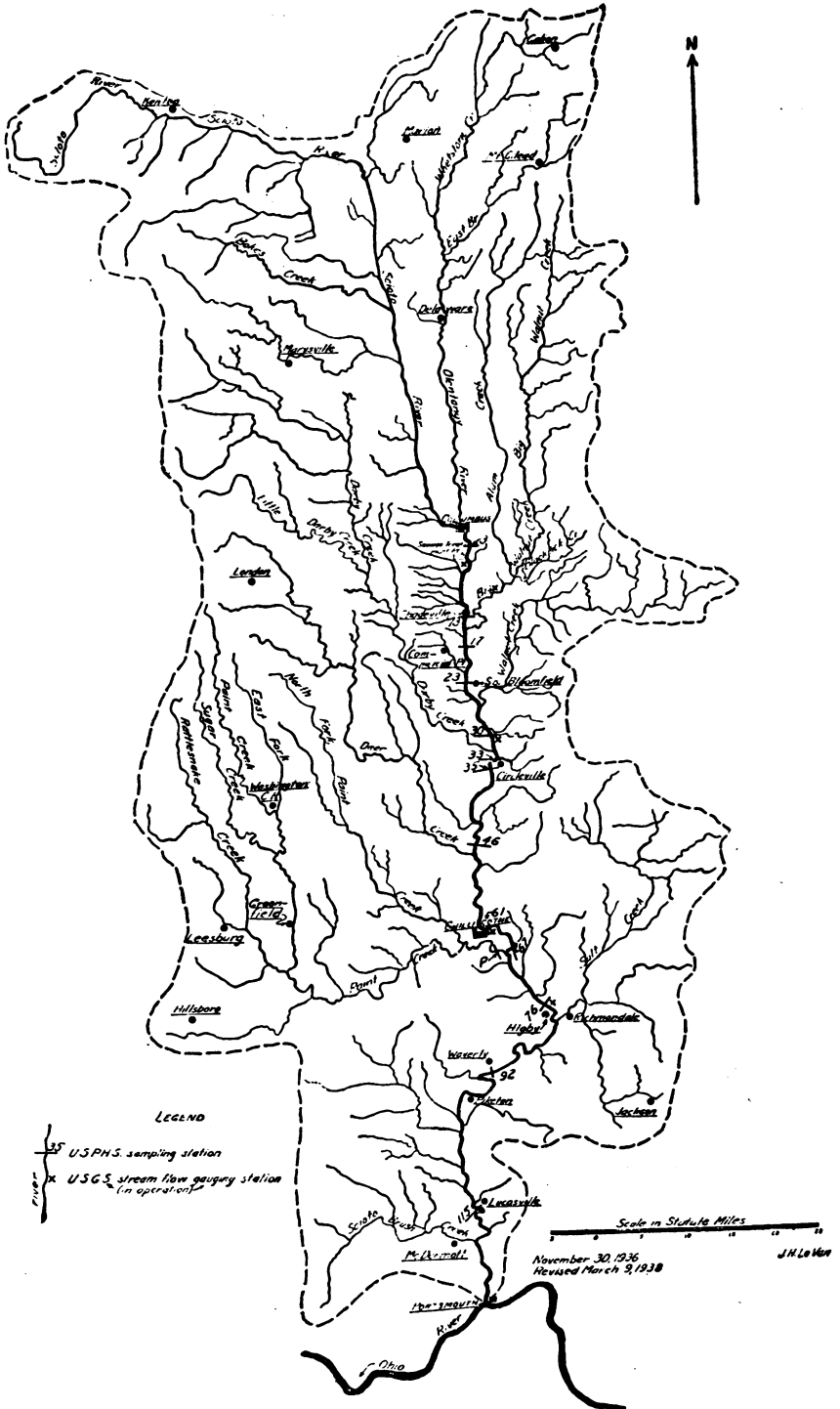


FIGURE 1.—Map of the Scioto River and its watershed. The numbers along the river represent sampling stations and their distance below Columbus.

study are listed in table 1. Some forms have been omitted because of uncertain identification, and a few because they are new and as yet unnamed species. This table shows that by studying fresh samples every other week most of the species can be recognized in formalin. It should be emphasized, however, that a study of fresh samples is an absolute necessity for many species. *Cryptomonas* is often scarcely recognizable in a formalin preserved sample unless it is first studied and recognized in a fresh sample. Disintegration is also progressive in formalin preserved samples for many species, possibly because of agitation.

Throughout the studies an attempt was made to find species, genera, or groups of organisms which are directly affected by pollution. It was expected that Ciliata, Euglenidae, and Volvocales would play important roles as indicator organisms.

TABLE 1.—*Information concerning six groups of plankton organisms in the Scioto River during 1937*

Organism	Genus recognizable in formalin	Species recognizable in formalin	Holozoic, food principally bacteria	Holozoic, food principally other organisms	Saprophytic	Holophytic	Produces O ₂ in light	Most abundant in polluted zones	Most abundant elsewhere
INFUSORIA									
<i>Ciliata</i>									
1. <i>Actinobolus radians</i>				X					X
2. <i>Amphisia</i> sp.....			X					X	
3. <i>Askenasia volvox</i>	X	X							X
4. <i>Aspidisca costata</i>	X		X					X	
5. <i>Bursaridium</i> sp.....				X					
6. <i>Carchesium</i> spp.....	X		X					X	
7. <i>Chaenea teres</i>								X	
8. <i>Chilodonella cucullulus</i>	X			X				X	
9. <i>uncinatus</i>			X					X	
10. sp.....									
11. <i>Cinetochilum margaritaceum</i>	X		X						
12. <i>Codonella cratera</i>	X	X							X
13. <i>Coleps hirtus</i>	X			X					X
14. <i>Colpidium campylum</i>			X					X	
15. <i>colpoda</i>			X					X	
16. <i>Colpoda aspera</i>			X					X	
17. <i>Cyclidium</i> spp.....	X		X						X
18. <i>Cyrtolophosis mucicola</i>	X		X						X
19. <i>Didinium balbiani</i>	X	X							X
20. <i>nasutum</i>	X	X						X	
21. <i>Dysteriopsis</i> sp.....	X								
22. <i>Epistylis</i> spp.....	X		X					X	
23. <i>Euplotes</i> spp.....	X							X	
24. <i>Frontonia leucas</i>	X			X					X
25. <i>Glaucoma frontata</i>	X		X						
26. <i>pyriformis</i>			X						
27. <i>scintillans</i>			X					X	
28. <i>Halteria grandinella</i>	X								X
29. <i>Hastatella radians</i>	X	X							X
30. <i>Holophrya</i> sp.....	X			X					X
31. <i>Holosticha</i> sp.....	X			X					X
32. <i>Lacrymaria</i> sp.....				X				X	
33. <i>Lembus saprophilus</i>	X		X					X	
34. <i>Lionotus fasciola</i>	X							X	
35. sp.....									
36. <i>Loxocephalus granulatus</i>	X		X						
37. <i>Lorodes</i> sp.....									

TABLE 1.—Information concerning six groups of plankton organisms in the Scioto River during 1937—Continued

Organism	Genus recognizable in formalin	Species recognizable in formalin	Holozoic, food principally bacteria	Holozoic, food principally other organisms	Saprosolic	Holophytic	Produces O ₂ in light	Most abundant in polluted zones	Most abundant elsewhere
INFUSORIA—continued									
Ciliata—Continued									
38. <i>Loxophyllum maleagris</i>	X			X					
39. <i>Metopus sigmoides</i>	X		X					X	
40. <i>Nassula aurea</i>	X			X					X
41. <i>Onychodromus grandis</i>				X					
42. <i>Opercularia</i> sp.....	X		X					X	
43. <i>Oxytricha</i> sp.....								X	
44. <i>Paramecium caudatum</i>	X		X					X	
45. <i>putrinum</i>			X					X	
46. <i>Prorodon</i> sp.....	X								
47. <i>Stentor polymorpha</i>	X	X	X					X	
48. <i>Strombidium</i> spp.....	X			X					X
49. <i>Strombidium humile</i>	X	X		X					X
50. <i>Stylonichia mytilus</i>	X			X				X	
51. <i>pustulata</i>				X				X	
52. <i>Trachelocerca</i> sp.....	X			X				X	
53. <i>Trimyema compressa</i>	X		X					X	
54. <i>Tintinnidium fluviatile</i>	X	X		X					X
55. <i>Uroleptus piscis</i>	X								
56. <i>Uronema marina</i>	X		X					X	
57. <i>Urotricha farcta</i>	X								X
58. <i>Vorticella campanula</i>	X		X					X	X
59. <i>microstoma</i>			X						
60. <i>spp</i>			X						
MASTIGOPHORA									
<i>Zoomastigoda</i>									
61. <i>Anthophysa vegetans</i>			X					X	
62. <i>Bicoeca lacustris</i>	X	X	X						
63. <i>Bodo</i> spp.....			X					X	
64. <i>Bodopsis</i> sp.....								X	
65. <i>Cercobodo caudatus</i>			X					X	
66. <i>Codonosiga botrytis</i>	X	X	X					X	
67. <i>Desmarella moniliformis</i>	X	X	X	X					X
68. <i>Dimorpha nutans</i>	X	X							
69. <i>Mastigamoeba</i> sp.....			X						
70. <i>Monas</i> spp.....								X	
71. <i>Monosiga ovata</i>	X	X	X					X	
72. <i>Oicomonas termo</i>			X					X	
73. <i>sociabilis</i>			X					X	
74. <i>sp</i>								X	
75. <i>Pleuromonas jaculans</i>			X					X	
76. <i>Poteriodendron petiolatum</i>	X	X	X						X
77. <i>Spiromonas</i> sp.....									
78. <i>Tetramitus rostratus</i>			X					X	
79. <i>Trepomonas rotans</i>			X					X	
EUGLENIDA (colorless)									
80. <i>Anisonema emarginatum</i>					X				
81. <i>ovale</i>					X				
82. <i>Astasia dangeardi</i>					X			X	
83. <i>Dinema griseum</i>					X				
84. <i>Distigma proteus</i>					X				
85. <i>Heteronema acus</i>	X				X				
86. <i>Menoidium incurvum</i>					X			X	
87. <i>Metanema variable</i>					X				
88. <i>Notosolenus apocampatus</i>					X			X	
89. <i>orbicularis</i>					X			X	
90. <i>Peranema granulifera</i>	X			X					
91. <i>ovalis</i>				X					
92. <i>trichophorum</i>				X				X	
93. <i>Petalomonas angusta</i>					X				
94. <i>carinata</i>	X	X			X				
95. <i>mediocanellata</i>					X				
96. <i>Sphenomonas quadrangularis</i>	X	X			X				
97. <i>Urceolus sabulosus</i>					X				

TABLE 1.—Information concerning six groups of plankton organisms in the Scioto River during 1937—Continued

Organism	Genus recognizable in formalin	Species recognizable in formalin	Holozoe, food principally bacteria	Holozoe, food principally other organisms	Saprozoe	Holophytic	Produces O ₂ in light	Most abundant in polluted zones	Most abundant elsewhere
EUGLENIDA (green)									
98. Colacium sp.	x					x	x		x
99. Cryptoglena pigra	x	x				x	x		x
100. Euglena acus	x	x				x	x		x
101. <i>acutissima</i>	x	x				x	x		x
102. <i>deses</i>						x	x	x	
103. <i>ehrenbergii</i>		x				x	x		x
104. <i>fusca</i>		x				x	x	x	
105. <i>oxyuris</i>		x				x	x	x	
106. <i>pisciformis</i>		x				x	x	x	
107. <i>polymorpha</i>		x				x	x	x	
108. <i>sociabilis</i>		x				x	x	x	
109. <i>spirogyra</i>		x				x	x		x
110. <i>torta</i>						x	x		x
111. <i>tripteris</i>		x				x	x		x
112. <i>viridis</i>						x	x	x	
113. <i>sp.</i>						x	x		
114. <i>Lepocinclis ovum</i>	x	x				x	x	x	
115. <i>texta</i>		x				x	x	x	
116. <i>Phacus acuminata</i>	x	x				x	x		
117. <i>anacoleus</i>		x				x	x		
118. <i>brevicauda</i>		x				x	x		
119. <i>longicauda</i>		x				x	x		x
120. <i>pleuronectis</i>		x				x	x	x	
121. <i>pyrum</i>						s	x	x	
122. <i>stokesii</i>		x				x	x	x	
123. <i>striata</i>		x				x	x		x
124. <i>triqueter</i>		x				x	x	x	
125. <i>Trachelomonas crebea</i>		x				x	x		x
126. <i>gibberosa</i>		x				x	x		
127. <i>euchlora</i>		x				x	x		
128. <i>hispidula</i>		x				x	x		x
129. <i>rugosa</i>		x				x	x		
130. <i>scabra</i>		x				x	x		
131. <i>urceolata</i>		x				x	x	x	
132. <i>volvocina</i>		x				x	x		x
133. <i>spp.</i>						x	x		
VOLVOCALES									
134. <i>Carteria cordiformis</i>	x					x	x		x
135. <i>globosa</i>						x	x	x	
136. <i>spp.</i>						x	x		
137. <i>Chlamydomonas</i> spp.	x					x	x	x	
138. <i>Chlorogonium elongatum</i>	x	x				x	x	x	
139. <i>Coccomonas orbicularis</i>	x	x				x	x		x
140. <i>Collodictyon triculiatum</i>				x				x	
141. <i>Endorina elegans</i>	x	x				x	x	x	
142. <i>Gonium pectorale</i>	x	x				x	x	x	
143. <i>sociale</i>	x	x				x	x	x	
144. <i>Heteromastix angulata</i>	x	x				x	x		x
145. <i>Pandorina morum</i>	x	x				x	x	x	
146. <i>Pedinomonas rotunda</i>	x	x				x	x		
147. <i>Phacotus lenticularis</i>	x	x				x	x	x	
148. <i>Polyblepharides singularis</i>	x	x							
149. <i>Polytoma granulifera</i>	x				x				x
150. <i>uvella</i>		x			x				
151. <i>Polytomella agilis</i>	x	x			x				
152. <i>Pteromonas</i> sp.	x					x	x		
153. <i>Pyramidomonas inconstans</i>	x	x				x	x		
154. <i>Spermatozopsis exultans</i>	x	x				x	x	x	
155. <i>Sphaerellopsis fluviatilis</i>	x	x				x	x	x	
156. <i>Spondylomorom quaternarium</i>	x	x				x	x	x	
157. <i>Thorakomonas ampla</i>	x	x				x	x		x
158. <i>irregularis</i>	x	x				x	x		x
159. <i>phacotoides</i>	x	x				x	x		x
160. <i>Wislouchiella planktonica</i>	x	x				x	x		x

TABLE 1.—*Information concerning six groups of plankton organisms in the Scioto River during 1937—Continued*

Organism	Genus recognizable in formalin	Species recognizable in formalin	Holozoe, food principally bacteria	Holozoe, food principally other organisms	Sap-ro-zoe	Holo-phytic	Pro-duces O ₂ in light	Most abundant in polluted zones	Most abundant elsewhere
CHRYSOMONADIDA									
161. <i>Chrysaopsis sagene</i>	X					X	X		
162. <i>Chrysococcus rufescens</i> et al. punctiformis.....	X	X				X	X		X
163.	X	X				X	X		X
164. <i>Chromulina globosa</i>	X	X		X		X	X		X
165. <i>ovalis</i>	X			X		X	X		
166. <i>Dinobryon</i> spp.....	X	X				X	X		X
167. <i>Hymenomonas roseola</i>	X	X				X	X		X
168. <i>Kephyrion aspera</i>	X	X				X	X		X
169. <i>Lagynton scherffeli</i>	X	X				X	X		
170. <i>Mallomonas akrokomos</i>	X					X	X		X
171. <i>caudata</i>						X	X		X
172. <i>sp.</i>						X	X		
173. <i>Synura uvella</i>	X	X				X	X		X
CRYPTOMONADIDA									
174. <i>Chilomonas paramecium</i>					X				
175. <i>Chroomonas</i> spp.....						X	X		X
176. <i>Cryptomonas maxima</i>	X	X				X	X		X
177. <i>erosa</i>						X	X		X
178. <i>sp.</i>						X	X		
179. <i>Cyathomonas truncata</i>				X					
180. <i>Nephroselmis</i> sp.....						X	X		
181. <i>Protochrysis viridis</i>	X	X				X	X		
182. <i>Rhodomonas lacustris</i>	X	X				X	X		X

Summary of table 1

	Totals	Genus recognizable in formalin	Species recognizable in formalin	Holozoe, food principally bacteria	Holozoe, food principally other organisms	Sap-ro-zoe	Holo-phytic	Pro-duces O ₂ in light	Most abundant in polluted zones	Most abundant elsewhere
Ciliata.....	60	40	8	26	17				28	19
Zoomastigoda.....	19	6	6	14					12	2
Euglenida, colorless.....	18	4	2		3	14			5	
Euglenida, green.....	36	6	29				36	36	14	13
Volvocales.....	26	23	20		1	4	22	22	12	8
Chrysomonadida.....	13	11	8		2		13	13		9
Cryptomonadida.....	9	3	3		1	1	7	7		4

ANALYSIS OF DATA ¹

The average distribution of the ciliates is shown in figure 2. In view of the sharp decrease in numbers just below Shadeville, and the much larger numbers encountered in the lower reaches of the stream, the species were considered separately and it was found possible to divide them into those showing a rise at Shadeville followed by a gradual decrease downstream, and those which showed a drop at Shadeville and a gradual rise downstream. The former group are

¹ It should be emphasized that this paper presents numbers per ml, not standard cubic volumes.

termed "pollutional" ciliates and comprise the genera *Amphisia*, *Aspidisca*, *Carchesium*, *Chaenia*, *Chilodenella*, *Cinetochilum*, *Colpidium*, *Colpoda*, *Epistylis*, *Euplotes*, *Glaucoma*, *Lacrymaria*, *Lembus*, *Lionotus*, *Loxodes*, *Opercularia*, *Oxytricha*, *Paramecium*, *Plagiopyla*, *Pleurotricha*, *Stentor*, *Stylonichia*, and *Vorticella*. These 23 genera represent several more than that number of species. In general they are bacterial feeders, have been found in numbers in sewage polluted streams, or sewage disposal plants, and many occur in large numbers in infusions containing large quantities of organic matter and an abundance of bacteria. That they may also occur in relatively unpolluted situations, or that they may use other food, e. g., *Stentor* may often be seen engorged with *Chlamydomonas*, does not obviate the generalization.

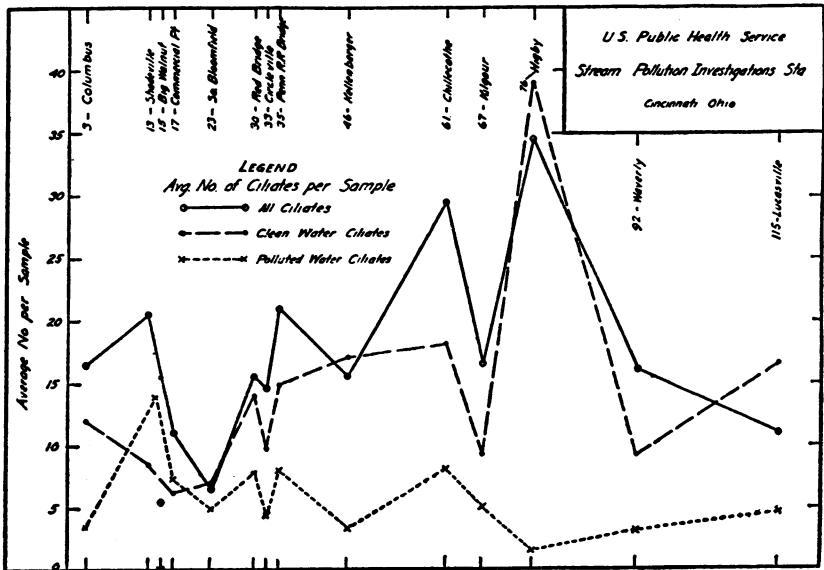


FIGURE 2.—Average distribution of ciliates in the Scioto River in 1937. In this and succeeding figures the ordinates refer to numbers per ml per sample.

The second group comprises the genera *Askenasia*, *Actinobolus*, *Bursaria*, *Codonella*, *Coleps*, *Cyclidium*, *Didinium*, *Frontonia*, *Halteria*, *Holosticha*, *Holophrya*, *Loxocephalus*, *Nassula*, *Onychodromus*, *Protrichon*, *Strombidium*, *Strobilidium*, *Trachelocerca*, *Tintinnidium*, *Urotricha*, and *Uronema*. These 20 genera also comprise more than that number of species and in a few cases at least might reasonably be expected in the pollution zone. Their food is more varied and may be other protozoa or algae. Their distribution in the Scioto River is shown in figure 2.

Table 1 also includes 8 genera of ciliates which occurred so seldom they are not placed in either of the above groups.

If an accurate species determination were possible for *Cyclidium* and *Vorticella*, the distribution of the two above-mentioned groups might show even more pronounced trends. Both genera comprise clean and foul water species, and both are abundant at Shadeville and in the lower river, so that a separation into clean and foul water species might affect each graph. But neither genus can be separated into species after formalin preservation, except for an occasional individual.

The maximum distribution of the ciliates as a whole does not coincide with the polluted zones. Their numbers rise sharply, then drop in this zone, and the greatest numbers are found 61 miles below Columbus, at Chillicothe, where chemical and bacteriological samples show only a slight degree of pollution. But two groups of ciliates are

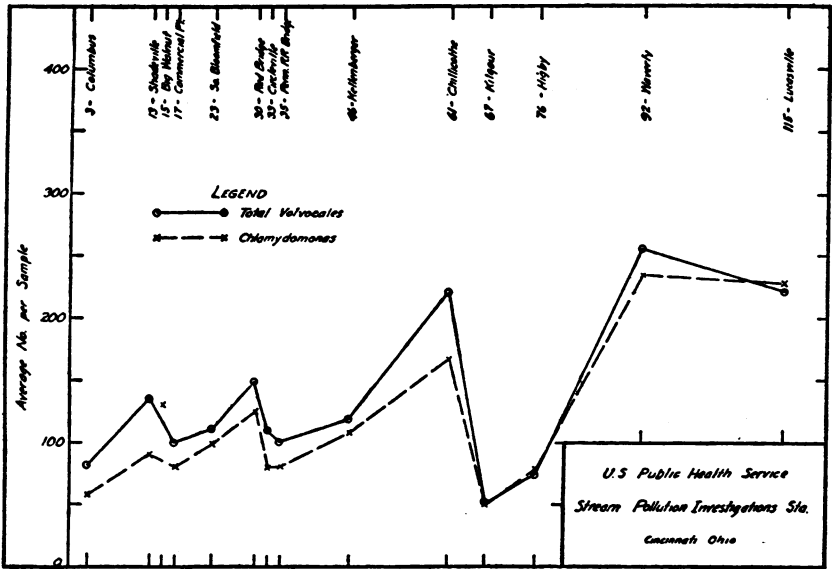


FIGURE 3.—Average distribution of all Volvocales and of *Chlamydomonas* in the Scioto River in 1937. Numbers per ml are shown.

shown to react sharply to the sewage at Shadeville and these two groups may reliably be used as indicators.

The Volvocales do not lend themselves to generalization either. *Chlamydomonas*, for example, is a very common organism on sludge beds, the top of digestion chambers, or in pools highly contaminated by barnyard manure; but in a total of 92 samples of 100 ml each from the Scioto River and tributaries, this organism occurred 81 times, or in 88 percent of the samples. Since more than 146 species of this organism have been described, it might easily be widespread, but it is believed that less than 10 species have occurred in these Scioto samples. If we discard the 5 sets of samples where less than 7 stations were analyzed, its maxima occurred 13 times at clean water stations and

5 times in polluted zones. Four times its maximum was at Chillicothe, and the greatest number ever recorded, 1,680 per ml, as well as the greatest total, occurred at this station. Evidently if one wants to use *Chlamydomonas* as an indicator, a particular species would have to be used, an almost impossible procedure. Figure 3 shows its distribution and the distribution of all Volvocales.

Of the remaining 18 or 19 genera of Volvocales few have occurred in large numbers, and then only during a short time. *Carteria cordiformis* has occurred in some abundance; it has been derived mainly from a tributary, Big Walnut Creek. Figure 4 shows its occurrence; and while its numbers are large at Commercial Point and South Bloom-

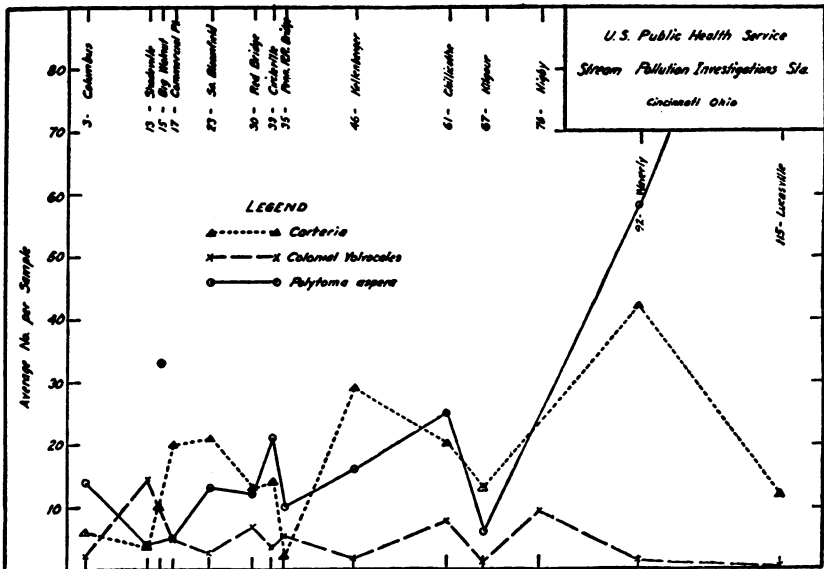


FIGURE 4.—Average distribution of three groups of Volvocales in the Scioto River in 1937. Average numbers of *Polytoma granulifera* contributed by Big Walnut Creek indicated by the isolated circle.

field, they undoubtedly are contributed by Big Walnut, and there is a gradual increase downstream. Considering the large numbers in the pure tributary, the indication is that this species is a clean water form. A similar conclusion is reached for an unnamed organism believed to be a new species of *Polytoma*. The only occurrence of *P. wella* has been in the polluted area. But on October 29 an organism appeared which is described elsewhere (18) as *Polytoma granulifera*, a total of 476 per ml being found in Big Walnut. Very few of these organisms ever appeared in the polluted zone, but they gradually increased to large numbers downstream. Its distribution is shown in figure 4, which gives the averages only for those samples in which it occurred.

The only Volvocales which were characteristic of the polluted stretches of the Scioto were the colonial genera *Eudorina*, *Pandorina*, *Gonium*, *Spondylomorom*, and *Chlamydobotrys*. These last two cannot be differentiated in practice. Figure 4 shows their distribution, and since these genera have had a seasonal occurrence, a seasonal average would show a slightly stronger preference for foul water. It should be pointed out, however, that *Gonium sociale* has been found for two years as a constant and abundant inhabitant of a small relatively unpolluted lake in a Cincinnati park, and *G. pectorale* has at times been abundant there. *Pandorina* is a common river form; in 1935-36 it was common in the Tennessee River at Wilson Dam, Alabama, where there is little pollution. Other genera of Volvocales occurred too sparingly or their distribution was too erratic to make them useful indicators. As far as this study indicates, only certain colonial Volvocales favor pollution.

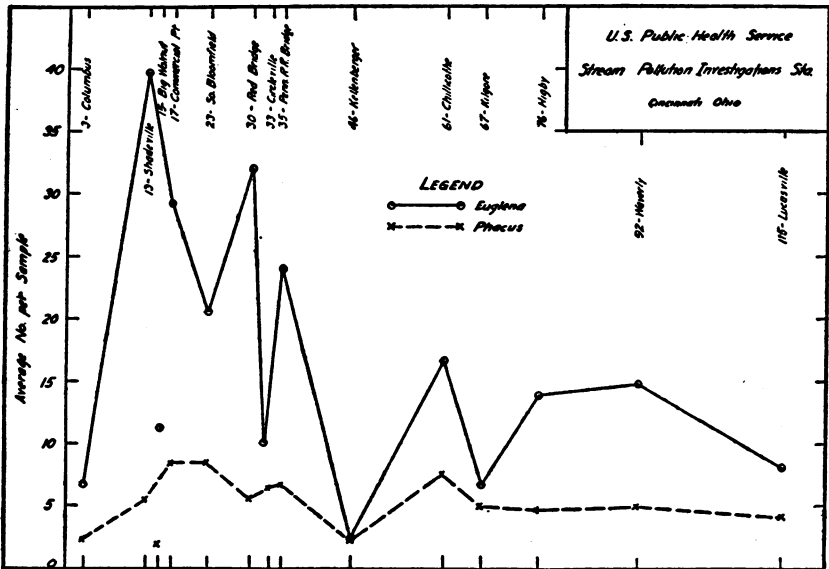


FIGURE 5.—Average distribution of all species of *Euglena* and *Phacus* in the Scioto River in 1937. The numbers per ml contributed by Big Walnut Creek are indicated by the circle and cross.

The Euglenidae were abundant in number and species. Most of the suspended forms were green, while the colorless forms occurred largely as bottom dwellers. As a whole, the Euglenidae were part of the summer plankton, reaching a maximum in the late summer. Some forms have been found throughout the year, while others have not occurred in the samples at all during the colder months. This fact would decidedly restrict their value as indicator organisms. During August they averaged 189 per sample at Red Bridge, and 96 per sample at this station in September, whereas in December and January they were completely absent from half the stations, even though water levels in the river were quite low, i. e., there was little dilution.

Figure 5 shows the average number of Euglenidae per ml per station during an entire year of sampling. It shows a very pronounced abundance in the zone of pollution, and the high numbers persist much further downstream than is true of the ciliates; while the maximum for pollution ciliates is at Shadeville, the maximum for Euglenidae is at Red Bridge.

The numbers of Euglenidae are largely composed of the genera *Euglena*, *Trachelomonas*, and *Phacus*. Figure 5 also shows the distribution of *Phacus*, which is fairly even throughout the length of the stream. It is regrettable that *Euglenas* preserved in formalin often cannot be identified as to species, for the most numerous of this genus is such a group. This group, with the species *polymorpha*, *pisciformis*,

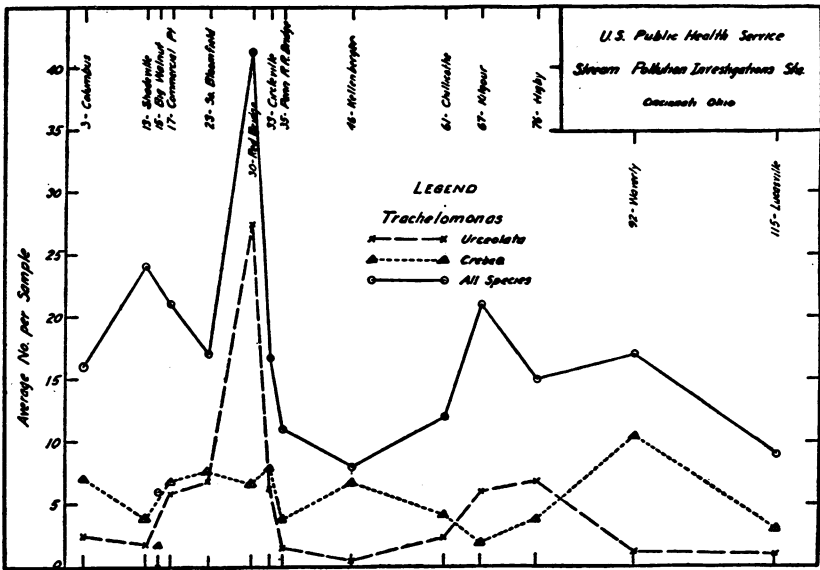


FIGURE 6.—The distribution of all species and two particular species of *Trachelomonas* in the Scioto River in 1937.

and *viridis* comprise most of the *Euglenas* in the samples, and show a fairly well defined high occurrence in the foul water stretch. Curiously enough, *Euglena gracilis*, a fairly common species in sewage disposal plants, has been recognized in only a few samples to date.

For *Trachelomonas*, the species *urceolata* and *crebea* are most important. The latter does not exhibit a marked preference for foul water and its distribution is somewhat like that of *Phacus*. *T. urceolata* shows considerable variation in shell shape and size but probably represents only a single species. It evidently shows a definite response to organic contamination, by increasing to a maximum some distance from the point of contamination, as indicated by the average numbers at Red Bridge and Higby. It is also noteworthy

that it is practically absent from the pure waters of Big Walnut. Neither *T. crebea* nor *T. urceolata* has been found in other clean streams or ponds of this region.

Trachelomonas also demonstrates that the mere occurrence of a species should be very carefully considered before it is called an indicator organism. In the 244 samples examined during the year, *Trachelomonas volvocina* occurred in 33 percent, *T. crebea* in 48 percent, and *T. urceolata* in 34 percent; yet the average occurrence of *T. volvocina* at any station never exceeded 2 per sample and was usually less than 1, while *T. urceolata* reached an average of 27.4 per sample at Red Bridge, and fell below 1 at only one station, Kellenberger's Bridge. It has been shown elsewhere (19) that *T. volvocina* is wide-

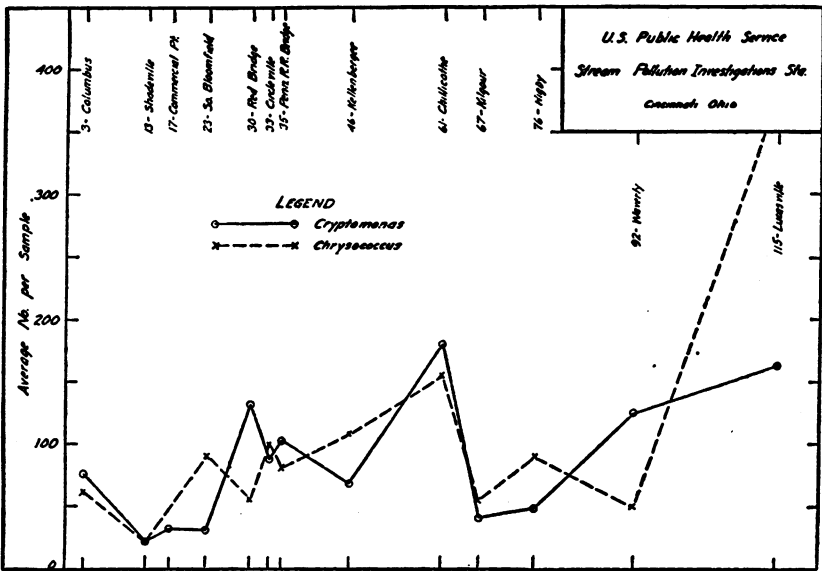


FIGURE 7.—The distribution of *Cryptomonas* and *Chrysococcus* in the Scioto River in 1937.

spread in nature and therefore its frequent occurrence in the Scioto is not significant, but whether or not it occurs in large numbers, and where. Its small numbers but wide occurrence in this stream are simply added evidence of its cosmopolitan nature.

The two groups of flagellates previously mentioned are so influenced by seasonal occurrence that their value as indicator organisms is largely limited to the summer. Two other groups of easily recognized flagellates occur in the Scioto, however, and both have been found in considerable numbers during the whole year. Furthermore, both groups seem to display a very marked negative reaction to contamination, tending to drop very sharply in the polluted zone. These are species of Cryptomonadida and Chrysomonadida, and their behaviour is shown in figure 7. The Cryptomonadida comprise only 10 genera,

8 of which have been identified from the Scioto. Three, *Cryptomonas Chroomonas*, and *Rhodomonas*, are common. *Cryptomonas* is so easily recognized when living that it would be ideal as an indicator organism if only fresh samples were studied; but in formalin-preserved samples its form and color usually change, its flagella are lost, and it is only by careful study that the majority of the specimens can be identified and counted. Once this difficulty is overcome, however, the genus becomes very useful in this respect. In 25 sets of samples taken during a year, 21 showed either a decline in the zone of pollution or a maximum below this zone, and three of the remaining four might be questioned because either a few stations were sampled or because the numbers per sample were very few. Figure 7 gives an excellent indication of the behaviour of this organism. It not only responds to the pollution at Shadeville by a sharp decline, but repeats this below Circleville and Chillicothe, the other points of river pollution. The figures on *Rhodomonas* and *Chroomonas*, the only two other genera of Cryptomonadida which are of importance, are not as complete as for *Cryptomonas*, but in practically every case these two organisms either show a decline in the polluted zone, or their maximum is at Columbus or in the lower portion of the river. *Chroomonas* can only be counted in fresh samples, however, for it is totally unrecognizable in preserved ones and despite its large numbers at times it has never yet been certainly identified in a preserved sample.

The remaining flagellate group, the Chrysomonadida, contains a number of representatives which at times are numerous, but only one genus, *Chrysococcus*, has consistently been present in large numbers. *Dinobryon* has had a sporadic occurrence, and the three or four species of *Mallomonas* have either occurred in few numbers or in few samples. *Chrysococcus* is customarily a very small, round, quite brown and freely motile cell, usually around 5 to 8 microns in diameter. Despite this small size, it is easily distinguished even at 125 diameters, with a little practice; but when its numbers become large, as they frequently do, counts are more accurate if made at 537 diameters, i. e., the high power. It also has the valuable property of being very little changed by formalin preservatives, so that in either fresh or preserved samples it is always easily counted. Figure 7 shows the average number per sample per station over a year, also the numbers contributed by tributary streams. Except for Big Walnut, however, these are limited to from one to three samples, and do not represent a fair average.

The distribution of *Chrysococcus* shows an initial decrease, followed by a second below Circleville and a third below Chillicothe. There is, withall, a steady rise downstream. All of the tributaries contribute to the river population; but the one tributary which is polluted, Paint Creek, contributes the smallest number per sample. The influence

of Big Walnut is shown in the rise from Shadeville to Red Bridge. Figure 8 shows how the organism was distributed on a single date. The numbers at Columbus were very high, but at Shadeville they had dropped almost to zero. A short distance below Shadeville, however, Big Walnut entered the river, diluting it about one-fifth with unpolluted water, and adding a new *Chrysococcus* population of 1,248 per ml. The result was a rise in these organisms which persisted downstream. Only a few *Cryptomonas* were added by Big Walnut, however, and the number of these remained low. Such a course of events could be repeatedly shown for these two organisms, and has occurred at all seasons. It tends to prove that *Chrysococcus* is a

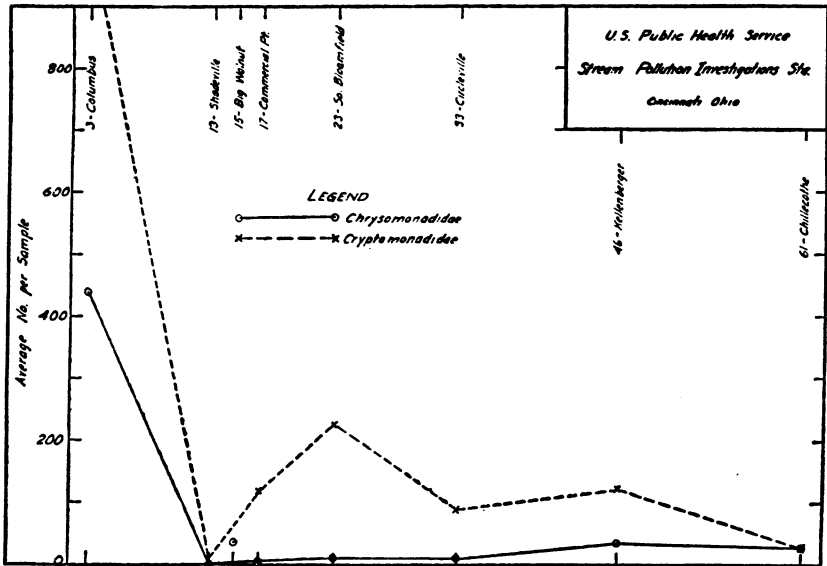


FIGURE 8.—The distribution of *Cryptomonas* and *Chrysococcus* on November 30, 1937, from Columbus to Chillicothe. On this date the Big Walnut Creek was pouring 1,848 *Chrysococcus* per ml into the Scioto, and despite the pollution a sharp rise in their numbers downstream is shown.

sensitive and useful biological indicator for the presence or absence of sewage in this river.

DISCUSSION

The organisms discussed above by no means exhaust the list of those present and identified, about 400 species of Protista having been enumerated. But they indicate the treatment for others as the work advances. Primarily, the aim in such treatment is to arrive at a method of determining lack of pollution, or extent and types of pollution, by examination for certain plankton forms. There is no *a priori* reason why standard determinations on river samples should not include a routine biological examination for some species or group of species just as carefully and exactly done as the 5-day biochemical

oxygen demand, or the *coli-aerogenes* count, and which would be much simpler and more easily performed. Such a determination would not take the place of standard biochemical or bacteriological examinations, nor would it necessarily compete with them, but rather would serve to aid and bring out more clearly their findings. But for such biological examinations an elaborate series of ecological studies is an absolutely necessary background, just as the biochemical and bacteriological standard determinations were gradually developed. This paper represents an attempt to furnish part of that background. Its findings must be taken cautiously because (a) it is the first river survey in which such a detailed study of the plankton has been made relative to pollution, (b) it reports on only the first year of work, and (c) other rivers should be studied in similar fashion to determine whether similar species are present. It cannot be too strongly emphasized that other comparably polluted streams as well as unpolluted ones must eventually be surveyed.

In this study an effort has been made to count and identify all species present in a definite volume of water, and to relate their occurrence to the condition of the river. Correlative studies are not yet advanced to a point where the time of flow from Columbus to Lucasville can be estimated, but it is evident that the water ages sufficiently in that distance so that some forms increase considerably in numbers while others decrease. Now the protozoan population of a river is a mixotropic one and there is no definite potamoplankton, so whatever changes in population are found in the length of the river are either ascribable to tributary streams, or to conditions in the river itself. If we compare the forms occasionally present at Shadeville with those occasionally present at Lucasville (table 1) not a great deal of difference is found. But if we compare those which are numerous at each of the two stations (columns 8 and 9) a marked difference is seen. The first comparison merely points out the tendency toward a cosmopolitan distribution of the protozoa; the second comparison differentiates sharply between those which tolerate or favor pollution, and those which are clean water forms. To this latter group could be added the organisms common to Big Walnut. This would not materially change the group since Big Walnut is a clean water stream. It contains a smaller group of organisms, its water being less aged than the river water. No tables are given in the present paper showing the occurrence of each species at each station. Tables giving quantitative distribution of these organisms will be presented in a detailed report at the conclusion of this Scioto River study. The figures show average numbers for various species which tables would only accentuate. Those which are most abundant in the polluted zone must also be carefully checked for their abundance in Big Walnut, lest its large numbers account for those present at stations below its

mouth. This is the case for *Chrysococcus* at times as well as *Carteria cordiformis* and the colorless *Polytoma* previously mentioned.

In general, the same protozoa are numerous in the polluted zone of the Scioto that Kofoid (1) found to be numerous in the upper reaches of the Illinois. One notable difference is that the Sarcodina are poorly represented in number and species in the Scioto as compared with the Illinois. On the contrary, free-swimming colorless flagellates (Proto-mastigida) as *Oicomonas*, *Desmarella*, *Monas*, and *Bodo* are very abundant in the Scioto. Kofoid did not consider the Cryptomonadidae of much importance, although they were of constant occurrence. Allen (9) was not certain that his identification of *Cryptomonas* was correct, but thought it favored sewage. Three diverse points of view are thus seen with regard to this organism. They illustrate very well the need for carefully specialized studies, as well as studies of other streams referred to in the preceding. *Cryptomonas*, as shown above, undergoes such great changes in a formalin preservative as to become unrecognizable unless previously identified in a living state from the unpreserved portion of the samples. Its general shape is usually lost, its color changes, the flagella are destroyed, and it exhibits a pronounced tendency to be found in the center of masses of silt. *Cryptomonas erosa*, which has been by far the most abundant of this genus in plankton samples examined by the writer, as well as the most widespread, is so small as to escape readily through a plankton net, and in formalin preservatives to escape identification at a hundred diameters or lower, thereby being easily overlooked, especially if in debris, in a Sedgwick-Rafter cell. But if concentrated by centrifuging there is practically no loss from the sample, and the catch can be counted by the drop method. The following figures illustrate some of the differences due to the behaviour of organisms in a formalin preservative, and the difficulties in counting:

Samples examined on May 4, 1937

Sample (pond water, no silt)	Number in 20 paths (1 drop) at 125 X			Number per ml (estimated)		
	Treatment			Treatment		
	A	B	C	A	B	C
<i>Chlamydomonas</i> sp. 1.....	14	1,280	1,470	280	256	294
<i>Chlamydomonas</i> sp. 2.....	1	90	0	20	18	0
<i>Trachelomonas volkocina</i>	4	410	430	80	82	86
<i>Euglena pisciformis</i>	1	10	60	20	2	6
<i>Cryptomonas erosa</i>	7	730	650	140	146	130

Treatment A consisted of shaking the sample (about a liter) thoroughly, withdrawing some with a pipette which delivered 20 drops per ml, placing a drop on a slide, covering with a 25 mm square cover-

glass, and counting two paths across the middle, at right angles to each other. This was done with 10 drops. Treatment B used the same counting procedure, but the sample was well shaken and 100 ml were centrifuged for about 4 minutes at 2,200 r. p. m., 99 ml then decanted, and the count was made on the remaining 1 ml containing the catch. Treatment C varied from B only by the addition of formalin to make a 4 percent strength some 10 minutes prior to centrifuging. On September 17, 1937, treatment C was used on a Scioto River sample, very silty, and with 100 ml decanted so that 50 drops were left; one drop equaled 2 ml instead of 5. *Cryptomonas erosa* was counted, and at 125 diameters (low dry) 240 were found; but at 537 diameters (high dry) 430 were found. These represented 120 and 860 per ml, respectively, and there is little doubt that the low power count in this last case is far too low. This low count is due to inability to distinguish *Cryptomonas* from particles of debris at 125 diameters, and inability to see those present in silt flocs. Both of these sources of error are removed with the higher magnification.

In the case of the second species of *Chlamydomonas* referred to in the table, the formalin probably changes it in such a way that it is no longer separable from the first species, and the two are probably counted together, as evidenced by the higher numbers of the first species after the formalin treatment. *Trachelomonas*, on the other hand, is easily recognizable and, being unchanged by any treatment, the numbers for all three procedures agree closely. The counts for *Euglena* illustrate the wide error which may occur when only very small numbers of an organism are present.

The diversity of views with regard to *Cryptomonas* might well extend to other organisms. Kofoid (1) and Allen (9) each found *Synura uvella* to be common, and Allen thought it was definitely benefited by sewage. Whipple (20) shows that various German writers have placed it in septic, pollutional, and contaminate zones; yet Forbes and Richardson (2) do not mention it as occurring in the Illinois River in 1911 and 1912, and its occurrence in the Scioto has been limited to very small numbers in 8 samples. Kofoid also found very few *Paramecium*, but was of the opinion that it favored sewage. *Eudorina elegans* is another organism on which there is disagreement. Allen states that it is deleted by sewage; Kofoid found large numbers in the Illinois; and in the Scioto this colonial flagellate has been far more abundant in the polluted zone than elsewhere, although it was common at all stations. Allen was uncertain about the identification of 17 of the organisms he used, and himself questions the validity of conclusions which might be sought from his work.

As long as such divergent findings are not more adequately explained, there can be no trustworthy utilization of protozoan species as true indicators of the condition of a body of water. And the first

step in this work is the collection and compilation of a sufficient mass of data for individual species so that their relationship to polluted and clean water is known. Questionable species should play a minor role, and only species for which clean-cut recognition is possible should be used.

SUMMARY

Two hundred and forty-four plankton samples were taken from 16 sampling stations along the Scioto River and a few tributaries, including stations in the zone of greatest pollution as well as transition and clean water zones. These were examined in part as fresh, unpreserved samples and in part as 4 or 5 percent formalin samples. The plankton was concentrated by centrifuging and examined drop by drop, so that the species could be identified and counted either at a magnification of 125 diameters or 537 diameters. One hundred and eighty-two species of protozoa were identified and their relative abundance at the various stations noted. In this paper it is shown that one group of ciliates definitely favors pollution, and another group is adversely affected by it. The Volvocales, an order of green flagellates, cannot be considered as a group, for those of the genus *Chlamydomonas* show large average numbers below the zone of pollution, while four colonial genera, *Endorina*, *Pandorina*, *Spondylomorom*, and *Gonium* show a rise in the foul water zone and a decline in the clean water zone.

Euglena shows a distinctly favorable reaction to polluted water, considering all species of this genus found in the Scioto. *Trachelomonas* behaves likewise, but the different species react somewhat differently to pollution, and it is probable that each species should be considered separately. The genus *Phacus* shows a fairly uniform distribution throughout the river, and as a genus is not a good indicator.

One genus of Cryptomonadida, *Cryptomonas*, probably represented by two species, is shown to be present throughout the year and to react very sharply to pollution by declining in numbers. Not heretofore used by investigators probably because unrecognizable in preserved samples, it promises to be a very valuable indicator.

Another organism not heretofore considered is a small flagellate, *Chrysococcus*, of the Chrysoomonadida, easily recognizable in preserved samples and reacting as sharply and negatively to pollution as *Cryptomonas*. It also is believed to be a valuable indicator. But both Cryptomonadida and Chrysoomonadida should be studied in other streams.

It is shown that some organisms which appear in the polluted zone in large numbers may be clean water forms added by tributaries, and diminishing in the presence of pollution, and that the importance of tributaries in this respect must be carefully recorded.

Recognition of organisms as to species is important and must be carried out wherever feasible. Examination of fresh samples greatly facilitates identification of preserved forms.

It is not safe to draw conclusions as to the ecologic status of a form because it is found in either clean or polluted waters. River plankton is a mixed one, and both clean streams and polluted ones should be studied. Conclusions may then be based on the relative numbers present in the two situations.

It appears probable that there are certain species of plankton protozoa which, because of clear cut reactions to the presence of sewage, may serve as indices of pollution in much the same way as a 5-day biochemical oxygen demand or a coli-aerogenes count. Quantitative determinations for such species would give a standard biological determination to supplement the chemical and bacteriological standard determinations. The first year's detailed examination of the Scioto River protozoan plankton, reported herein, gives an indication of some such species but must be accepted cautiously because of the short time the studies have been in progress, the lack of comparison with other rivers, and the fact that some species within groups heretofore generally accepted as favorable to pollution, e. g., the Euglenida, apparently do not favor pollution.

ACKNOWLEDGMENT

The writer wishes to acknowledge with thanks the preparation of figure 1 by Passed Assistant Sanitary Engineer James H. Le Van, and of figures 2 to 8 by Associate Sanitary Engineer Russell S. Smith.

REFERENCES

- (1) Kofoid, C. A.: Plankton studies. IV. The plankton of the Illinois River 1894-1899, with introductory notes upon the hydrography of the Illinois River and its basin. Part 1. Quantitative investigations and general results. Bulletin Illinois State Lab. Nat. History, vol. 6, Art. 2, 95-629 (1903).
- (2) Forbes, Stephen A. and Richardson, R. E.: Studies on the biology of the upper Illinois River. Bulletin Illinois State Lab. Nat. History, vol. 9, Art. 10, 481-574 (1913).
- (3) Purdy, W. C.: A study of the pollution and natural purification of the Illinois River. II. The plankton and related organisms. Pub. Health Bull. No. 198, U. S. Government Printing Office, 1930.
- (4) Galtsoff, P. S.: Limnological observations in the upper Mississippi, 1921. U. S. Bureau of Fisheries Bull., 39: 347-438 (1924). (Document 958.)
- (5) Eddy, Samuel: The plankton of the Sangamon River in the summer of 1929. Bulletin Illinois Nat. History Survey, vol. 19, Article 5, 469-486 (1932).
- (6) Eddy, Samuel: A study of fresh water plankton communities. Illinois Biol. Monographs, vol. 12, No. 4 (1934).
- (7) Purdy, W. C.: Plankton studies. In Investigation of the pollution and sanitary conditions of the Potomac watershed, with special reference to self-purification and the sanitary condition of shell-fish in the lower Potomac River. Hygienic Lab. Bull. No. 104, U. S. Government Printing Office, 1916.

- (8) Purdy, W. C.: A study of the pollution and natural purification of the Ohio River. I. The plankton and related organisms. Public Health Bulletin No. 131, U. S. Government Printing Office, 1923.
- (9) Allen, Winfred E.: A quantitative and statistical study of the plankton of the San Joaquin River and its tributaries in and near Stockton, California, in 1913. Univ. Calif. Pub. Zool., vol. 22, No. 1 (1920).
- (10) Rudolfs, Willem, Heukelejian, H., Lackey, J. B., Zeller, P. J. A. and Lacy, I. O.: Studies on Raritan River pollution 1927-28. Bulletin 489, N. J. Agr. Exp. Station, 1929.
- (11) Turner, C. L.: Biological survey of Fox, Wisconsin, and Flambeau Rivers, Wisconsin, with special reference to pollution. Stream Pollution in Wisconsin. Special Report. A joint report of the Conservation Commission and State Board of Health of Wisconsin concerning activities in the control of stream pollution, from July 1, 1925 to December 31, 1926. Prepared by the Bureau of San. Eng., Wisc. State Bd. of Health, Madison, January 1927. P. 242.
- (12) Wiebe, A. H.: Preliminary report concerning the biological survey of the upper Mississippi River with special reference to pollution. *Ibid.*, p. 322.
- (13) Fritsch, F. E.: Algological notes. VI. The plankton of some English Rivers. *Ann. Bot.*, 19: 162-167 (1905).
- (14) Butcher, R. W., Longwell, J., and Pentelow, F. T. K.: Survey of the River Tees. Part III. The Non-tidal reaches—chemical and biological. Water Pollution Research Technical Paper No. 6. H. M. Stationary Office, London, 1937.
- (15) Seeler, Theodor: Über eine quantitative Untersuchung des Planktons der deutschen Ströme unter besonderer Berücksichtigung der Einwirkung von Abwässern und der Vorgänge der biologischen Selbstreinigung. [I. Die Elbe.] *Arch. f. Hydrobiologie*, 28: 323-356 (1935).
- (16) Seeler, Theodor: Über eine quantitative Untersuchung des Planktons der deutschen Ströme unter besonderer Berücksichtigung der Einwirkung von Abwässern und der Vorgänge der biologischen Selbstreinigung. II. Der Rhein. *Arch. f. Hydrobiologie*, 30: 85-114 (1936).
- (17) Bennin, E.: Das Plankton der Warthe in den Jahren 1920-24. *Arch. f. Hydrobiologie*, 17: 545-593 (1926).
- (18) Lackey, James B. In Press.
- (19) Lackey, James B.: A study of some ecologic factors affecting the distribution of protozoa. *Ecologic Monographs*, October 1938.
- (20) Whipple, Geo. C.: *The Microscopy of Drinking Water*. 4th ed., rev. by G. M. Fair and M. C. Whipple. John Wiley & Sons, New York, 1927.

COMPARISON OF MODIFIED EIJKMAN MEDIUM AND STANDARD LACTOSE BROTH IN THE EXAMINATION OF OYSTERS, CLAMS, AND SHELLFISH-GROWING WATERS

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The investigation described in this paper was conducted for the purpose of comparing the results of fermentation tests made in modified Eijkman medium at 46° C., with the results of similar tests conducted in standard lactose broth at 37° C. For the purpose of this study, samples of oysters, clams, and of shellfish-growing waters were examined by each of the two methods under comparison. It is hoped that the results obtained, and herein presented, will augment our present knowledge, promote discussion, and incite further investigation of bacteriological methods in the analysis of shellfish.

Many means have been employed in the attempt to differentiate *Bacterium coli* from the non-*coli* section of the *coli-aerogenes* group.

Prior to 1904, the principal investigations made used a fermentation test of 37° C. Eijkman (1904) began the first work on the fermentation method at a temperature of 46° C. His view was that *Bact. coli*, originating from the intestinal tract of man and warm-blooded animals, could multiply and produce gas in glucose broth at 46° C., and that this temperature would prevent the growth of other members of the *coli-aerogenes* group, generally considered as having no sanitary significance.

Interest has increased in recent years in the use of the Eijkman test at 46° C. as a possible substitute for the standard procedure using lactose broth at 37° C. Perry and Hajna (1, 2), of the Maryland State Health Department, have used the modified Eijkman test to enumerate *Bact. coli* in extensive studies of water from shell-fish-growing areas, oysters, and crabmeat. They found that this medium and temperature inhibited the growth of practically all of the intermediate types of *Bact. coli*, *Citrobacter*, and *Aerobacter* which are present in water. Dodgson (3) has carried on numerous experiments at 46° C. and is of the opinion that this temperature is too high for the growth of *Bact. coli*. Minkevich et al. (4) decided that 46° C. is the maximum temperature at which *Bact. coli* will grow, and that it invariably grows at this temperature if massive inoculations are made; that it frequently fails to grow if the inoculations are not massive, but if the temperature is reduced to 43° to 43.5° C. even single-cell inoculations will demonstrate their presence. He recommends the latter temperature for obtaining the *coli* content of water.

Further reference to studies made of this subject may be found in the reports of Leiter (5), Brown and Skinner (6, 7), and Ruchhoft, Kallas, Chinn, and Coulter (8).

METHODS

The bacteriological examinations were made according to the following detailed outline of laboratory procedure:

I. Original inoculations were made in parallel in both standard lactose broth and modified Eijkman broth.

1. *Oysters*.—The composite shell liquor from 5 oysters was used for each sample:

(a) Each of 5 tubes was inoculated with 1 ml of undiluted oyster liquor.

(b) Each of 5 tubes was inoculated with 1 ml of 1:10 dilution (1 ml undiluted oyster liquor to 9 ml sterile 2-percent salt solution).

(c) Each of 5 tubes was inoculated with 1 ml of 1:100 dilution (1 ml of dilution (b) above, added to 9 ml sterile 2-percent salt solution).

2. *Clams*.—The composite shell liquor from 5 clams was used for each sample and the original inoculations were made in exactly the same manner as that described for oysters.
3. *Shellfish-growing waters*.—50 to 60 ml of sea water collected in a sterile bottle were used for each sample.
 - (a) One tube was inoculated with 10 ml of undiluted sea water.
 - (b) One tube was inoculated with 1 ml of undiluted sea water.
 - (c) One tube was inoculated with 1 ml of 1:10 dilution (1 ml of undiluted sea water to 9 ml of sterile 2-percent salt solution).

II. All standard lactose broth tubes were incubated at 37° C., while all modified Eijkman broth tubes were incubated at 46° C.

III. Examination of the inoculated fermentation tubes and confirmation for *Bact. coli* and for the *coli-aerogenes* group.

1. Standard lactose broth tubes—

- (a) After 24 hours' incubation, gas formation in any amount was considered a positive presumptive test. Eosin methylene blue agar plates were streaked from tubes showing gas and incubated for 18 to 24 hours at 37° C. Tubes not showing gas were incubated an additional 24 hours, and those showing gas at end of 48 hours were streaked on E. M. B. agar.
- (b) After 48 hours' incubation, the absence of gas formation was considered a final negative test.

2. Modified Eijkman broth tubes—

- (a) Examined in identically the same manner as the standard lactose broth tubes described in 1 above.

IV. E. M. B. agar plates were examined after 18 to 24 hours' incubation at 37° C. and one or more colonies were selected for identification. The absence of growth was considered a final negative test.

V. Colonies fished from E. M. B. agar plates were transferred to Koser's citrate, to Eijkman broth, and to lactose broth. The lactose broth and the citrate media were incubated at 37° C., while the Eijkman broth was incubated at 46° C. for 48 hours.

VI. When these colonies, fished from E. M. B. agar plates, gave a positive Eijkman test within 48 hours, produced gas in lactose broth, and failed to grow in Koser's citrate medium, they were considered as *Bact. coli* in pure culture. The cultures which formed gas in lactose broth and produced definite turbidity in citrate in 48 hours were classified as members of the *coli-aerogenes* group of bacteria.

The Eijkman broth tubes were incubated in a large sized incubator equipped with two ventilation fans, with temperature controlled by a metastatic thermo-regulator and special relay. With this type of incubator, temperature control to within plus or minus 0.25° C. may be had in all parts of the incubator chamber. During this study only minor variations from this limit were observed.¹

For incubation the tubes were stored in wire baskets to permit a free circulation of air. As a further check on broth temperatures, an accurate thermometer placed in a test tube of water was kept in the incubator at all times. The variations noted (see footnote 1) were from readings made on this thermometer.

RESULTS

The results obtained in this study are presented in tables 1 and 2. Table 1 gives a detailed analysis of the results with reference to the number of tubes inoculated, the number of tubes showing gas in both 24 and 48 hours, and the number confirming for *Bact. coli* or for members of the *coli-aerogenes* group. Calculated from the data given, percentages are presented of the total number of tubes showing gas production, of the inoculated tubes which confirmed for *Bact. coli* and for the *coli-aerogenes* group, and of the gas-forming tubes which confirmed for the pure culture and for the group. It is to be noted that the results given for the *coli-aerogenes* group include the tubes which separately confirmed for *Bact. coli*.

In table 2 the average most probable numbers of *Bact. coli* and the average M. P. N. of *coli-aerogenes* group organisms recovered from each type of sample by each of the two methods employed, are presented.

DISCUSSION

Inspection of the results given in table 1 reveals some interesting points in a comparison of these two media: First, it is evident that the standard lactose broth "picked up" more of the bacteria which are capable of fermenting these media than did the Eijkman broth. For the 713 water samples and for the 72 oyster samples, the number of tubes with fermentation in lactose broth was almost double the number of Eijkman broth tubes showing fermentation. For the 139 clam

¹The following variations in temperature were noted:

1. A drop of 1.5° C. or less immediately after loading, always going back to 46° C. within a period of 2 hours. 2. For 81.1 percent of the water samples examined the incubator temperature remained within the possible range of plus or minus 0.25° C., except for the initial drop. 3. For 3.6 percent of the water samples the maximum temperature variation was plus 0.3° C. during 13.5 hours of the total 48. 4. For 2 percent of the water samples the maximum variation was a plus 0.5° C. for a period of 13½ hours. 5. For 4.9 percent of the water samples the maximum variation was a minus 0.5° C. during a period of 6 hours. 6. For 2 percent of the water samples the maximum variation was a minus 1.5° C. in a 4-hour period. 7. For 6.4 percent of the water samples the temperature varied to a plus 0.5° C. during a 4-hour period. 8. No variations in temperature, beyond the possible control range, were noted for the oyster and clam samples.

samples, the difference is very much less but still follows the same trend.

TABLE 1.—Comparative results with a modified Eijkman medium and with standard lactose broth

	Oyster water, 713 samples		Oyster, 72 samples		Clams, 139 samples	
	Lactose broth	Eijk- man broth	Lactose broth	Eijk- man broth	Lactose broth	Eijk- man broth
Total tubes inoculated.....	2, 139	2, 139	1, 080	1, 080	2, 085	2, 085
Tubes having gas 24 and 48 hours.....	1, 312	672	661	407	739	607
Tubes having gas at 24 hours.....	992	499	542	329	568	499
Tubes having gas at 48 hours.....	320	173	119	78	171	108
Total confirmation coli-aerogenes group.....	952	337	613	309	521	304
Number 24 hours tubes confirmed.....	846	317	575	266	466	277
Number 48 hours tubes confirmed.....	106	20	38	43	55	27
Total confirmation Bact. coli.....	719	260	456	254	409	260
Number 24 hours tubes confirmed.....	651	243	451	232	382	252
Number 48 hours tubes confirmed.....	68	17	5	22	27	8
Percent of tubes with fermentation, 24 and 48 hours....	61. 3	31. 4	61. 2	37. 6	35. 4	29. 1
Percent of inoculated tubes confirmed for Bact. coli....	33. 6	12. 1	42. 3	23. 5	19. 5	12. 4
Percent of gas tubes confirmed for Bact. coli.....	54. 8	38. 6	68. 9	62. 4	55. 3	42. 8
Percent of inoculated tubes confirmed for coli-aero- genes group.....	44. 5	15. 7	56. 7	28. 6	24. 9	14. 5
Percent of gas tubes confirmed for coli-aerogenes group..	72. 5	50. 1	92. 7	75. 9	70. 5	50. 0

TABLE 2.—Average most probable number of *Bacterium coli* and coli-aerogenes group organisms recovered from oysters, clams, and water by Eijkman broth and by lactose broth

Sample	Number of samples	Bacterium coli		Coli-aerogenes group	
		Eijkman	Lactose	Eijkman	Lactose
Water (salt).....	713	31	97	36	132
Oysters.....	72	257	1, 635	650	3, 219
Clams.....	139	310	561	337	945

Second, the percentage of inoculated tubes confirming for *Bact. coli* was consistently greater for standard lactose broth in each of the three kinds of samples. Likewise, the percentage of lactose broth tubes showing gas production which later confirmed for *Bact. coli* exceeded the percentage confirmed from Eijkman broth.

Third, comparing these two media in respect to the percentage of inoculated tubes and the percentage of gas-forming tubes which confirmed for the coli-aerogenes group, it appears that the Eijkman broth failed to eliminate many of the members of the non-*coli* section of the coli-aerogenes group, which it is supposed to inhibit. It would seem that many aerogenes grow at 46° C., as evidenced by the fact that the number of coli-aerogenes isolated at this temperature greatly exceeded the number of *Bact. coli* isolated.

Table 2 shows the average M. P. N. of *Bact. coli* and the average M. P. N. of the *coli-aerogenes* group organism isolated with each medium, using the same samples. Again, on this basis, it is evident that the standard lactose broth "picked up" more *Bact. coli* than did the Eijkman test. For the 713 water samples the average M. P. N. is over 3 times as great from lactose broth as from the Eijkman test; for the 72 oyster samples the ratio is more than 6 to 1, and for the 139 clam samples, almost 2 to 1. The average M. P. N. of the *coli-aerogenes* group isolated from these two media also indicates that Eijkman broth at 46° C. did not prohibit the growth of many more of the group organisms than did the standard lactose broth.

During this study considerable difficulty was experienced in obtaining typical growth transplants from positive tubes incubated at 46° C. When 48-hour positive Eijkman tubes were streaked on E. M. B. agar plates, they often failed to give the characteristic reaction of either *A. aerogenes* or *Bact. coli*. The colonies were large, opaque, and faintly colored. Many of them were fished to standard lactose broth, incubated at 37° C., and later replated, and this process carried through several times. Most of the cultures were slow in fermenting lactose broth, requiring about one week of incubation to produce any evidence of gas. When plated on E. M. B., the appearance of the colonies was the same as when first observed. Invariably, after several weeks of such enrichment in lactose broth and many purifications, these cultures were found to produce the typical reaction of either *A. aerogenes* or the characteristic sheen of *Bact. coli*. It would seem that many of these originally irregularly reacting cultures conform to the common *Bact. coli* or the *coli-aerogenes* group reacting strains, only after repeated transfer and purification at 37° C.

CONCLUSIONS

Standard lactose broth is more suitable for the detection of *Bact. coli* than the modified Eijkman procedure. The Eijkman test inhibits the growth of some strains of *Bact. coli* and fails to eliminate some non-*coli* members of the *coli-aerogenes* group. The inability to obtain typical growth transplants from positive Eijkman broth tubes limits its value for quantitative studies.

REFERENCES

- (1) Perry, C. A., and Hajna, A. A.: A modified Eijkman medium. *J. Bact.*, **26**: 419-429 (October 1933).
- (2) Perry, C. A., and Hajna, A. A.: Routine use of a modified Eijkman in the examination of oysters, crabmeat, and other substances. *Am. J. Pub. Health* **25**: 720-724 (June 1935).
- (3) Dodgson, R. W.: Shellfish and the public health. *Pub. Health*, **50**: 279-284 (June 1937).
- (4) Minkevich, I. E., Aleksandrov, N. I., and Soboleva, E. I.: The application of the principle of Eijkman's fermentation test for determining the coli titre of water. *J. Hyg.*, **36**: 64-66 (February 1936).

- (5) Leiter, L. W.: The Eijkman fermentation test as an aid in the detection of fecal organisms in water. *Am. J. Hyg.* 9: 705-734 (May 1929).
- (6) Brown, J. W., and Skinner, C. E.: Is the Eijkman test an aid in the detection of fecal pollution of water? *J. Bact.*, 20: 139-150 (August 1930).
- (7) Skinner, C. E., and Brown J. W.: The failure of bacterium coli from human feces to grow at 46° in the Eijkman or the Bulfr tests. *J. Bact.*, 27: 191-200 (February 1934).
- (8) Ruchhoft, C. C., Kallas, J. G., Chinn, B., and Coulter, E. W.: Coli-aerogenes differentiation in water analysis; biochemical differential tests and their interpretation. *J. Bact.*, 22: 125-181 (August 1931).

DEATHS DURING WEEK ENDED OCTOBER 29, 1938

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

	Week ended Oct. 29, 1938	Correspond- ing week, 1937
Data from 88 large cities of the United States:		
Total deaths.....	7,981	¹ 8,126
Average for 3 prior years.....	¹ 7,993	-----
Total deaths, first 43 weeks of year.....	348,653	373,368
Deaths under 1 year of age.....	542	¹ 510
Average for 3 prior years.....	¹ 516	-----
Deaths under 1 year of age, first 43 weeks of year.....	22,659	24,036
Data from industrial insurance companies:		
Policies in force.....	68,282,548	69,848,865
Number of death claims.....	12,594	12,266
Death claims per 1,000 policies in force, annual rate.....	9.6	9.2
Death claims per 1,000 policies, first 43 weeks of year, annual rate.....	9.3	9.8

¹ Data for 86 cities.

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

CURRENT WEEKLY STATE REPORTS

These reports are preliminary, and the figures are subject to change when later returns are received by the State health officers.

In these and the following tables, a zero (0) indicates a positive report and has the same significance as any other figure, while leaders (.....) represent no report, with the implication that cases or deaths may have occurred but were not reported to the State health officer.

Cases of certain diseases reported by telegraph by State health officers for the week ended November 5, 1938, rates per 100,000 population (annual basis), and comparison with corresponding week of 1937 and 5-year median

Division and State	Diphtheria				Influenza				Measles					
	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median		
NEW ENG.														
Maine.....	12	2	1	1	.....	.....	.....	.....	3	.....	183	30	37	20
New Hampshire.....	0	0	0	0	.....	.....	.....	.....	.....	.....	.....	.....	45	3
Vermont.....	0	0	0	0	.....	.....	.....	.....	.....	.....	109	8	39	3
Massachusetts.....	11	9	3	7	.....	.....	.....	.....	.....	.....	94	80	59	59
Rhode Island.....	8	1	3	1	.....	.....	.....	.....	.....	.....	.....	.....	2	2
Connecticut.....	6	2	4	5	6	2	1	2	111	37	4	15	4	15
MID. ATL.														
New York.....	6	16	28	28	17	110	116	113	52	128	77	239	77	239
New Jersey.....	13	11	11	11	25	21	15	15	20	17	155	23	155	23
Pennsylvania.....	20	39	34	47	.....	.....	.....	.....	20	40	675	97	675	97
E. NO. CEN.														
Ohio.....	44	57	48	138	.....	.....	2	7	12	16	160	79	160	79
Indiana.....	47	31	42	85	24	16	36	28	6	4	10	10	6	10
Illinois.....	42	63	41	49	8	12	15	12	17	25	300	20	17	25
Michigan.....	28	26	22	24	.....	.....	.....	.....	2	64	59	50	64	59
Wisconsin.....	4	2	2	4	18	10	27	29	89	50	32	32	89	50
W. NO. CEN.														
Minnesota.....	8	4	12	12	2	1	.....	.....	193	98	3	16	193	98
Iowa.....	65	32	5	13	2	1	.....	.....	39	19	2	2	39	19
Missouri.....	30	23	39	67	25	19	17	39	17	13	293	8	17	13
North Dakota.....	52	7	4	2	.....	.....	.....	.....	1,485	201	.....	2	1,485	201
South Dakota.....	23	3	3	3	15	2	.....	.....	23	3	.....	5	23	3
Nebraska.....	8	2	7	9	4	1	13	1	11	8	1	3	11	8
Kansas.....	22	8	14	14	8	3	6	.....	11	4	22	4	11	4

See footnotes at end of table.

Cases of certain diseases reported by telegraph by State health officers for the week ended November 5, 1938, rates per 100,000 population (annual basis), and comparison with corresponding week of 1937 and 5-year median—Continued

Division and State	Diphtheria				Influenza				Measles			
	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median
SO. ATL.												
Delaware.....	40	2	1	0					60	3		
Maryland 2.....	25	8	10	17	12	4	1	1	75	24	6	9
Dist. of Col.....	33	4	5	10	8						3	3
Virginia.....	195	101	63	66	227	118			85	44	28	38
West Virginia.....	75	27	47	49	28	10	8	10	39	14	15	8
North Carolina 2.....	212	142	117	119	6	4		5	151	101	174	39
South Carolina 2.....	89	32	16	30	818	294	163	192	11	4	37	5
Georgia 2.....	74	44	42	44	34	20			7	4		
Florida 2.....	62	20	46	15			10	1	125	40	22	1
E. SO. CEN.												
Kentucky.....	71	40	33	52	34	19	9	14	7	4	29	29
Tennessee 2.....	56	32	21	91	49	27	66	46	2	1	72	7
Alabama 2.....	49	27	41	55	83	46	91	36	16	9	5	4
Mississippi 2.....	80	31	20	21								
W. SO. CEN.												
Arkansas.....	94	37	31	25	122	48	26	14	10	4	4	2
Louisiana.....	27	11	27	21	2	1	5	5	108	44	1	3
Oklahoma.....	61	30	38	16	156	76	22	22	31	15	1	2
Texas 2.....	78	92	58	63	160	189	203	131	10	12	18	12
MOUNTAIN												
Montana.....	10	1	0	2	87	9	3	3	1,470	152	13	3
Idaho.....	0	0	2	0	63	6	2	2	550	52	2	2
Wyoming.....	0	0	0	0					111	5	1	1
Colorado.....	49	10	3	7	15	3			24	5	31	4
New Mexico.....	124	10	4	5	12	1		1	173	14	29	25
Arizona.....	38	3	2	2	721	57	36	13	13	1		6
Utah 2 4.....	0	0	105	1	20	2			100	10	17	15
PACIFIC												
Washington.....	6	2	1	2					63	20	25	44
Oregon.....	10	2	5	2	61	12	29	22	46	9	9	10
California.....	30	35	24	49	17	20	22	22	275	324	39	39
Total.....	44	1,081	1,085	1,428	52	1,065	847	846	72	1,750	2,547	1,494
44 weeks.....	22	23,569	21,661	29,009	61	53,784	280,241	146,188	719	770,913	253,534	349,314

Division and State	Meningitis, meningococcus				Poliomyelitis				Scarlet fever			
	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median
NEW ENG.												
Maine.....	0	0	0	0	0	0	1	1	37	6	11	12
New Hampshire.....	0	0	0	0	0	0	0	0	10	1	6	7
Vermont.....	0	0	0	0	0	0	0	0	41	3	9	7
Massachusetts.....	0	0	0	1	1.2	1	1	3	92	78	129	129
Rhode Island.....	0	0	0	0	0	0	0	0	46	6	15	12
Connecticut.....	6	2	0	0	0	0	5	3	90	30	39	33
MID. ATL.												
New York.....	2	5	7	5	1.2	3	10	10	72	178	241	270
New Jersey.....	0	0	0	1	0	0	6	3	62	52	61	81
Pennsylvania.....	0.5	1	6	3	8	6	3	7	111	216	337	337

See footnotes at end of table.

Cases of certain diseases reported by telegraph by State health officers for the week ended November 5, 1938, rates per 100,000 population (annual basis), and comparison with corresponding week of 1937 and 5-year median—Continued

Division and State	Meningitis, meningococcus				Poliomyelitis				Scarlet fever			
	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median
E. NO. CEN.												
Ohio.....	0	0	8	3	0.8	1	2	10	198	256	316	406
Indiana.....	3	2	1	1	0	0	2	2	149	99	152	188
Illinois.....	0.7	1	2	2	1.3	2	18	5	154	232	325	336
Michigan ¹	1.1	1	1	1	3	.3	1	4	318	295	296	188
Wisconsin.....	0	0	0	1	1.8	1	7	4	249	140	119	163
W. NO. CEN.												
Minnesota.....	2	1	0	0	0	0	10	6	142	72	101	95
Iowa.....	0	0	0	0	0	0	15	2	141	69	129	97
Missouri.....	2.6	2	3	0	0	0	3	2	153	117	242	113
North Dakota.....	0	0	1	1	0	0	1	1	126	17	42	33
South Dakota ²	0	0	0	0	8	1	1	1	136	18	21	26
Nebraska.....	0	0	0	0	0	0	7	0	80	21	34	34
Kansas.....	0	0	4	0	0	0	2	2	352	126	120	99
SO. ATL.												
Delaware.....	0	0	0	0	0	0	0	0	120	6	6	6
Maryland ²	0	0	1	1	0	0	0	2	106	34	68	84
Dist. of Col.....	0	0	1	2	0	0	0	0	67	8	10	10
Virginia.....	1.9	1	3	2	0	0	1	2	94	49	52	82
West Virginia.....	0	0	3	1	0	0	0	1	207	74	107	117
North Carolina ³	3	2	6	3	1.5	1	2	1	131	88	77	85
South Carolina ³	6	2	0	0	0	0	0	0	58	21	2	11
Georgia ³	0	0	1	1	1.7	1	1	1	41	24	32	20
Florida ²	0	0	0	0	0	0	1	0	50	16	14	6
E. SO. CEN.												
Kentucky.....	1.8	1	4	2	1.8	1	0	2	152	85	43	95
Tennessee ²	7	4	2	0	0	0	4	4	43	24	49	104
Alabama ²	4	2	3	0	1.8	1	0	1	43	24	26	28
Mississippi ²	0	0	0	0	2.6	1	5	0	54	21	19	19
W. SO. CEN.												
Arkansas.....	0	0	1	1	0	0	1	1	81	32	24	11
Louisiana.....	0	0	0	1	2.4	1	4	0	51	21	11	13
Oklahoma.....	2	1	1	1	6	3	2	0	65	32	81	22
Texas ²	0.8	1	0	0	0	0	3	3	76	90	107	66
MOUNTAIN												
Montana.....	0	0	1	1	0	0	0	0	300	31	16	16
Idaho.....	0	0	0	0	0	0	0	0	42	4	24	24
Wyoming.....	0	0	0	0	0	0	0	0	133	6	8	10
Colorado.....	5	1	0	0	0	0	1	0	170	35	35	48
New Mexico.....	0	0	0	0	0	0	2	0	161	13	11	20
Arizona.....	0	0	0	0	13	1	0	0	139	11	6	8
Utah ²	0	0	1	0	0	0	1	1	131	13	51	27
PACIFIC												
Washington.....	0	0	0	1	0	0	1	1	79	25	17	40
Oregon.....	0	0	0	0	0	0	2	2	173	34	21	42
California.....	1.7	2	1	2	0.8	1	24	11	126	149	130	176
Total	1.3	32	62	62	1.2	29	150	150	121	3,002	3,792	4,318
44 weeks	2.3	2,531	4,794	4,794	1.4	1,543	9,003	6,759	144	157,454	187,431	187,431

Cases of certain diseases reported by telegraph by State health officers for the week ended November 5, 1938, rates per 100,000 population (annual basis), and comparison with corresponding week of 1937 and 5-year median—Continued

Division and State	Smallpox				Typhoid and paratyphoid fever				Whooping cough		
	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases	1933-37 median	Nov. 5, 1938, rate	Nov. 5, 1938, cases	Nov. 6, 1937, cases
NEW ENG.											
Maine.....	0	0	0	0	6	1	4	4	207	34	78
New Hampshire.....	0	0	0	0	0	0	0	0	0	0	11
Vermont.....	0	0	0	0	0	0	0	1	681	50	15
Massachusetts.....	0	0	0	0	5	4	4	2	133	113	91
Rhode Island.....	0	0	0	0	0	0	1	0	153	20	22
Connecticut.....	0	0	0	0	6	2	0	0	147	49	29
MID. ATL.											
New York.....	0	0	0	0	6	16	12	13	190	471	318
New Jersey.....	0	0	0	0	2.4	2	4	4	249	207	80
Pennsylvania.....	0	0	0	0	10	20	15	32	123	241	-----
E. NO. CEN.											
Ohio.....	0	0	0	0	9	12	15	21	101	131	142
Indiana.....	6	4	11	1	8	5	10	10	20	13	27
Illinois.....	1	2	16	1	3	5	16	24	322	486	88
Michigan ¹	9	8	1	0	3	3	4	7	207	192	-----
Wisconsin.....	5	3	6	6	0	0	1	3	666	374	182
W. NO. CEN.											
Minnesota.....	8	4	3	4	6	3	0	0	206	105	49
Iowa.....	6	3	31	7	14	7	1	1	41	20	59
Missouri.....	10	8	7	2	5	4	12	12	30	23	81
North Dakota.....	0	0	60	2	7	1	2	1	52	7	31
South Dakota ¹	15	2	7	7	8	1	1	1	38	5	19
Nebraska.....	0	0	0	5	0	0	2	0	11	3	17
Kansas.....	3	1	2	2	6	2	2	3	70	25	38
SO. ATL.											
Delaware.....	0	0	0	0	20	1	2	2	240	12	2
Maryland ^{1 2}	0	0	0	0	37	12	10	8	115	37	65
Dist. of Col.....	0	0	0	0	17	2	1	0	83	10	3
Virginia.....	0	0	0	0	15	8	9	11	60	31	59
West Virginia.....	0	0	0	0	25	9	9	17	67	24	32
North Carolina ³	0	0	0	0	10	7	24	9	330	221	120
South Carolina ³	0	0	0	0	14	5	2	7	131	47	32
Georgia ³	0	0	0	0	8	5	11	9	5	3	10
Florida ³	0	0	0	0	0	0	1	1	0	0	3
E. SO. CEN.											
Kentucky.....	9	5	0	0	21	12	13	25	29	16	111
Tennessee ³	0	0	5	0	13	7	11	18	40	22	31
Alabama ³	0	0	0	0	7	4	5	10	9	5	16
Mississippi ¹	0	0	1	0	8	3	6	7	-----	-----	-----
W. SO. CEN.											
Arkansas.....	5	2	1	1	10	4	16	9	53	21	13
Louisiana.....	2	1	0	0	22	9	7	11	7	3	10
Oklahoma.....	6	3	1	2	27	13	16	16	92	45	32
Texas ³	2	2	3	3	25	29	42	34	29	34	86
MOUNTAIN											
Montana.....	10	1	20	3	29	3	1	4	252	26	16
Idaho.....	0	0	4	0	32	3	1	2	11	1	2
Wyoming.....	0	0	10	0	67	3	2	0	22	1	18
Colorado.....	10	2	0	0	0	0	5	6	122	25	12
New Mexico.....	12	1	0	0	148	12	5	19	185	15	26
Arizona.....	0	0	0	0	63	5	2	2	101	8	-----
Utah ⁴	0	0	1	0	0	0	1	0	131	13	17
PACIFIC											
Washington.....	6	2	6	6	22	7	3	3	157	50	52
Oregon.....	0	0	3	1	15	3	0	2	36	7	23
California.....	2	2	0	0	13	15	7	7	117	138	208
Total.....	2	56	199	72	11	269	318	388	139	3,394	2,377
44 weeks.....	12	13,192	8,861	5,758	12	12,944	13,609	15,678	167	179,650	-----

¹ New York City only.
² Period ended earlier than Saturday.
³ Typhus fever, week ended November 5, 1938, 58 cases, as follows: Maryland, 1; North Carolina, 6; South Carolina, 4; Georgia, 17; Florida, 3; Tennessee, 3; Alabama, 3; Texas, 16.
⁴ Rocky Mountain spotted fever, week ended November 5, 1938, Utah, 1 case.

SUMMARY OF MONTHLY REPORTS FROM STATES

The following summary of cases reported monthly by States is published weekly and covers only those States from which reports are received during the current week:

State	Menin- gitis, menin- gococ- cus	Diph- theria	Influ- enza	Ma- laria	Mea- sles	Pel- lagra	Pollo- mye- litis	Scarlet fever	Small- pox	Ty- phoid and paraty- phoid fever
<i>September 1938</i>										
Texas.....	5	155	294	770	211	102	6	147	2	208
Wisconsin.....	0	5	89	-----	-----	-----	9	283	-----	10
<i>October 1938</i>										
Arkansas.....	2	124	116	680	32	43	3	78	1	61
Connecticut.....	2	6	18	-----	75	-----	4	87	0	11
Delaware.....	0	3	1	-----	3	-----	0	32	0	3
Missouri.....	2	123	66	32	37	-----	1	351	7	42
Nebraska.....	0	17	2	-----	9	-----	1	49	1	5
North Carolina.....	10	657	10	91	320	34	2	386	0	63
Pennsylvania.....	10	121	-----	-----	307	2	13	744	0	166

<i>September 1938</i>		<i>October 1938—Continued</i>		<i>October 1938—Continued</i>	
Texas:	Cases	Encephalitis, epidemic or lethargic:	Cases	Septic sore throat:	Cases
Encephalitis, epidemic or lethargic.....	2	Connecticut.....	3	Arkansas.....	34
Wisconsin:		Missouri.....	7	Connecticut.....	15
Chickenpox.....	244	Pennsylvania.....	1	Missouri.....	36
Encephalitis, epidemic or lethargic.....	2	German measles:		Nebraska.....	3
German measles.....	13	Connecticut.....	1	North Carolina.....	26
Mumps.....	82	North Carolina.....	9	Tetanus:	
Tularaemia.....	3	Pennsylvania.....	21	Arkansas.....	1
Undulant fever.....	5	Hookworm disease:		Trachoma:	
Whooping cough.....	1,377	Arkansas.....	1	Arkansas.....	9
		Mumps:		Missouri.....	67
		Arkansas.....	17	Tularaemia:	
<i>October 1938</i>		Connecticut.....	63	Missouri.....	1
Chickenpox:		Delaware.....	25	North Carolina.....	2
Arkansas.....	9	Missouri.....	57	Typhus fever:	
Connecticut.....	110	Nebraska.....	26	North Carolina.....	17
Delaware.....	10	Pennsylvania.....	711	Undulant fever:	
Missouri.....	92	Ophthalmia neonatorum:		Connecticut.....	7
Nebraska.....	26	Missouri.....	1	Delaware.....	2
North Carolina.....	118	Pennsylvania.....	2	Missouri.....	4
Pennsylvania.....	1,268	Puerperal septicemia:		North Carolina.....	6
Dysentery:		Arkansas.....	2	Pennsylvania.....	11
Arkansas (amoebic).....	1	Rabies in animals:		Whooping cough:	
Arkansas (bacillary).....	6	Arkansas.....	21	Arkansas.....	52
Connecticut (bacillary).....	16	Missouri.....	5	Connecticut.....	267
Missouri (amoebic).....	14	Rabies in man:		Delaware.....	12
North Carolina (bacillary).....	1	Pennsylvania.....	4	Missouri.....	101
Pennsylvania (amoebic).....	2	Rocky Mountain spotted fever:		Nebraska.....	24
Pennsylvania (bacillary).....	20	North Carolina.....	5	North Carolina.....	506
				Pennsylvania.....	854

WEEKLY REPORTS FROM CITIES

City reports for week ended Oct. 29, 1938

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	Small-pox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Data for 90 cities: 5-year average	251	110	33	297	484	919	6	350	50	823	-----
Current week	224	97	37	415	443	691	3	347	52	1,317	-----
Maine:											
Portland	0		1	0	2	0	0	0	2	4	31
New Hampshire:											
Concord	0		0	0	0	0	0	0	0	0	13
Manchester	0		1	0	2	0	0	1	0	0	21
Nashua	0		0	0	1	0	0	0	0	0	9
Vermont:											
Barre	0		0	0	1	0	0	0	0	0	4
Burlington	0		0	0	6	6	0	0	1	0	12
Rutland	0		0	0	2	0	0	0	0	0	6
Massachusetts:											
Boston	2		0	10	19	13	0	10	0	18	195
Fall River	0		0	0	1	1	0	3	0	0	27
Springfield	0		0	3	3	0	0	1	0	3	32
Worcester	0		0	0	5	7	0	1	0	14	43
Rhode Island:											
Pawtucket	0		0	0	0	0	0	0	1	2	24
Providence	0		0	0	4	2	0	1	1	37	56
Connecticut:											
Bridgeport	0	2	2	0	0	1	0	0	0	0	23
Hartford	0		0	1	1	4	0	5	0	2	29
New Haven	0	1	0	0	1	2	0	1	0	17	42
New York:											
Buffalo	0		0	12	6	16	0	2	0	11	94
New York	25	17	5	18	87	32	0	70	9	204	1,398
Rochester	0		0	6	5	2	0	1	0	10	60
Syracuse	0		0	0	3	7	0	1	0	8	38
New Jersey:											
Camden	1		0	0	5	2	0	0	0	0	26
Newark	0	2	1	4	2	7	0	8	1	38	131
Trenton	0		0	1	1	2	0	2	0	1	33
Pennsylvania:											
Philadelphia	3	3	3	4	21	31	0	9	2	69	456
Pittsburgh	6		0	0	11	17	0	9	1	18	139
Reading	9		0	0	1	1	0	0	0	0	24
Scranton	1			1		2	0		0	2	
Ohio:											
Cincinnati	17	2	1	2	9	19	0	7	0	10	120
Cleveland	3	10	0	3	11	15	0	10	0	43	176
Columbus	17		0	2	2	4	0	2	0	2	78
Toledo	0		0	5	2	19	0	4	2	7	70
Indiana:											
Anderson	0		0	0	2	3	0	0	0	0	8
Fort Wayne	0		0	0	1	7	0	0	0	2	22
Indianapolis	5		2	2	11	22	1	8	0	0	93
Muncie	0		0	0	2	4	0	0	0	0	8
South Bend	0		0	0	1	3	0	0	0	0	8
Terre Haute	8		0	0	0	8	0	0	0	0	13
Illinois:											
Alton	0		0	0	0	0	0	0	0	0	12
Chicago	19	4	2	6	29	96	0	35	1	354	671
Elgin	0		0	0	0	2	0	1	0	0	11
Moline	0		0	0	0	2	0	1	0	0	5
Springfield	0		0	1	3	0	0	0	0	2	22
Michigan:											
Detroit	17		1	8	9	86	0	26	1	102	269
Flint	1		0	1	2	23	0	1	0	4	19
Grand Rapids	0		0	2	3	16	1	0	0	4	31
Wisconsin:											
Kenosha	0		0	0	0	2	0	0	0	4	6
Madison	0		0	0	0	1	0	0	0	8	22
Milwaukee	1	1	0	2	5	37	0	4	0	153	113
Racine	0		0	0	0	0	0	1	0	13	9
Superior	0		0	0	0	1	0	0	0	0	8

City reports for week ended Oct. 29, 1938—Continued

State and city	Diph- theria cases	Influenza		Mea- sles cases	Pneu- monia deaths	Scar- let fever cases	Small- pox cases	Tuber- culosis deaths	Ty- phoid fever cases	Whoop- ing cough cases	Deaths, all causes
		Cases	Deaths								
Minnesota:											
Duluth.....	0		2	0	1	0	0	0	0	6	24
Minneapolis.....	1		4	44	2	8	0	1	0	3	111
St. Paul.....	0		0	15	9	8	0	1	0	3	73
Iowa:											
Cedar Rapids.....	0			0		0	0		0	0	
Davenport.....	1			0		1	0		0	0	
Des Moines.....	0		0	0	0	12	0	0	0	0	39
Sioux City.....	0		0	5		3	0		0	2	
Waterloo.....	12			1		8	0		0	6	
Missouri:											
Kansas City.....	1		0	1	4	12	0	4	0	0	107
St. Joseph.....	0		0	0	1	1	0	1	0	0	33
St. Louis.....	5		0	2	5	12	0	10	2	11	190
North Dakota:											
Fargo.....	0		0	87	3	4	0	0	0	0	12
Grand Forks.....	1			0		1	0		0	0	
Minot.....	1		0	3	0	0	0	0	0	0	6
South Dakota:											
Aberdeen.....	0			0		0	0		0	0	
Sioux Falls.....	0		0	0	0	4	0	0	0	0	12
Nebraska:											
Lincoln.....	1			0		2	0		0	0	
Omaha.....	0		0	1	2	2	1	1	0	0	36
Kansas:											
Lawrence.....	0	1	0	0	0	0	0	0	0	0	4
Topeka.....	0		0	0	0	4	0	1	0	0	27
Wichita.....	1		0	0	2	3	0	0	0	1	30
Delaware:											
Wilmington.....	1		0	1	3	1	0	1	0	0	30
Maryland:											
Baltimore.....	1	6	1	36	15	8	0	15	4	21	215
Cumberland.....	0		0	0	0	0	0	0	0	0	15
Frederick.....	0		0	0	0	0	0	0	1	0	7
Dist. of Col.:											
Washington.....	6	1	0	1	8	13	0	6	3	3	154
Virginia:											
Lynchburg.....	7		0	0	3	2	0	1	5	4	14
Norfolk.....	0		0	0	2	0	0	1	0	0	25
Richmond.....	3		1	0	3	5	0	0	0	0	51
Roanoke.....	3		0	0	1	1	0	0	0	0	16
West Virginia:											
Charleston.....	1	1	0	0	0	3	0	0	1	0	14
Huntington.....	2			0		3	0		1	0	
Wheeling.....	0		0	0	3	1	0	0	0	10	20
North Carolina:											
Gastonia.....	0			0		1	0		0	0	
Raleigh.....	3		0	0	4	0	0	1	0	3	34
Wilmington.....	1		0	1	3	1	0	0	0	0	9
Winston-Salem.....	1		0	1	3	2	0	0	2	0	15
South Carolina:											
Charleston.....	0	22	0	0	1	0	0	0	2	0	15
Florence.....	0		0	0	4	0	0	0	0	0	12
Greenville.....	2		0	0	0	0	0	0	0	0	5
Georgia:											
Atlanta.....	6	6	1	1	9	8	0	8	0	0	79
Brunswick.....	0		0	0	0	0	0	1	0	0	8
Savannah.....	4	13	1	0	2	1	0	2	0	9	37
Florida:											
Miami.....	0		0	1	1	0	0	3	0	0	34
Tampa.....	0		0	0	0	0	0	0	0	0	18
Kentucky:											
Ashland.....	11		0	0	1	0	0	0	0	0	7
Covington.....	4		0	0	0	3	0	1	0	0	19
Lexington.....	1		0	1	1	3	0	1	0	0	22
Louisville.....	1	3	0	0	3	13	0	2	1	1	69
Tennessee:											
Knoxville.....	10		0	0	3	1	0	0	0	0	45
Memphis.....	3		1	0	7	4	0	2	0	3	85
Nashville.....	5		2	0	9	1	0	1	0	3	46
Alabama:											
Birmingham.....	0		1	0	1	1	0	4	1	0	71
Mobile.....	2		1	0	0	1	0	1	1	0	23
Montgomery.....	3	1		0		0	0		0	0	

City reports for week ended Oct. 29, 1938—Continued

State and city	Diphtheria cases	Influenza		Measles cases	Pneumonia deaths	Scarlet fever cases	Small-pox cases	Tuberculosis deaths	Typhoid fever cases	Whooping cough cases	Deaths, all causes
		Cases	Deaths								
Arkansas:											
Fort Smith.....	4			0		0	0		0	0	
Little Rock.....	0		0	0	1	2	0	0	0	0	
Louisiana:											
Lake Charles.....	0		0	0	0	2	0	0	1	0	4
New Orleans.....	10		0	1	12	4	0	6	1	1	152
Shreveport.....	0		0	0	5	3	0	2	0	0	35
Oklahoma:											
Oklahoma City.....	1		0	1	5	0	0	1	0	0	39
Tulsa.....	1			0		2	0		0	0	
Texas:											
Dallas.....	2		0	1	1	11	0	3	1	4	51
Fort Worth.....	0		0	1	1	5	0	4	1	2	38
Galveston.....	0		0	0	1	1	0	0	0	0	8
Houston.....	5		1	0	3	3	0	3	1	0	75
San Antonio.....	1		0	0	3	2	0	8	1	0	56
Montana:											
Billings.....	0		0	0	2	4	0	0	0	1	10
Great Falls.....	0		0	0	0	2	0	0	0	1	7
Helena.....	0		0	0	0	0	0	0	0	0	2
Missoula.....	0		0	0	0	0	0	0	0	0	4
Idaho:											
Boise.....	0		0	0	1	0	0	0	0	0	7
Colorado:											
Colorado Springs.....	0		0	1	0	1	0	1	0	1	10
Denver.....	6		0	2	6	6	0	6	0	11	69
Pueblo.....	0		0	0	1	5	0	0	0	0	12
Utah:											
Salt Lake City.....	0		0	2	4	1	0	1	0	4	28
Washington:											
Seattle.....	0		0	0	7	8	0	6	0	3	95
Spokane.....	0	1	1	0	5	4	0	0	5	0	36
Tacoma.....	0		0	0	2	2	0	1	0	5	37
Oregon:											
Portland.....	2	1	0	3	3	12	0	1	0	0	56
Salem.....	0			0		3	0		0	0	
California:											
Los Angeles.....	10	4	0	10	13	34	0	19	2	34	346
Sacramento.....	0	1	1	0	2	0	0	1	2	2	36
San Francisco.....	1		1	120	5	6	0	8	0	24	152

State and city	Meningitis meningococcus		Polio-myelitis cases	State and city	Meningitis meningococcus		Polio-myelitis cases
	Cases	Deaths			Cases	Deaths	
Massachusetts:				Maryland:			
Fall River.....	3	1	0	Baltimore.....	0	1	0
New York:				District of Columbia:			
Buffalo.....	1	0	0	Washington.....	1	1	3
New York.....	2	0	1	Virginia:			
Pennsylvania:				Richmond.....	0	0	2
Philadelphia.....	1	0	5	Tennessee:			
Ohio:				Nashville.....	1	1	0
Cleveland.....	1	0	0	Alabama:			
Illinois:				Birmingham.....	1	1	0
Chicago.....	3	1	0	Louisiana:			
Michigan:				Shreveport.....	0	1	0
Detroit.....	1	0	0	Idaho:			
Iowa:				Boise.....	0	1	0
Cedar Rapids.....	0	0	1				

Encephalitis, epidemic or lethargic.—Cases: New York, 1; Philadelphia, 1; Pittsburgh, 1; St. Paul, 1; Mineot, 1; Birmingham, 1; Spokane, 1; San Francisco, 1.
Pellagra.—Cases: Savannah, 4; Birmingham, 4; Los Angeles, 1.
Typhus fever.—Cases: Wilmington, N. C., 2; Charleston, S. C., 3; Atlanta, 1; Savannah, 4; Mobile, 1; Dallas, 1; Fort Worth, 1; Houston, 1; Los Angeles, 1.

FOREIGN AND INSULAR

YUGOSLAVIA

Communicable diseases—4 weeks ended October 9, 1938.—During the 4 weeks ended October 9, 1938, certain communicable diseases were reported in Yugoslavia as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Anthrax.....	57	4	Paratyphoid fever.....	53	1
Cerebrospinal meningitis.....	9	5	Poliomyelitis.....	24	3
Diphtheria and croup.....	642	25	Scarlet fever.....	242	-----
Dysentery.....	168	20	Sepsis.....	12	1
Erysipelas.....	168	4	Tetanus.....	51	19
Favus.....	11	-----	Typhoid fever.....	722	45
Leprosy.....	-----	2	Typhus fever.....	15	1
Lethargic encephalitis.....	1	-----			

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER

NOTE.—A table giving current information of the world prevalence of quarantinable diseases appeared in the PUBLIC HEALTH REPORTS for October 28, 1938, pages 1946-1959. A similar cumulative table will appear in future issues of the PUBLIC HEALTH REPORTS for the last Friday of each month.

Cholera

China.—During the week ended October 29, 1938, cases of cholera were reported in China as follows: Hong Kong, 7; Macao, 15; Shanghai, 24.

India (French)—Chandernagor Territory.—During the week ended September 24, 1938, 1 case of cholera was reported in Chandernagor Territory, French India.

Plague

Hawaii Territory—Island of Hawaii—Hamakua District—Paauhau sector.—A rat found on October 18, 1938, and another rat found on October 20, in Paauhau sector, Hamakua District, Island of Hawaii, Hawaii Territory, have been proved positive for plague.

Peru.—During the month of September 1938, plague was reported in Peru as follows: Lambayeque Department, 1 case; Lima Department, 6 cases, 3 deaths.

(2073)

Smallpox

Colombia.—During the month of August 1938, smallpox was reported in Colombia as follows: Antioquia Department, 32 cases; Caldas Department, 11 cases; Cundinamarca Department, 18 cases; Tolima Department, 1 case, 1 death; Valle del Cauca Department, 6 cases.

Typhus Fever

Syria—Beirut.—During the week ended October 29, 1938, 1 case of typhus fever was reported in Beirut, Syria.

Yellow Fever

Ivory Coast—Dedougou.—On November 1, 1938, 1 suspected case of yellow fever (not confirmed clinically) was reported in Dedougou, Ivory Coast.