Report of the Pellagra Commission of the State of Illinois, November, 1911.

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STATE OF ILLINOIS

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INTRODUCTION.

This commission was appointed by His Excellency, Charles S. Deneen, Governor of the State of Illinois, on October 14, 1909. The first meeting was held at the University of Illinois, November 26, 1909 at which all members were present. In an address Governor Deneen announced that the purpose for which the commission was appointed was the investigation of pellagra and the study of the dietary of the State Hospitals for the Insane. The meeting then went into executive session for the purpose of organization. Dr. Frank Billings of Chicago was elected president, Dr. J. L. Greene, alienist of the State Board of Administration, vice-president, and Dr. Oliver S. Ormsby of Chicago, secretary. The following members were then appointed as an executive committee: Dr. Howard T. Ricketts of Chicago, Prof. W. S. Grindley and Dr. W. J. MacNeal of Urbana, Ill., Dr. H. Douglas Singer of Kankakee, Ill., and Dr. Oliver S. Ormsby of Chicago.

Soon after its organization the commission suffered an irreparable loss by the death of Dr. Howard T. Ricketts as the direct result of zealous devotion to duty in the elucidation of a problem of public health, a field in which, young as he was, Dr. Ricketts had already won, and eminently deserved, an international reputation. We had counted greatly upon his knowledge and investigative skill and desire here to express our deep admiration for him as a man and a scientist and our lasting regret for his untimely but magnificent death.

Numerous meetings of the Executive Committee have been held for the purpose of collecting and coördinating the material contained in this report and from time to time the commission has met as a whole.

On November 22nd, 1910, a preliminary report, the substance of which is embodied herewith, was submitted to His Excellency, the Governor, at a conference with the State Board of Administration, the State Charities Commission, the State Civil Service Commission and the State Pellagra Commission.

This Commission has many grateful acknowledgments to make to those who have so earnestly and willingly assisted it in its efforts. Among these must be mentioned first the Brigadier-General, Torney, of the United States Army, who so generously placed at the disposal of the Commission the services of Capts. H. J. Nichols and J. F. Siler. To these two gentlemen personally we also extend our grateful thanks for much valuable aid and advice without which we should have been sorely handicapped. We also owe much to the unfailing courtesy of the Superintendents and medical staffs of all the State Hospitals and

especially those at Peoria, Elgin and Kankakee. Dr. George A. Zeller, superintendent of the Peoria State Hospital, has had to bear the main brunt of the attack upon the pellagra situation and he has met it with unflagging zeal and unfailing courtesy. Members of the commission and others engaged in this work have put these qualities to the test times without number and often for long periods. The completeness of the records of the cases in the Peoria State Hospital and references to most of those outside the State Hospitals were rendered possible mainly through Dr. Zeller's personal interest and activity. The hospital, patients, records, kitchens and dietary have been open for study and investigation at any and all hours and the prolonged feeding experiment suggested by Capts. Nichols and Siler owed its successful achievement largely to the personal supervision and attention of Dr. Zeller. We gladly take this opportunity of expressing, although inadequately, our great indebtedness to him. To Dr. Sidney D. Wilgus, until lately superintendent of the Elgin State Hospital, we are also indebted for his interest in securing autopsies and personally studying the cases under his care and to Dr. F. P. Norbury at Kankakee for numerous courtesies and assistance.

Prof. Forbes of the State Entomological Department has rendered most valuable assistance in the study of the distribution of simulia in the State, his report upon which is included.

Our thanks are also due to Dr. J. F. Waugh of Chicago who has devoted considerable time and energy to the performance of numerous complement fixation tests and to Dr. Hirschfelder of Baltimore for the privilege of embodying the results of his anaphylactic experiments in this report. To Dr. Waldemar Koch of the University of Chicago we owe the first chemical analysis of a pellagrous brain that has yet been published. We are also indebted to the superintendent of the Cook County Institutions for information concerning pellagra and diet at the Dunning Hospital and to Dr. W. A. Pusey and his assistants at the Cook County Hospital for the privilege of, and assistance in, studying one of the most interesting and important of the cases we have seen.

Finally we wish to express our grateful acknowledgements of the zealous and valuable assistance which has been rendered by those who have worked more directly with us. The amount of careful and detailed material has been great and has fallen largely upon their shoulders. Among them should be mentioned especially Mr. A. F. Wussow, Mrs. Josephine (Kerr) Allison, Dr. J. T. Rooks, Dr. Clifford E. Smith and Dr. L. J. Pollock.

The decision to ask for a dissolution of this commission is due not to any feeling that the work for which it was appointed is in any way completed, as we believe that this study is only just beginning, but rests upon two main reasons. Firstly the fact that the funds furnished for working expenses are nearly exhausted while no steps have been taken to replenish them, and secondly because we have lost the services of some of our most active members. The first loss, as already mentioned, was

unfortunately by death. Recently Dr. J. L. Greene and Dr. W. J. Mac Neal have left the State. We therefore feel that further continuation of the work of this commission is impossible.

The report will be found arranged under various chapters as follows in order:

I.

CURRENT VIEWS UPON PELLAGRA.

(By H. Douglas Singer.)

There is no need in this report to enter extensively into the history and geographical distribution of pellagra, since many excellent treatises are available. The disease was apparently first described by the Spanish physician Casal, in 1735, although this was not published until after his death in 1762. The following paragraph, quoted from the monograph by the late Dr. J. N. Hyde, of Chicago,[1] will sufficiently indicate the wide distribution of the disease. "Frapoli, of Milan, in 1771, is commonly reported as first to have given the name to the disease by which today it is most generally known, but in fact he merely reproduced a title current among the people of his day: 'Morbus vulgo, Pellagra.' In the long list of authors who followed, from Strambio, Marzari, Alibert, Rayer and Raymond, to Lombroso, Sandwith, Babes and Sion, and Sir Patrick Manson, can be traced the progress of the disease in Europe from Spain to southern France, northern and central Italy, Corfu, upper Egypt and other parts of Africa, Austria, Servia, Bulgaria, Roumania, Asia Minor, India, Mexico, Barbadoes, and portions of North and South America."

With regard to the etiology of pellagra, numerous views have been promulgated and it is well to say that the members of this commission entered upon this study without prejudice or preconceived ideas with regard to the nature of the disease, or its causation. The plans upon which the work has been organized have been aimed towards the consideration of all the manifold theories which have been evolved, in order, if possible, to narrow the lines of research into some more or less definite channel. The great drawback of most of the work which has so far been carried out is that the investigator has started with some hastily formed hypothesis, based upon coincidences or chance observations which have not been submitted to careful scientific analysis. He has then been only too willing to see, and insist upon, the pellagrous nature of the most variable symptoms produced in lower animals as the result of experiments founded upon such hypothesis.

One of the best critical reviews of previous work upon pellagra will be found in the Progress Report of the British commission for the investigation of pellagra, by Louis W. Sambon,[2] especially in regard to the relation with maize. Free use has been made of this article in compiling the following statements.

The various theories which have obtained may be subdivided under two main headings, (1) those concerning maize or Indian corn; (2) those alleging other causative agents. The supporters of the first group are commonly known as zeists, and of the second as antizeists.

(1) Theories which allege some causative relation between maize and pellagra have been most widely accepted, but are gradually losing ground.

[1] "Pellagra and some of its problems" Amer. Journ. of the Med. Sci., Jan. 7, 1910.
[2] Journ. of Tropical Med. & Hygiene, 1910, pp. 271, 282, 305 and 319.

They have been, and still are, almost universally believed in Italy, where this disease is probably more prevalent than in any other part of the world. This is largely due to the influence of Lombroso, by whom it was firmly believed and widely expounded, with the result that the Italian government was led to promulgate laws dealing with the use and care of Indian corn. In fact, Sambon, with considerable justice, points out that the Italians have been studying corn rather than pellagra.

Various authorities differ in their views as to the nature of the relationship between corn and pellagra. These views may be briefly classed under the following headings:

(a) According to Lussana, Frua and others, Indian corn is deficient in, or lacks, some nutrient principle necessary for health, and pellagra results from a diet consisting too exclusively of maize.

As a corollary to this view should also be mentioned other conditions of malnutrition. Pellagra is unquestionably a disease which occurs most frequently among the poorer and less well fed classes and some have regarded it as the direct result of insufficient food. In most of the different theories malnutrition and defective hygiene are given as contributory factors.

(b) Corn contains some toxic substance which, in individuals who are especially susceptible for any reason, gives rise directly to pellagra.

(c) Maize undergoes some form of decomposition, as the result of the growth of bacteria, in the intestine of certain individuals. The toxins resulting from this change give rise to pellagra.

As will be observed, these theories deal with maize, which is healthy in itself. The following views concern maize which is damaged or spoiled in some way:

(d) That healthy maize is innocuous, but at some stage in its preparation for consumption, either in the ear, when stored, or after being cooked, it undergoes decomposition as the result of the growth of certain fungi. Various moulds and bacteria have been isolated and incriminated by different authors, e. g., Penicillium glaucum (the commonest variety of mould), different varieties of Aspergillus, Sporisorium maydis, Ustilago maydis (smut), Bacterium maydis, Bacillus pellagræ, etc. It is supposed that toxins are produced in this process of decomposition, which, when absorbed, cause pellagra.

(e) That some one of these organisms, which are commonly found on moulded or spoiled maize, and which may be eaten with it, directly invades the human body, where it elaborates toxins, causing pellagra.

(2) The *antizeist views* regard the disease as a specific infection of the body with a parasitic organism, either bacterial or protozoal in character.

(a) The causative agent is some bacterium of unknown nature and habitat. This view is obviously similar to that given under (1) (e), but differs in that it does not specify any relation to maize.

(b) An infection with some variety of amoeba or other protozoon. The frequency of concomitant amœbiasis in pellagra has been emphasized by many authors, notably Long in this country. Alessandrini in Italy claims to have found a filarial infection of certain wells in pellagrous districts.

(c) That the disase is due to a protozoal infection of the blood stream in much the same manner as malaria and trypanosomiasis (sleeping sickness). These views are all based upon supposed resemblances in the epidemiology, endemicity, seasonal occurrence, etc., to these diseases. Some authors have also urged in support of this view the results of treatment. Sambon, who is one of the chief exponents of this view, goes to the length of incriminating some species of Simulium (the blackfly, sandfly, or buffalo gnat) as being the agent which carries the organism, and by biting the

human host injects the protozoa into man. It should be stated that Sambon formulated this hypothesis, even to the naming of the carrier, as the result of comparative reasoning, before entering upon his investigations. The hypothesis is attractive and plausible in many respects, but so far lacks much more evidence that simulia are the carriers than the fact that in many places simulia and pellagra are found in the same locality.

This list does not exhaust all the theories which have been propounded, but it covers the grounds that have been considered in the work carried out by this commission.

II.

PELLAGRA IN ILLINOIS.

(H. Douglas Singer.)

Pellagra was first recognized in the State of Illinois at the Cook County Institutions at Dunning about June, 1909. The diagnosis first made by Dr. L. J. Pollock was reported to Dr. W. A. Evans, Health Officer of Chicago, and was confirmed at his request by Passed Assistant Surgeon C. H. Lavinder of the Public Health and Marine Hospital Service in July. Shortly afterwards cases were recognized at the Peoria State Hospital and at the Elgin and Kankakee State Hospitals. The diagnosis once made, the managing officers and medical staffs at Dunning and Peoria were able to recall instances of exactly similar eruptions in the past, although it was, of course, impossible to gather any figures which could give any idea as to the actual number of cases. We have, therefore, thought it advisable to collect only those cases which have been definitely diagnosed since July, 1909. It has been also thought wise to exclude all cases in which there seemed to be any doubt as to diagnosis, although this will probably result in an underestimate of the actual numbers. Another fact which will also tend to render the figures smaller than they should be is that at present the disease is still but little known by the profession at large and there are undoubtedly cases which are not recognized, both inside and outside the State Hospitals for the Insane. Many attacks are probably of extremely mild character, and are not accompanied by any, or but the most transient, constitutional symptoms, and are consequently not called to the attention of medical men. It is possible also that errors in diagnosis may have the opposite effect of swelling the totals, as we have seen various skin diseases which have been diagnosed as pellagra, and until the medical profession becomes better acquainted with the characteristic features of the disease it will probably be impossible to get data which are absolutely reliable.

With regard to cases occurring outside the State and County Hospitals for the Insane but little reliable information is available. We have been able to collect a few cases, mainly through the kind offices of Dr. George A. Zeller. The State Board of Health has apparently no information on the subject. A letter addressed to the Secretary, asking for data elicited the following reply:

(COPY.)

PELLAGRA D.

STATE BOARD OF HEALTH,
OFFICE OF THE SECRETARY.
SPRINGFIELD, Sept. 13, 1911.

Dr. Oliver S. Ormsby, Secretary Pellagra Commission, 32 North State Street, Chicago:

DEAR DOCTOR—But few, if any, cases of pellagra occurring outside of State institutions have been reported to the State Board of Health since August, 1909.

I recollect one or two cases, but could not well trace them down at the present writing. Hence, my inability to comply with your request.

Very truly yours,

(Signed) J. A. EGAN, *Secretary.*

The figures for the number of cases in the different institutions, including those at the Cook County Institutions at Dunning, have been furnished by the Superintendents of each institution, with the exception of Peoria, where they are the result of data furnished by Dr. Zeller and the hospital medical staff, by Captains Nichols and Siler, and by personal observations at frequent intervals by the members of this commission. During the height of the pellagra seasons all patients who have previously had attacks of the disease have been examined for evidences of recurrence and upon several occasions all patients in the institution have been inspected. Visits have also been made to suspects and others at the Jacksonville, Anna, Watertown and Elgin State Hospitals.

Table I. presents the total number of cases occurring in the three periods, August, 1909, to January, 1910; January, 1910, to January, 1911, and January, 1911, to Sept. 1, 1911, in so far as we have been able to collect them. Recurrent attacks in individuals recorded as pellagrins for the preceding periods are not included a second time, so that the figures represent the actual number of persons attacked.

TABLE I.

Institution.	1909.		1910.		1911.		Total.			Dead.†	Case mortality.
	M.	F.	M.	F.	M.	F.	M.	F.	Total.		
Anna State Hospital	----	------	3	0	3	0	6	0	6	2	33.3
Elgin State Hospital	3	7	2	2	20	4	25	13	38	12	31.6
Jacksonville State Hospital	0	0	1	0	0	0	1	0	1	.....	.....
Kankakee State Hospital	0	5	0	2	*1	*4	1	11	12	5	41.7
Peoria State Hospital	73	104	*42	*25	5	9	120	138	258	128	49.6
Watertown State Hospital	0	0	0	*1	0	2	0	3	3	3	100.0
Chester State Hospital	0	0	0	0	0	0	0	0	0	.....	.....
Lincoln State School and Colony	0	0	0	0	0	0	0	0	0	.....	.....
‡Dunning C. I.	14	14	18	17	6	7	38	38	76	30	39.5
Cook County Hospital	----	------	1	2	5	----	6	2	8	6	75.0
Elsewhere	----	------	1	1	2	2	3	3	6	3	50.0
Total	90	130	68	50	42	28	200	208	408	189	46.3

* One was admitted to the hospital with the disease fully developed. See Table II.

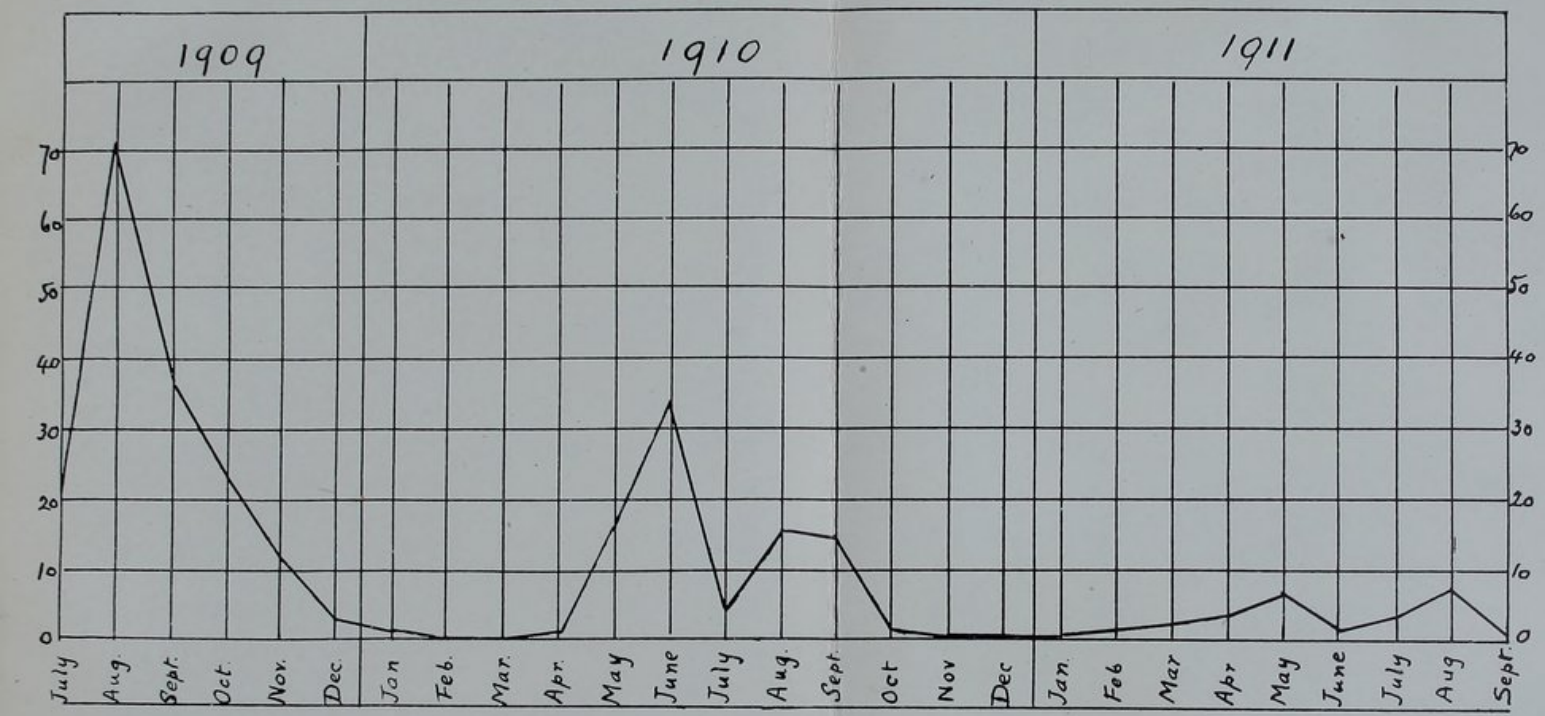
† With the exception of those for Dunning the numbers given in this column include all deaths in pellagrins whether immediately due to pellagra or not.

‡ The figures furnished to the commission for each year were totals only. It was however, stated that the sexes were equally affected and hence the figures given for each sex have been estimated by dividing the total by two.

It should be stated that at most of the institutions there have been patients not included in the figures in this table presenting some suspicious appearances not sufficiently definite in character to justify a positive diagnosis. At Peoria in 1909 there were a number of such cases and we have a list of 49 suspects in 1910. It is probable that some of them were pellagrous, whereas others certainly were not.

In Table II. is given a list of the cases outside the hospitals for the insane concerning which we have been able to obtain definite information. Dr. Ormsby has kept careful watch upon suspected cases at the Cook County Hospital, and the diagnosis has been confirmed by him in all those instances recorded in the table. For the sake of completeness there have also been added to this table a list of the cases which have been admitted to the hospitals for the insane with the disease already developed.

TABLE IV


1909
1910
1911
70
60
50
40
30
20
10
0
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan
Feb.
Mar.
Apr.
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June
July
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July
Aug
Sept.

TABLE II.

Case.	Age.	Occupation.	Sex.	County.	Town.	Urban or rural.	Hospital.	Physician.	Result.
1.....	30	Housewife.....	F	Cook.....	Chicago....	C	Cook county.....	S. Kuh.....	F
2.....	58	Switchman....	M	..do.....	..do.....	C	..do.....	O. S. Ormsby..	F
3.....	44	Porter.....	M	..do.....	..do.....	C	..do.....	..do.....	F
4.....	47	Laborer.....	M	..do.....	..do.....	C	..do.....	W. A. Pusey...	F
5.....	40	Railroad agent.	M	..do.....	..do.....	C	..do.....	O. S. Ormsby..	R
[1] 6.....	43	Housework....	F	..do.....	..do.....	C	..do.....	W. A. Pusey...	F
7.....	50	Liveryman....	M	..do.....	..do.....	C	..do.....	O. S. Ormsby..	F
8.....	42	Upholsterer....	M	..do.....	..do.....	C	..do.....	S. R. Slaymaker	R
[2] 9.....	37	Housewife.....	F	Peoria.....	Peoria.....	C	.....	J. H. Bacon ...	F
[2]10.....	40	Laborer.....	M	..do.....	..do.....	C	.....	..do.....	R
[3]11.....	60	.....	M	..do.....	..do.....	C	Dispensary	..do.....	R
12.....	38	Rag picker.....	F	..do.....	..do.....	C	St. Francis	R. L. Green ...	R
[4]13.....	46	Housewife	F	Knox.....	Galesburg..	C	.....	J. H. Bryant...	F
[5]14.....	61	.....	M	Vermilion..	Danville...	....	.....	C. E. Wilkinson	F
		CASES ADMITTED TO THE STATE HOSPITALS WITH THE ERUPTION PRESENT.							
W. C..	91	None.....	M	Henderson.	Poor farm..	....	Peoria S. H.....	.....	R
E. P..	54	None.....	M	Woodford..	Washburn..	R	..do.....	.....	F
[6]D. S..	42	Baker.....	F	Mason.....	Havana....	R	..do.....	.....	F
[7]J. V ..	57	Housework....	F	Grundy....	Mazon.....	R	Kankakee S. H..	.....	F
[8]A. S ..	63	Railroad foreman.....	M	Cook.....	Chicago....	C	..do.....	.....	R
X. X..	....	.....	F	Carroll.....	.....	....	Watertown S. H.	.....	F

C, city; R, rural or small town; F, fatal; R, recovered from this attack.

[1] Case 6 is recorded in detail in the section on clinical and pathological studies. (Case 1, A. D. p. 26.) She had lived in Mississippi but no attacks had been observed while there.

[2] Cases 9 and 10 were sister and brother. Case 9 had seven attacks in seven consecutive years.

[3] Case 11 had an attack also in 1910 as well as in 1911.

[4] Case 13 had removed to Galesburg from Peoria 3 months before the onset of symptoms and possibly belongs to the Peoria group of cases although no previous attack was known.

[5] Case 14 lived in West Lebanon, Ind., and went to Danville for medical treatment. He had attacks in 1908, 1909, 1910 and 1911.

[6] Case D. S. recorded in detail p. 38.

[7] Case J. V. recorded in detail p. 30.

[8] This man had had previous attacks in the Panama Canal zone.

It should further be mentioned that we have heard rumors of cases in Canton, Fulton county, and also in Henderson, Williamson and Rock Island counties.

The statistics relating to the Peoria State Hospital will be found in Tables III., IV., V. and VI. The first of these shows the average age, the number of cases arising in each decade of life and the relative numbers affected of the two sexes. In Table IV. is shown a curve representing the month in which attacks have started. The date of onset has often been very difficult to fix, as it may be extremely insidious and accompanied by but few or no constitutional symptoms. The patients, furthermore, do not complain of the eruption and often belittle its importance when it is called to their attention. In many cases they are so inaccessible as the result of dementia that direct examination is necessary in order to discover any evidence at all. The figures given in Table IV., therefore, cannot be regarded as entirely accurate, but represent approximately the months in which the disease appears to have become acute. The onset of recurrent attacks has been included in the figures given. It will be observed that one case was noticed in January, 1910, and another in February, 1911. Both of these were recurrences in individuals who had had attacks in the preceding year.

TABLE III.

Year.	Average age.	Decade of life.								Sex.		Total.
		2d.	3d.	4th.	5th	6th.	7th.	8th.	9th.	Males.	Females.	
1909.....	52.3	7	27	40	44	42	14	3	.....	73	104	177
1910.....	57.1	1	9	10	15	20	7	3	2	42	25	67
1911.....	55.1	.....	1	3	5	3	2	.....	.....	5	9	14
Total..	53.7	8	37	53	64	65	23	6	2	120	138	258

Youngest, 22; oldest, 93; males are to females in the proportion of 1 ; 1.15.

In Table V. are recorded the number of recurrences in patients who have had known previous attacks. Occasionally it is found that patients in whom a positive diagnosis is made are said to have had attacks in previous years, but these have in each instance been recorded as new cases. One of those given as a new case for 1911 is said to have had an attack in the summer of 1910. Futhermore, four of the patients who unquestionably had pellagra in 1909 showed two exacerbations in 1910, which have been recorded as only one recurrence for each during that year, in order to avoid confusion.

TABLE V.

Year.	New cases.	Deaths, July, 1909-May 1, 1910.	Living in pellagra season of 1910.	Recurrences in 1910.	Percentage of recurrences.	Deaths, May 1, 1910-May 1, 1911.	Living in pellagra season of 1911.	Recurrences in 1911.	Percentage of recurrences.	Deaths, May 1, 1911-Sept. 1, 1911.	Living on Sept. 1, 1911.
1909.....	177	97	80	25	31.25	12	68	9	13.24	1	†67
1910.....	67	.....	.....	.....	.....	11	56	5	8.9	3	*53
1911.....	14	.....	.....	.....	.....	.....	.....	.....	.....	4	‡10
Total.	258	.....	.....	.....	.....	.....	124	14	11.3	.....	130

* Five of these are now at Kankakee.
† Three of these have since died.
‡ Two of these have since died.

In Table VI is shown the mortality at the Peoria State Hospital. It will be noticed that in a very large percentage death is recorded as being directly due to pellagra. This must certainly be questioned for the year 1909 because at that time there was also an epidemic of amoebic dysentery, many of the autopsies showing amoebic ulceration of the intestine in the walls of some of which the amoebæ were demonstrated by Capts. Nichols and Siler. Two cases of liver abscess of typical character were also seen. It has seemed impossible in many cases to determine what weight is to be assigned to pellagra as the primary cause of death and how much belongs to any other coexisting disease. It has therefore seemed advisable to make no division which could only be misleading. In those cases recorded as dying from some other cause there were no active pellagrous symptoms present at the time of, or shortly before, death.

TABLE VI.

Year.	Pellagra given as immediate cause.		Other causes.		Total deaths.	Percentage of cases.
	Number.	Per cent.	Number.	Per cent.		
1909	89	81.0	21	19.0	110	62.15
1910	8	63.7	6	36.3	14	16.42
1911	4	100.0	.....	.....	4	28.57
Total	101	78.9	27	21.1	128	49.61

OTHER CAUSES OF DEATH.

Pulmonary Tuberculosis	6
Valvular Heart Disease	4
Pneumonia	4
Epilepsy	2
Cerebral Haemorrhage	2
Cerebral Embolism	1
Cholecystitis	2
Amoebic Dysentery	1
Chronic Nephritis	1
Senile Gangrene	1
General Paralysis of the Insane	1
Carcinoma Uteri	1
Accidental	1
	27

In discussing these tables attention may first be directed to the class of individuals most affected. In general it may be said that the disease is especially frequent for some reason, at present unknown, among the chronic insane. Most of the patients who have suffered from pellagra have belonged to the groups of defectives, senile dements, epileptics, and the terminal stages of dementia praecox. They have been for the most part poorly nourished and in an enfeebled state of bodily health. The total population of the Peoria State Hospital during the great epidemic of 1909 was about 2,100 and of this number of patients we find at least 8.4 per cent showed definite symptoms of pellagra. Yet during this period none of the employés suffered from the disease in spite of the fact that they were exposed fully as much to the bites of insects and drew their food and water supply from exactly the same source as the patients. This freedom from pellagra upon the part of doctors, nurses, attendants and other employés has been absolute in all the institutions. It is furthermore almost certain that some of those employés have been in a run-down state of health at some time during the seasons in which pellagra was rampant.

While the general statement made above is true that the individuals have been weakly and ill-nourished there are however notable exceptions. Some of the pellagrins have been apparently robust and well nourished. In this connection it may be of interest to refer to a patient seen by Dr. Oliver S. Ormsby in 1911 who does not figure in the tables given here as the disease was contracted in Kentucky and the patient came to Chicago only for medical advice. This lady was 44 years of age, native of Maine, but had lived in Kentucky for 12 years where she was at the head of a college department of domestic science. Her duties therefore consisted of the teaching of hygiene as regards management and dietary of the household. She had

had attacks of "morning diarrhoea" for several summers and was subject to attacks of acute indigestion. The first known attack of dermatitis occurred in October, 1910, but was very mild and without severe constitutional symptoms. The second attack in 1911 was much more severe and led her to come to Chicago for assistance. When seen she presented an entirely characteristic skin eruption of pellagra involving the hands, arms, forearms, and across the sternum with sore mouth and diarrhoea. In spite of this she appeared to be in a good state of nutrition. With such facts before us it is certainly difficult to understand the freedom of hospital employés.

Attention should be directed to the coexistence of intestinal parasitism with the larger outbreaks of pellagra at the Peoria State Hospital; 1909 also saw an epidemic of amoebic dysentery and we find that since that year pellagra has subsided very rapidly. It is of course possible that the enormous fatality during 1909 may have removed most of the more susceptible individuals. The question of the relation of protozoal infection to pellagra is more fully discussed in later sections of this report (See report by Capts. Siler and Nichols and also by J. T. Rooks) and need not further detain us here.

The question of the dietary of the State Hospitals is also the subject of detailed study later (See report by Grindley and Wussow). It may however be mentioned here that the chief point of deficiency in the dietaries has been in regard to animal protein, and yet the institution feeding the smallest amount of meat, which forms the main source of this material, has shown no pellagra.

A few words are advisable in regard to the habits of the patients which would expose them to biting by insects, etc. In all institutions patients are out of doors as much as possible. At Peoria probably the majority of the patients who have contracted pellagra have spent the time, while out of doors, sitting upon the porches of the buildings which they leave only for a short time if at all. So many have been more or less helpless dements that any more active outdoor life has been out of the question. Others it is true have had the free run of the grounds. It should be noted that this outdoor period of the day does not include the early morning and late evening at which time blood-sucking insects would be most prevalent. Furthermore many attacks of pellagra have arisen in patients confined to the hospital wards and not out of doors at all. In this connection reference may be made to the striking example quoted by Dr. Hyde[1] from the Elgin State Hospital: "The patient, a woman, ———, had been bedridden for years and occupied a room in common with another insane woman, also pellagrous. The first patient occupied a bed at the farther extreme corner of an apartment lighted by a single window. The only light accessible for a long period prior to the advent of the pellagrous disorder was furnished by this one window." It is but fair to state that inquiries at the Elgin State Hospital failed to elicit the name of this patient but the medical staff has changed since this observation was made (1909). The facts are substantiated however by Dr. Ormsby who was with Dr. Hyde upon the occasion of the visit.

With regard to other insects, such as fleas, bedbugs and body lice, it cannot be said that any institution is entirely free from them, but they certainly are not numerous in any of the hospitals where constant warfare is maintained against them.

The distribution of the cases in the different wards and buildings at the Peoria State Hospital, built strictly upon the cottage plan, revealed no special foci. Cases apparently originated in all of them and were not more common even in those cottages in which a large number were segregated for observation. Furthermore, there were no differences in the dietary of the different wards, with the exception of the hospital wards, all being supplied from the same kitchen.

As regards the distribution of pellagra throughout the State outside the hospitals for the insane, we feel that the data are still too few to justify

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1 "Pellagra and Some of its Problems" Amer. Journ. of the Med. Sci., Jan. 7, 1910, p. 10.

any conclusions. It is certainly striking that the great majority of the cases upon which we have definite information have arisen in persons living and working in the two largest cities of the State, Chicago and Peoria. This is contrary to general experience in Italy and elsewhere. Sambon states that pellagra does not occur in big cities, and bases much of his reasoning as to the relation with simulia upon this point. He claims that simulia do not enter large cities or human habitations. In this respect he is certainly wrong as regards some species, e. g., S. Venustum. (See report by Prof. Forbes.) Sambon believes the disease to be almost confined to agricultural laborers and explains the few instances in which city dwellers have been affected by occasional visits to the country. Such reasoning is difficult to refute, as most people occasionally go beyond the city limits. There seems to be one possible explanation for the differences in the experience in this State as compared with that in Italy. The disease has only recently been recognized here, and it is obvious that the country practitioner is likely to be the last to become informed concerning it. Nevertheless there has been so much written in the lay, as well as the medical, press concerning the disease that it seems hardly possible that the majority of the doctors throughout the country districts have not become acquainted with its prevalence and very striking and obvious characteristics. A further fact is also pertinent upon this point. If, as is claimed by those most competent to judge, pellagra leads sooner or later to manifestations of mental disorder, surely the State hospitals would be receiving more examples. Judging from the experience of Sambon in Italy, if the disease were so much more common in agricultural communities than in large cities, there should be several hundred pellagrins in the country districts to balance the few we have been able to collect in Chicago and Peoria among persons who are strictly city dwellers. This point can only be determined by a careful investigation of the rural population of the State, and seems to us a very proper subject for investigation by the State Board of Health.

Until such investigations are made it would be unwise to attempt to state the probable number of pellagrins at present in the State of Illinois. Our tables show that there has been a marked decrease in the number of fresh cases at the Peoria State Hospital, whereas at Elgin they have increased. But another fact which must be regarded as disquieting is that the numbers outside the State Hospitals, while still very small, are increasing. It seems to us advisable that every effort should be made to determine the actual numbers at the earliest possible date, in order to be able adequately to determine the progress which the disease is making. As a conservative estimate we would say that since July, 1909, when the disease was first recognized, there have been 500 cases in this State.

III.

CLINICAL AND PATHOLOGICAL STUDIES.

(By Oliver S. Ormsby and H. Douglas Singer.)

It has not been thought necessary to include in this report a detailed description of the various manifestations of pellagra, since many excellent articles covering this ground have already been published by various authors.[1] We propose to give only the results of our own observations, with brief descriptions of the main characteristics. With regard to pathological material we have been at a disadvantage, in that it has been difficult to obtain autopsies upon undoubted cases until within the past few months. The microscopic examination of the nervous system is consequently yet far from complete. The cases upon which the pathological examinations were made are reported in some detail below, and have been obtained from the following sources: Case 1 was studied by the courtesy of Dr. W. A. Pusey at the Cook County Hospital; Case 2 from the Kankakee State Hospital; Cases 3, 4, 5 and 6 from the Elgin State Hospital, the autopsies with the exception of 3 being performed by the medical officers of that institution; Cases 7 and 8 were from the Peoria State Hospital, the autopsy in Case 7 having been performed by Dr. Ellis of that institution. Our hearty thanks are due to Drs. J. T. Rooks and L. J. Pollock for valuable assistance in preparing the microscopical sections.

The clinical study has been made upon six cases transferred from the Peoria to the Kankakee State Hospital, upon cases arising in the latter hospital, together with material collected upon frequent visits to Peoria. The table at the end of this report, showing the symptoms, etc., of 83 cases, was compiled from the records of the Peoria State Hospital, with the assistance of Dr. C. E. Smith.

Cutaneous System—In a study of more than two hundred patients, the manifestations exhibited on the skin were sufficiently characteristic to enable one to make a diagnosis of the general condition. In general, the symptoms corresponded to the cases described abroad, in Italy and other countries. It can hardly be said, however, that they were exhibited in the stages which have artificially been made in European cases. Rather than being stages of a disorder, they appeared to exhibit degrees of activity of the process. The arrangement of the lesions was characteristic. In the major portion of the cases the dorsum of the hands, the wrists, and some part of the face, neck or scalp were involved. The disease only occasionally involved the feet or ankles, areas which were so often affected in the European cases. In a large number the lesions occurred on the arms and chest; in a smaller percentage, the ears and other parts of the body were involved. In a very few the inflammatory process involved the palmar surface of the hands, and occasionally the eruption was generalized. The peculiar collar described abroad, while seen here occasionally, was not common.

[1] See "Pellagra and Some of its Problems" by J. N. Hyde, Amer. Journ. of the Med. Sci., Jan. 7, 1910.

In the case of several women quite a severe dermatitis occurred about the vulva and involved the mucous membrane of the vagina. The lesions were always symmetrically placed and ran through a pretty typical course. In the major portion the distribution on the hands was as follows: a solid area extending over practically the entire dorsal surface of the hand, involving the fingers to the knuckles, also the wrist on the extensor surface for a distance of about two inches. In the latter area it would frequently sweep around and involve about two-thirds of the flexor surface, then come to an abrupt ending. This partial gauntlet was interesting and occurred frequently. In the most moderate degree of erythema the process went through about the following course: Large macular lesions, light or dark red, would appear, which soon fused, forming a patch of dermatitis almost identical in appearance with that caused by the sun. After a period of from seven to fourteen days, or a little longer, desquamation would begin, at which time a roughened, scaling surface was presented. Early in the process moderate to marked swelling was usually present. No subjective sensations were complained of. That none was present was manifest by the absence of any sign of interference on the part of the patient. In some patients pigmentation occurred, while in others, after desquamation was complete, the area was lighter than formerly. In the more active cases on the erythematous base bullous lesions would soon develop. Some of these were very large. After several days they would gradually dry, leaving a thickened, crusted epidermis. Secondary pyogenic infection not infrequently followed in the vesicular and bullous cases. In many the œdema was sufficient to produce fissures to quite a marked extent. The lesions, whether erythematous or bullous, were always well defined. It was particularly noticeable that after the bullous lesions had cleared the skin was somewhat thinner than formerly and there was no hyperpigmentation. In the older patients, where the process was subacute, the areas presented the appearance of a simple chronic dermatitis with marked hyperpigmentation. The atrophy described in chronic cases in Europe was present to a slight degree only. Loss of pigmentation did occur, but true cutaneous atrophy has been uncommon. That sunlight played a part in producing or determining the location of lesions was demonstrated by having suspected patients wear fenestrated gloves, when the eruption would be largely limited to the exposed surfaces. We have, however, seen many patients exhibiting typical lesions occupying the hands and other usual areas who were not exposed to the direct rays of the sun at any time. Bedridden patients developed lesions in the same situation as those able to be out of doors. That the cutaneous lesions resemble an ordinary sunburn was frequently emphasized by reports of attendants stating that certain patients were suffering with sunburn, which on examination proved to be a pellagrous erythema. The importance of the cutaneous symptoms is at present paramount, for without them a diagnosis can rarely be made. It is probably true that the disease may occur without these symptoms, but in the present state of knowledge they are essential in arriving at correct conclusions.

Pathology—Cutaneous—In a large number of sections studied, the general picture was that of an angio-neurotic process, and resembled to a marked extent that seen in multiform erythema. The most marked change was noted in the superficial part of the corium, almost all infiltration occurring in the pars papillaris. The specific findings are as follows: With a low power, the stratum corneum was thickened, the stratum granulosum and rete practically normal. The upper portion of the corium showed inflammatory reaction, and the connective tissue appeared œdematous. With a high power, the hyperkeratosis was seen to be well marked. Here and there areas of parakeratosis were present, as evidenced by the presence of nuclei extending to the upper layer of the stratum corneum. Many pigment granules were present. The rete was practically normal, except in places where its integrity was interfered with by infiltrating cells. In the

papillary layer cellular infiltration was quite marked, particularly in the region of blood vessels. Collagen and elastin were present, the former showing œdematous changes. The deeper parts of the corium were comparatively normal. In parts of the papillary layer elastin was absent.

From a survey of these findings no specific statement can be made concerning the process. No micro-organisms were found. That the process was moderately destructive was evidenced by the absence of certain structures. As a whole there appeared to be a reaction on the part of the skin, either to a local toxic irritant or an angio-neurotic process influenced from a distant focus.

Gastro-intestinal System—The symptoms referable to this system unquestionably stand next in importance to the skin lesions and are present in a very large proportion of all cases. They seem to be especially marked in all more severe examples. They cannot, however, be regarded as characteristic in as much as very similar manifestations are also met with in other disorders. We would hesitate to base a diagnosis upon them in the absence of typical skin lesions.

The tongue becomes swelled and denuded presenting a bright red appearance with, in severe cases, more or less ulceration along its edges and upon its under surface and the appearance of yellowish sloughs in these regions which bleed very easily. The lips and cheeks, where they come in contact with the teeth, also show, in the more serious forms, a similar bleeding sloughy appearance. The whole condition presents features which are very similar to the aphthous stomatitis seen in other debilitating states, especially in children but also in adults as for example in pemphigus. The ulcers are always superficial and in the event of recovery heal without leaving scars. This state of the mouth is often very painful and renders eating difficult. In the slighter forms there is usually nothing more to be seen than a redness and smoothness of areas, especially at the tip and along the margins which has received from Sandwith the name of "bald tongue." Scrapings from the sloughing surface have not shown the presence of any mycelial growth.

Diarrhoea has also been a very constant concomitant, being as a rule more severe in those cases which terminate fatally. In the milder cases close questioning may be necessary to find that there has been a looseness and excessive action of the bowels and we have in some been able to obtain no such evidence. In this regard some attention must be paid to the class of patients with whom, in the main, we have had to deal, a class of chronic dements from whom but little information can be obtained directly. Nevertheless it has appeared that in some there has been either no change in the usual state of the bowels or even constipation. The appetite may be preserved and in some cases it has even appeared to be excessive, especially in relation to the actual digestive capacity. In more severe cases, however, appetite is poor. Examinations of the stools have been carried out carefully. The study of the fecal flora is the subject of a special report by Dr. MacNeal and Mrs. (Kerr) Allison, while Captains Siler and Nichols devoted considerable time to the study of the protozoal contents. The results of these investigations will be found in their report.

Apart from this the stools have shown much undigested food both animal and vegetable. In one case J. N., upon a strict milk diet curds were found in the stools. More or less mucus is constantly present and at times red blood cells. The odor is peculiar and very disagreeable apparently as the result of putrefactive changes.

Nervous System—The classical descriptions of pellagra give somewhat vague accounts of the symptoms due to involvement of the nervous system, especially in regard to the mental picture. The material at our disposal is, unfortunately, almost entirely unsuited for a study of this question, since almost all cases have arisen in patients already suffering from mental disorder and presenting more or less evidence of interference with the projection system. In most instances the records of previous examination of

the nervous system are almost entirely lacking and it is, hence, impossible to decide which, if any, of the present manifestations are due to pellagra. In cases (1) and (2) recorded below and another seen with Dr. Baker of Peoria, where pellagra occurred in individuals previously healthy there were no evidences of gross lesion of the nervous system except in the final stages. The exaggeration of reflex did not appear to be more than could be accounted for by the condition of exhaustion. In the final stages there have in many cases developed symptoms of central neuritis (see report by Dr. Sidney D. Wilgus, and also Case 2, below), and this must unquestionably be regarded as worthy of more than passing mention. It will be discussed further in considering the course of the disease.

With regard to mental symptoms we can quote but two cases (Nos. 2 and 8) which bear upon the point. In the first of these there developed a psychosis of delirious character, which appeared to run parallel to the physical manifestations. Besides this there was an intensification of the querulousness peculiar to the personality of the patient, together with some depression and irritability. In the second case a typical manic-depressive excitement arose shortly after the appearance of gastro-intestinal symptom, which seem to have been the early manifestations of an attack of pellagra. The scanty history of this individual prior to the onset which was available seemed to indicate that she had had periods of depression, with mutism and apathy, which would suggest the occurrence of transient attacks of the depressed phase of manic-depressive insanity. Hence, one is not justified in regarding the manic excitement as a picture forming part of the pellagra complex. It is to be considered only as a personal type of reaction.

Case 1 quoted below showed no mental symptoms up to the time of her death beyond a change in disposition, in which she became more depressed and irritable. This may be considered as probably adequate to her general condition of weakness and exhaustion. Another case of interest in this connection is that seen by the courtesy of Dr. J. H. Bacon in the city of Peoria, details of which were published in the American Medical Journal, Vol. LIV, p. 1783. In a personal communication Dr. Baker informs us that this patient, who had seven attacks of pellagra in seven consecutive years, had become more irritable and depressed ever since the first attack in 1903, but there were no more definite mental symptoms until the last and fatal attack in 1910. The depression then became more marked, although still accompanied by insight. During the last stages she also had episodic periods of apprehensive excitement, accompanied by sense falsifications and extreme restlessness. These episodes occurred mostly at night and were followed by amnesia. During them she threatened suicide, accused her daughter of immorality and heard robbers trying to break into the house. During the intervals she was depressed and hopeless, but was able largely to direct the affairs of her household from her bed.

Among individuals already insane there have been no definite changes produced by the onset of pellagra. Some are reported as having been more restless and excited, others have seemed more depressed and irritable, but in the vast majority the pellagra does not seem to have led to any change in the mental attitude of the patient.

From our personal experience we, therefore, do not feel justified in making any very definite statements regarding the nervous and mental symptoms of pellagra. It has seemed that in the projection system there are no characteristic changes until the final stages, when there is a great liability to the occurrence of central neuritis. (In this relation the observation of increased sensitiveness of nerve trunks and muscles to pressure made in Case 2 at the time of a generalized pellagrous eruption is of considerable interest, in that it suggests that the nerve trunks are also at times susceptible to the pellagrous toxin whatever be its nature.) In regard to the associative system of the brain our observations would suggest that there is a liability to the occurrence of deliria similar to those seen in other infective

and toxic states. Here reference may be made to the report of the Georgia State Sanitarium at Milledgeville for 1910. A large number of patients were admitted to this institution suffering from pellagra with mental symptoms, and it is interesting to note that the psychoses presented are included in the infective exhaustive group which contains the deliria due to bacterial and other organic toxins. Apart from this acute condition, which is to be regarded only as a type of reaction on the part of the brain to acute intoxication of any kind, there does not seem, in our limited experience, to be any "pellagrous insanity." The change in disposition, which is not by any means constant, is very similar to that seen in other chronic exhausting diseases, such as tabes dorsalis and tuberculosis.

In our opinion it still remains to be proved that pellagra gives rise to any more chronic form of nervous or mental disorder. It does give rise to symptoms of acute intoxication of the nervous system, such symptoms being not in any way characteristic of any particular toxin. Furthermore, like other intoxications, it may act as the exciting cause for outbreaks of acute psychoses, such, for instance, as those belonging to the manic-depressive group, in individuals who are susceptible.

There is one further point which is also especially worthy of emphasis. althought its explanation is still to be found. This is the great susceptibility of the chronic insane to pellagra. The proportion of those affected outside the State and county hospitals for the insane to the inmates of these institutions is certainly extremely small in this State, even if allowance be made for many failures to recognize the disease.

Blood—Results of blood examinations in pellagra have been published by many different authors without the demonstration of any changes which are in any way constant or characteristic. Points which have chiefly been emphasized in regard to the cytology are the occurrence of a high color index and an increase in the proportion of mononuclear leucocytes. Leucocytosis has occasionally been observed, but as a rule is absent. In reading the results of blood counts upon most of the cases examined in this State it must be remembered that we are dealing, in the main, with individuals who were not normal before the onset of the pellagra. Blood changes are found in many of the chronic insane and this fact should be borne in mind in considering the examinations of such individuals who subsequently become pellagrins.

With this in view, it was thought well to tabulate, for comparison, the blood findings in a group of individuals suffering from chronic mental disorder and comparable in that respect with the great majority of available pellagrins. They include cases of senile dementia, dementia præcox and defective mental development. The results of 25 such examinations performed by Dr. Addison Bybee, late clinical pathologist to the Psychopathic Institute, are given in Table I. These cases were selected for the reason that in age, type of mental disorder and long residence in hospital they fairly correspond with the bulk of the population of the Peoria State Hospital.

TABLE I.

Cases.	Age.	Years in hospital.	Red cells per cubic mm.	Haemoglobin in grammes per cent.	Color index.	White cells per cubic mm.	Per cent.						
							Polymorph. neutrophils.	Small lymphocytes.	Large lymphocytes.	Mononuclear leucocytes.	Transitional cells.	Eosinophils.	Basophils.
W. H.	62	8	4,248,000	13.44	1.12	12,500	39.8	12.6	17.0	25.0	1.0	4.0	0.6
W. S.	44	19	4,696,000	16.86	1.27	8,160	65.2	10.4	11.2	9.2	1.6	2.2	0.4
C. S.	56	19	4,845,000	15.88	1.15	10,540	59.0	18.8	9.4	6.8	2.2	2.8	1.0
L. R.	45	24	5,442,000	17.3	1.13	8,250	55.8	15.2	14.4	5.8	1.6	7.0	1.0
J. H.	50	12	5,836,000	16.8	1.02	11,380	60.0	14.8	11.6	9.8	1.0	2.6	0.2
S. S.	52	19	5,036,000	13.92	0.98	8,120	63.8	14.8	10.2	8.0	1.8	1.2	0.2
C. H.	60	39	4,800,000	13.92	1.03	12,200	54.0	13.6	12.2	17.2	1.8	2.0	1.2
A. S.	46	26	2,566,000	10.26	1.11	10,400	66.4	17.0	11.6	1.0	0.4	1.2	1.4
B. S.	68	8	4,936,000	12.96	0.94	7,280	62.6	12.2	11.0	10.6	1.2	1.8	0.6
W. V.	39	12	6,016,000	16.8	1.00	10,640	56.0	14.4	6.8	11.4	2.0	8.8	0.6
D. N.	72	25	4,640,000	14.40	1.04	7,440	58.2	12.0	8.0	11.4	3.0	6.6	0.8
J. S.	45	25	4,816,000	12.44	0.91	10,840	63.2	10.2	7.6	10.0	1.4	7.2	0.4
J. D.	55	18	4,528,000	11.04	0.87	13,800	65.2	11.4	7.6	10.4	3.4	1.4	0.6
B. S.	62	12	5,848,000	14.40	0.88	6,800	73.8	8.0	5.0	8.0	3.2	1.8	0.2
S. L.	38	7	6,288,000	15.36	0.85	11,440	78.2	6.4	3.8	3.6	4.0	3.2	0.8
C. C.	36	14	4,220,000	12.44	1.06	12,960	75.0	9.0	4.4	7.0	2.8	1.2	0.6
B. M.	50	21	4,696,000	13.92	1.05	13,700	71.4	9.8	6.0	6.2	4.6	2.0	....
A. B.	43	7	4,116,000	12.00	1.04	8,380	67.6	11.6	7.8	6.0	5.8	0.4	0.8
L. P.	23	3	4,880,000	12.44	0.91	8,160	50.0	11.0	7.0	18.6	9.4	3.4	0.6
H. H.	63	21	4,496,000	11.52	0.94	10,720	76.8	6.2	3.2	6.5	3.8	2.6	0.8
E. L.	74	1	4,352,000	11.52	0.94	13,120	57.0	22.0	3.0	9.6	6.0	1.8	0.6
L. M.	52	14	4,992,000	12.96	0.92	9,200	65.0	13.8	7.2	8.6	2.8	2.4	0.2
M. D.	46	18	4,328,000	11.04	0.91	15,000	56.0	10.4	5.2	20.4	....	4.0	1.2
A. K.	44	9	5,048,000	13.92	0.98	12,140	70.2	11.0	8.4	7.4	1.2	1.8	....
O. L.	66	2	6,080,000	12.00	0.71	7,860	41.6	18.8	8.4	16.4	6.0	7.0	1.8
Average	51	15	4,872,000	13.62	0.99	10,416	61.7	12.6	8.4	10.2	2.7	3.2	0.6
Maximum	74	39	6,288,000	17.3	1.27	15,000	78.2	22.0	17.0	25.0	9.4	8.8	1.8
Minimum	23	1	2,566,000	10.26	0.71	6,800	39.8	6.2	3.0	1.0	....	0.4	....

It will be observed that in 12 the color index is normal or slightly above, in spite of the fact that some of these show a diminished number of red cells. The two cases presenting the smallest number of red cells, viz: 2,566,000 and 4,116,000, have respectively a color index of 1.11 and 1.04. With regard to the proportions of the different varieties of white cells it will be seen that on an average also the relative number of large mononuclear leucocytes and transitional cells is somewhat high. Attention should also be called to the presence of eosinophilia in several of the cases.

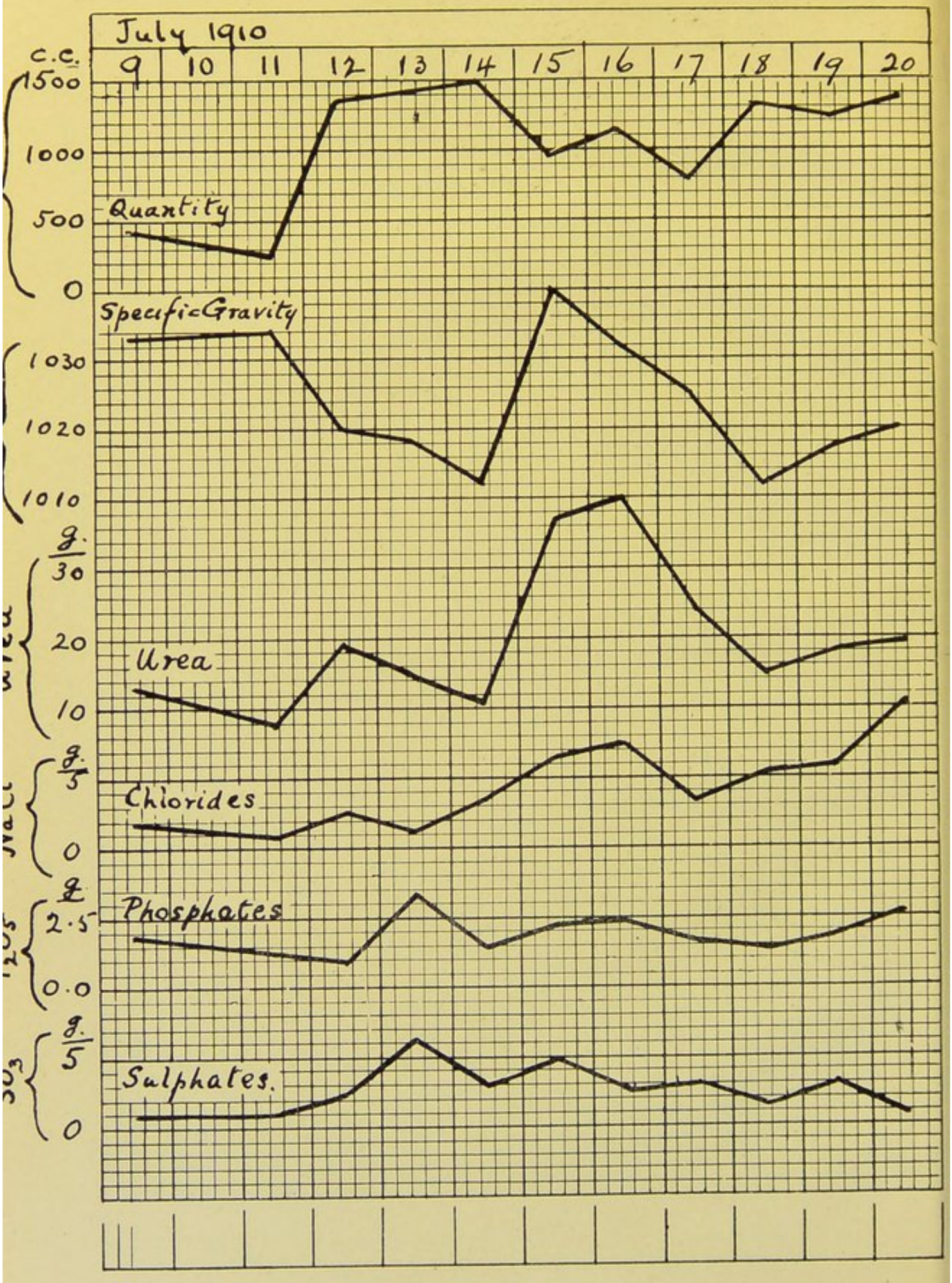
In Table II will be found the results of 11 examinations made upon nine different patients during the acute or subsiding stages of pellagra.

TABLE II.

Cases.	Red cells per cubic mm.	Haemoglobin in grammes per cent.	Color index.	White cells per cubic mm.	Per cent.							
					Polymorph. leucocytes.	Small lymphocytes.	Large lymphocytes.	Mononuclear leucocytes.	Transitional cells.	Eosinophils.	Basophils.	Unclassified.
J. B.	4,088,000	11.52	1.0	7,400	54.20	28.33	5.66	4.21	0.59	5.59	1.22	0.18
N. A.	5,032,000	10.56	0.76	6,620	69.6	14.07	10.2	2.22	1.11	1.16	0.37	0.0
C. G.	4,205,000	11.52	1.0	6,400	47.33	33.83	10.5	3.17	0.33	2.00	1.16	0.0
J. S.	5,200,000	12.0	0.82	9,000	60.43	25.96	4.3	1.37	0.58	7.0	0.19	0.0
C. A.	3,960,000	11.5	1.3	9,600	64.46	29.15	3.2	0.0	0.0	2.96	2.3	0.0
J. S.	3,652,000	10.06	1.0	7,600	66.0	21.0	6.0	2.4	1.5	3.1	0.0	0.0
E. S.	4,664,000	13.9	1.06	7,400	61.43	20.28	12.6	2.57	1.86	1.0	0.29	0.0
J. N.	5,120,000	9.6	0.7	7,200	31.78	34.68	17.1	1.36	1.16	13.4	0.58	0.0
	4,542,000	9.6	0.76	7,000	38.0	50.4	0.0	4.8	0.0	6.8	0.58	0.0
	4,682,000	10.8	0.8	7,200	.....	.....	.....	.....	.....	.....	.....	.....
J. V.	4,640,000	.....	.....	16,920	78.0	15.0	0.0	5.0	0.0	2.0	0.0	0.0
Average.	4,524,864	11.1	0.97	8,394	57.22	34.22		3.42		4.5	0.67	.....
Maximum.	5,208,000	13.9	1.3	16,920	78.0	51.78		5.0		13.4	2.3	.....
Minimum.	3,632,500	9.6	0.7	6,400	31.78	24.27		0.0		1.0	0.0	.....

It will be observed that in five of these the color index is at or slightly above the normal, although in all five the number of red cells is more or less subnormal. In only one case, J. V., was there any leucocytosis. This patient, reported in more detail below (Case 2), was apparently not insane before the onset of pellagra. The number of leucocytes increased at subsequent examinations from 16,920 to 20,480 per cub. m.m. The attack was very severe, with fatal result, and at autopsy no evidence of any septic focus was found to account for the leucocytosis, with absolute and relative increase in the polymorpho-nuclear leucocytes. One must, therefore, conclude that this was due to pellagra. Apart from this case all others have shown a relative lymphocytosis and there is apparently a diminution in the proportion of large mononuclear leucocytes. It will be observed that the increased number of lymphocytes was not limited to the larger varieties, so that it cannot be explained by differences in nomenclature and a confusion between large lymphocytes and large mononuclear leucocytes. Eosinophilia is also present in five of the nine cases. In one of these, J. N., the proportion is as high as 13.4 per cent, and it may be noted that this patient also showed amœbæ in the stools. The eosinophilia, however, does not always correspond with amœbiasis, as, for instance, in J. B. no amœbæ were found. In view of the findings in Table I, however, one need not be surprised at these figures.

A blood count of the patient J. N., made 18 months after the disappearance of all pellagrous symptoms and without recurrence, at a time when the patient was apparently in good health, gave the following results: Red cells, 4,720,000 per cub. mm.; hæmoglobin, 11.5 per cent; color index, 0.87;


July 1910
c.c.
9
10
11
12
13
14
15
16
17
18
19
20
1500
1000
500
0
Quantity
Specific Gravity
1030
1020
1010
g.
30
20
10
Urea
g.
5
0
Chlorides
g.
2·5
0·0
Phosphates
g.
5
0
Sulphates.

white cells, 8,200 per cub. mm., of which 50.5 per cent were polymorphonuclear neutrophils; 42 per cent lymphocytes, 1.5 per cent mononuclear leucocytes and transitional cells, 5 per cent eosinophils and 1 per cent basophils.

Besides these enumerations, several weeks were occupied in the careful study of blood, both in the fresh state and after staining by various methods. The fresh blood was examined with direct illumination and the dark field illuminator. The stains employed have been those of Jenner, Giemsa, Levaditi and Methylene blue. In no specimen has anything been observed which seemed to be in any way abnormal.

Cultures were made from the blood in several cases with negative results, except in one instance, J. N., at the Kankakee State Hospital. In this case a large motile bacillus was obtained, which grew freely, but somewhat slowly, on all media. That it was not a contamination seemed to be proved by the fact that the organism was agglutinated by the patient's serum. No clumping was obtained, however, with the sera of other pellagrins or healthy individuals, and the bacillus gave no evidence of pathogenicity, even in large doses when injected into a monkey and a guinea pig. We are, therefore, inclined to regard this as evidence only of a lowered resistance to the invasion of the individual by parasites.

Urine—Specimens have been examined repeatedly from the cases transferred to Kankakee from Peoria and also in cases arising in the former institution. No constant changes have been found with the exception of a very marked indican reaction which was present in all and can probably be correlated with the intestinal putrefaction. In a few instances a trace of albumen and a few hyaline casts have been present.

One striking feature also has been the great variability in quantity, color and specific gravity of the specimens obtained on various days from the same patient. In the case J. N., who passed through a very severe attack these variations were remarkable and are recorded in graphic form opposite. It should be stated that the estimations of chlorides, phosphates and sulphates were made by the Purdy centrifuge method and hence cannot be regarded as accurate. Nevertheless since they were all made with the same centrifuge revolved for the same length of time a comparison between the readings for the different days is quite permissible. These results cannot be regarded as indicating anything more than evidence of great disturbance in metabolism and suggest the advisability of more exact study of the exchanges.

The course of the disease—The great majority of cases have shown an acute course with sudden onset and have arisen for the most part in individuals of poor physique, although some few have been well nourished and apparently healthy. As a rule the earliest symptom observed has been the skin eruption upon the hands with simultaneous or rapidly succeeding soreness of the mouth and more or less diarrhoea. This acute phase lasts for one or two weeks and then gradually subsides with the replacement of the erythema by a thickened dry, scaly condition of the skin which may last several weeks or even months during which desquamation occurs.

A certain proportion of the cases have begun with gastro-intestinal symptoms, consisting of chronic and often severe diarrhoea with more or less stomatitis. At this stage the diagnosis is very difficult to make and we have observed cases in which these symptoms have been present for one or two months before the appearance of the characteristic rash. The eruption has appeared suddenly and has generally been very severe with marked bleb formation and ulceration. These cases in our experience have been extremely fatal, the patient rapidly losing flesh and becoming weaker. We are inclined to regard the occurrence of severe mouth symptoms in any case as of very grave import. Nevertheless in some cases where death has seemed to be only a question of a few days, improvement has occurred with an apparently complete recovery. One such example, J. N., at the Kankakee State Hospital where death was momentarily expected in the spring of 1910 made a good recovery and has had no recurrence up to November, 1911, being

apparently in fully as good health as before the attack. This patient, though not robust was nevertheless in a good state of nutrition and health before the onset of the pellagra.

Another form of course deserves to be especially mentioned because it touches upon the important question as to what constitutes pellagra and when it may be considered as recovered. In these cases the gastro-intestinal symptoms are usually severe and there is consequently progressive emaciation and exhaustion. After a few weeks the skin lesions disappear and the mouth may get well, diarrhoea becoming less or even disappearing, and yet the patient does not improve or only slightly and then temporarily. Without any recurrence of the acute symptoms of pellagra there is a gradual decline with increasing evidence of involvement of the nervous system until the picture becomes unmistakably that of central neuritis which ends fatally in a short time. (See report by Dr. Sidney D. Wilgus and the case of J. V., recorded below.)

In some instances these symptoms have occurred within a few days of the subsidence of the characteristic pellagrous phenomena or even while they are still present whereas in others they have been delayed for several months. We do not feel justified in expressing any definite opinions upon the meaning of this condition but it may be suggested that the sequence is somewhat similar to that which occurs in diphtheria where a peripheral neuritis follows at a longer or shorter interval after the actual infective agent has been eliminated. Yet it is unquestionably due to the action of the toxins produced by the organisms upon the peripheral nervous system. In pellagra the neuritis is more particularly central but may well be a late effect of the toxins, whatever their nature, as in diphtheria and does not necessarily indicate that the disease is still active. Progressive emaciation and exhaustion after the subsidence of the characteristic manifestations of pellagra have been noted by many authors and have been regarded by some as evidence that the disease is still active. We are unable to say whether all such cases present symptoms of central neuritis or not as the necessary data are not available. Attention to this point is certainly desirable as it offers the possibility of a definite explanation for this otherwise puzzling course.

It is usually stated that in most cases after the subsidence of an attack the patient regains his health more or less completely and may seem to be entirely recovered, but with the appearance of the next spring or autumn there is a recrudescence of the active symptoms. The short time during which cases have been under observation in this State renders it impossible to give any very reliable data concerning this question but it may be stated that many of the cases showing attacks in 1909 and 1910 have not presented any recurrence up to date, although they have been closely watched. The actual figures are given in the statistical study. Of the six cases transferred from the Peoria to the Kankakee State Hospital in July, 1910, selected for the reason that they presented unquestionable symptoms of pellagra none up to the end of November, 1911, have shown any further symptoms of the disease. (One of these cases died from pneumonia on April 15, 1911.) The best marked example of annual recurrence was seen in the city of Peoria by the courtesy of Dr. J. H. Bacon who published a history of the patient in the Journal of the A. M. A., Vol. LIV, p. 1783. This patient had had seven attacks in seven years although the diagnosis was not made until the seventh and fatal attack in March, 1910.

Finally there are to be mentioned cases which present a much more chronic course as regards the individual attacks. In these cases there is as a rule but little constitutional disturbance and the initial erythema is slight or may not be seen at all. There occurs, however, a slowly increasing pigmentation with some thickening and roughness of the skin of characteristic distribution, symmetry and outline. The color in these cases becomes extremely dark often almost black and persists for some months when desquamation occurs and the skin gradually resumes a more normal color. This condition

has only rarely been observed among the cases in this State and is perhaps more difficult of diagnosis, especially when it occurs in old people, than the more acute forms.

Pathological findings—The postmortem findings in so far as they have yet been worked up are described in detail below in connection with the descriptions of the cases. While it cannot be said that there is anything specific about the changes found, yet there are certain features which seem to be constant and open up certain more or less definite lines for future search. These may be summarized as follows:

(1) The *nervous system* presents a picture of axonal chromatolysis involving especially the Betz and larger pyramidal cells of the praecentral convolutions and the cells of the nuclei in the cerebellum, pons, medulla and cord as well as the post-root and sympathetic ganglia. Besides these changes numerous cells in most cases show a marked pigmentary degeneration of fatty nature similar to that found in the senile nervous system and in some other conditions. With this there is in most cases, but little evidence of connective tissue reaction and we would especially emphasize the absence of infiltration of the perivascular sheaths. In some cases there is more or less overgrowth of glia cells along the vessels and around the nerve cells. The picture here described is identical with that published by others notably Spiller and Anderson[1] in cases of pellagra, but is also strikingly similar to the picture of central neuritis. This similarity indeed led us to ask whether the patient did not have the clinical picture of that condition before we were aware that Dr. Wilgus had already observed and commented upon it.

Central neuritis, like peripheral neuritis, must not be regarded as a disease, *sui generis*, but merely as a type of reaction upon the part of the nervous tissue, capable of being produced by various harmful agents. In response to a letter, Dr. Adolf Meyer, who first described the changes which bear this name, writes that he is not surprised to hear that they are found in the end stages of pellagra and gives the interpretation contained in the above

(2) The *liver* has been constantly the seat of small islets of a low grade

(2) The *liver* has been constantly the seat of small islets of a low grade inflammation of the portal connective tissue lying in the interlobular septa. The intralobular capillaries are engorged and in most cases there are many small blood extravasations. The liver cells have undergone fatty degeneration which is in some instances remarkable and the change is distributed in every case along the periphery of the lobule. This, in the absence of any marked cirrhosis, at once suggests that there may have been some toxin circulating in the portal blood stream. Some of the specimens even suggest a picture of a very early stage of acute yellow atrophy or the more acute forms of alcoholic cirrhosis.

(3) *Intestinal* ulceration has been present in three out of seven cases. This has not the acuity of an amoebic infection and no amoebae have been found in the walls. Even where no ulceration was found a low grade infiltration of the mucosa and submucosa has been present in places. These findings are certainly of interest in relation to the condition of the liver.

(4) The *kidneys* show degenerative changes in the renal epithelium and in all cases more or less interstitial nephritis in spite of the fact that the ages in some of the cases is certainly not great. Engorgement of capillaries with small hemorrhages are also frequent.

(5) The *spleen* shows some fibrous overgrowth and again small hemorrhages.

(6) Pigmentary changes are present in the *heart muscle* at an age which is below that at which they are usually found.

(7) In some of the cases hyaline changes in the intima of the blood vessels has been marked, but this is not constant.

All these appearances suggest the presence of some toxic substance in the blood. One may even go further, and from the changes in the intestine,

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[1] Am. Journ. of Med. Sciences, new series, 141, January-June, 1911, p. 94.

and especially in the liver, suspect that this toxin originates in the intestine and enters the circulation by way of the portal system. The great frequency of gastro-intestinal symptoms during the clinical course of the disease might be regarded as pointing in the same direction. There is always, however, to be borne in mind the possibility that these changes may be secondary to the pellagra. That is to say, that as the result of the gross disturbances in metabolism and vital resistance which certainly accompany the disease there may follow a secondary invasion of the intestinal tract with organisms which then gives rise to the changes found by virtue of the toxins elaborated during their growth. Secondary changes such as this would be quite in accordance with what is found in other diseases.

If, however, we look for evidences of the localization of a blood borne parasite in other parts of the body we find entirely negative results. The nervous system does not present any features similar to those found in such diseases as trypanosomiasis or parasyphilis. The absence here of any focal changes and of perivascular infiltration are strikingly different from the conditions found there. The picture presented is much more that of a diffuse toxic state than of one due to a blood infection. The only tissues in which there seemed to be any focalization of lesion were in the intestinal wall and the liver. In this latter organ the areas of infiltration present in the interlobular septa were decidedly local and often widely separated, and where found existed in the form of more or less circular islets. There was no generalised invasion of the whole of the connective tissue. The intensity of the infiltration was certainly of low grade and did not suggest a very acute inflammation.

As already indicated, the study of degenerations in the nervous system is very incomplete, but from what has been seen so far there is no evidence of any system degeneration. The fibers in the cord which stain by the Marchi method are scanty and widely scattered, and there is nothing to support the suggestion made by Long that the nerve roots are pressed upon as they pass through the intervertebral foramina. It might also be mentioned that the distribution of the skin lesions does not correspond with that of the posterior roots of the cord. The perfect symmetry so characteristic of the skin lesions in pellagra is hardly conceivable as the result of any gross nervous lesion, and suggests far more some generalized noxious agent which is capable of a far finer biochemical selective power than could possibly be conceived from pressure or other gross lesion of like kind.

Pellagra is sometimes described as a disease especially involving the nervous system. From the findings here described the nervous system seems to be involved only as a secondary process and at a late stage of the disease, in this respect confirming the opinion expressed above from clinical study.

Without expressing any opinion as to causal relations, it seems to us that the main indications revealed by the pathological study point to the need for closely following up investigations upon the intestinal tract. At the same time we can admit that this habitat would not contradict the hypothesis that the parasite has entered the system through the blood stream as the result of bites by insects.

Case 1.

Pellagra in a previously healthy woman which without improvement in the specific symptoms led to death in three months.

A. D., a white female, aged 43, seamstress by occupation, and a widow. She is said to have been a healthy woman, though always in poor circumstances, and during the last few months has had a hard struggle for existence. She has four living children and had one still birth, but no miscarriages. The menopause occurred five years ago. Her only illnesses during adult life have been gonorrhœa "several years ago," and malaria "on several

occasions." She had been living in Corinth, Mississippi for "several years," until June, 1910, when she came to Chicago, where she has been since. Previous attacks of pellagra are denied.

Present illness began in October, 1910, the first symptoms being "chapping of the hands," with diarrhœa and progressive emaciation. The hands became raw and fissured and this was accompanied by pain of a burning character. Diarrhœa has been very profuse, and for two months there had frequently been blood in the stools, sometimes in the form of clots. The mouth also became very sore, rendering eating difficult, and there was profuse salivation. In spite of this she showed a craving for food, the ingestion of which would often give rise to "cramps." No definite mental symptoms have been noted, with the exception of a change in temperament, in that she was more fretful and irritable than usual. At no time has there been any evidence of "wandering in her mind."

She was admitted to the Cook County Hospital on Jan. 12, 1911, under the care of Dr. W. A. Pusey, to whose courtesy we are indebted for permission to use this case. At this time she presented an extremely emaciated condition, with incessant diarrhœa. Mentally she was clear and remained so until the time of her death, but was listless and apathetic. Some degree of depression was present, but this did not seem to exceed the limits justified by her condition. She answered questions clearly and readily and her memory seemed to be good, although the examination was not very thorough.

Upon the backs of the hands, extending upwards to about two inches above the wrists, and forming a cuff around the wrist, was a characteristic pellagrous eruption, completely symmetrical on the two sides. The skin over this area was deeply pigmented, fissured and excoriated with yellowish exudate between the roots of the fingers. The mucosa of the lips, tongue and inside the cheeks was markedly red, swollen and partially denuded with yellowish exudation where the lips came in contact with the teeth.

The diarrhœa continued with great severity, accompanied sometimes by the passage of blood, and the patient rapidly became weaker. She was first seen by us on the 20th of January, 1911, at which time she was so weak and ill that an exhaustive examination was not permissible. She rapidly became tired out when talked to, the swelling of the mouth and tongue rendering it difficult for her to converse. She, however, seemed to be clear and gave some details concerning her illness without hesitation or error. She was not unduly depressed, but realized that she was dying and was very willing to permit any examination which would help to elucidate the disease, which she recognized as being somewhat rare. The knee jerks were greatly exaggerated, but equal on the two sides, yet did not appear to be more marked than is commonly found in advanced exhaustion. The plantar reflexes were both of flexor type. Rough testing revealed no gross changes in sensibility of the skin.

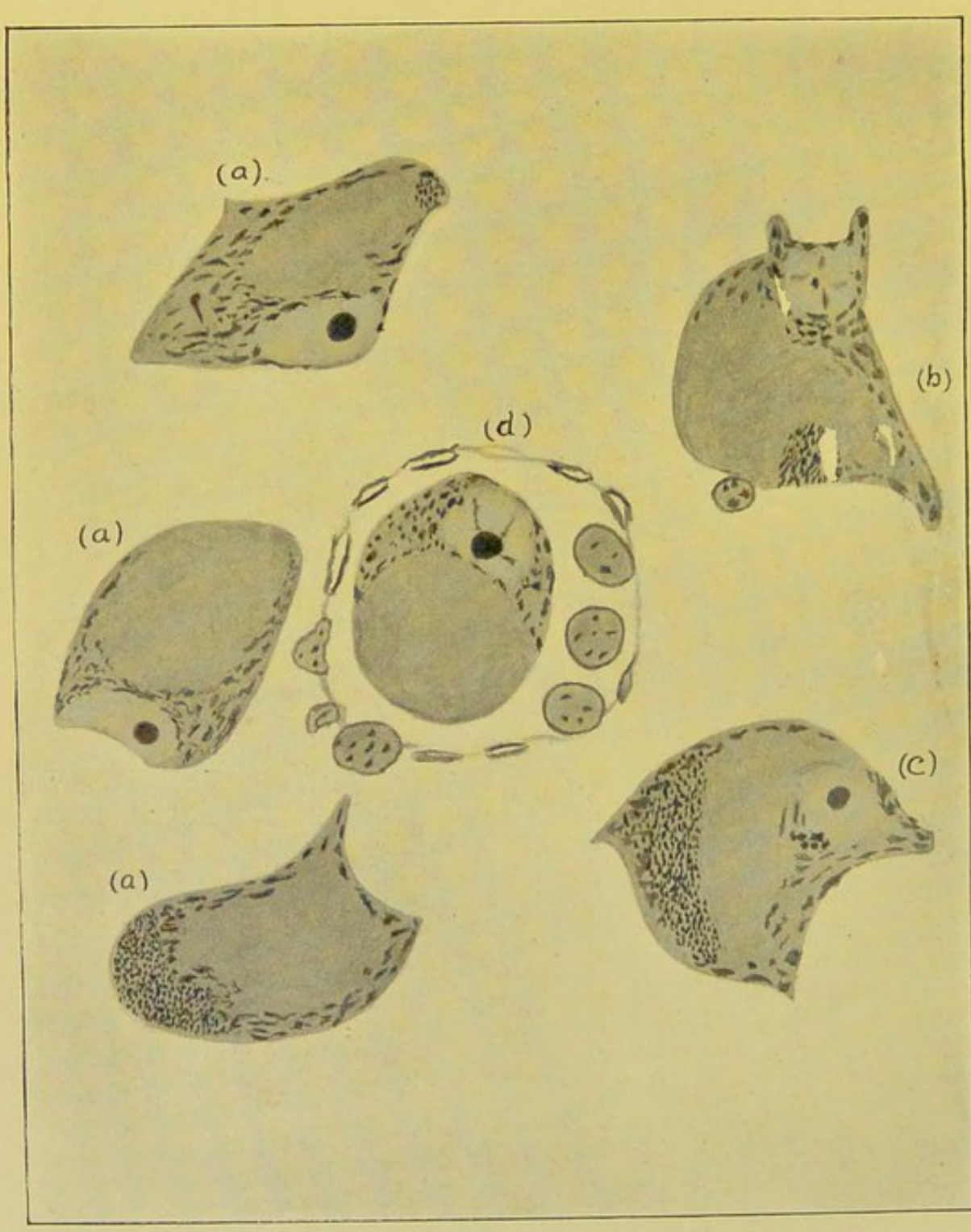
Blood was taken by venipuncture for agglutination and complement fixation tests. The stools were also examined for amœbæ, but none were found.

Death occurred on Jan. 22, 1911, at 1:30 p. m., and an autopsy was performed the following day at 11 a. m. At this time the pellagrous eruption was still well marked and the evidences of excoriation in the mouth were quite distinct. Upon section the lungs showed considerable œdema, especially at the bases. There was a healed calcareous scar at the right apex, but otherwise no change. The pericardium contained some excess of clear fluid, but the heart and vessels showed no notable changes. The heart muscle was somewhat thin and flabby and there was no hypertrophy of the left side.

The kidneys showed some evidences of early chronic interstitial nephritis. Adrenal bodies were firm, each weighing 4 g.

The spleen was larger than normal (weight, 200 g.) and its substance seemed to be unduly firm, but there was no evidence of great increase in fibrous tissue.

The intestinal tract appeared normal everywhere, with the exceptions of the mucosa of the mouth and the lower part of the sigmoid flexure, in which



CASE A. D.—Nerve cells showing chromatolysis and pigmentary changes. (*a*) From Clarke's column; (*b*) from ant. central convolution; (*c*) from ant. cornu in cervical region; (*d*) from post. root ganglion.

elements and moderate small celled infiltration. A careful search was made for the presence of amœbæ in the ulcer wall and sections were submitted to Captain Nichols of the Army Medical School, Washington, D. C., who examined them in collaboration with Dr. Neate, microscopist to the Museum of the Army Medical School. They report that they "have been unable to satisfy ourselves that they contain any amœbæ. The general picture, too, does not seem to be active enough for an amœbic ulceration."

Besides the ulcers similar infiltrations of the submucosa and even deeper than the muscularis mucosæ were found in the apparently healthy wall of the intestine.

Mesenteric lymph glands on section showed marked engorgement of the vessels, with blood and some dilatation of the lymph spaces, but there appeared to be no increase of connective tissue and no other pathological changes.

Sections of the *ovary* and *tonsil* revealed nothing worthy of special note.

Central Nervous System—The pia mater showed no changes, either with regard to its connective tissue or blood vessels.

Nerve Cells—Sections were examined from various regions of the cortex and also from different levels in the cord and medulla. Stained with Methylene blue and Cresyl violet, marked chromatolytic changes of an axonal type were found in the large pyramidal cells of the rolandic region, but especially of the Betz cells. Of these latter practically all show extreme changes. The cells are swollen and stain faintly, the nucleus is displaced and the nucleolus often stains poorly. The Nissl granules have largely disappeared, small collection of them remaining at the base of the larger processes along the edges of the cell, and often collected as a small mass around the nucleus. Very many of these cells show masses of a yellowish green pigment, sometimes almost filling the larger part of the cell. This pigment stains black with osmic acid. The large pyramidal cells show somewhat similar changes, especially in regard to the pigmentation, but the chromatolytic changes are not so marked and many healthy cells are still present.

In other regions of the cortex an occasional larger pyramidal cell is found, showing evidences of chromatolysis, but they are nowhere very marked. The Purkinje cells of the cerebellum show generally a somewhat poor content of chromophil granules, but are not otherwise changed. The dentate nucleus shows many cells with chromatolysis.

In the medulla oblongata the cells of practically all nuclei show marked chromatolytic and pigmentary changes, especially in the larger types of cell.

In the spinal cord similar changes are found in some anterior horn cells at all levels examined, but the great majority of these cells appear healthy. The most marked changes were found in the cells of Clarke's column, where the majority of them were undergoing chromatolysis and pigmentary degeneration. Chromatolytic changes were also found in the cells of the posterior root ganglia. In specimens stained by the Marchi method the pigment deposits, both in anterior horn and Clarke's column cells, are very evident.

Marchi Method—Brain sections by this method have not yet been studied, but in the spinal cord there are a few degenerated fibers scattered diffusely through the white matter. This does not especially involve the pyramidal tracts. Degenerated fibers are also present in both anterior and posterior spinal roots.

Glia and Vessels—The absence of any increase of glia cells is very striking. Not more than one or two Satellite cells are found in relation with the degenerated cells, and the glia nuclei are nowhere more numerous than normal, except possibly around some of the larger vessels. The cerebral vessels show in places a slight increase of the adventitial nuclei, but there is absolutely no infiltration of the perivascular sheaths. This is true in all sections examined, and certainly forms a striking contrast to the pictures seen in syphilis, parasyphilis and trypanosomiasis.

Attention may also be called to the large number of Corpora amylacea which are present in the spinal cord, situated especially along the course of the postero-lateral septa and along the borders of the anterior fissure. In these regions as many as 10 or 12 may be seen in the field of a 4 mm. objective. When the age of this case (43 years) is considered the pigmentary changes and corpora amylacea must be regarded as definitely pathological.

CHEMICAL EXAMINATION OF THE RIGHT CEREBRAL HEMISPHERE.

(By Waldemar Koch, Ph. D. Dept. of Physiology, University of Chicago.)

Brain of A. D. Collected Jan. 22, 1911. Analyzed May, 1911.

			A. D. age 43.	Normal brain age 43.
Total solids—20 g.				
Constituents in per cent of solids:				
Colloidal—				
Total proteins (including solid structure)			40.2	40.3
	A. D.	Norm.		
Phosphatids	23.5	24.1		
Cerebrosids	9.3	.....		
Sulphatids	7.5	6.5		
Total lipoid (by diff.)			48.9	48.9
Non-colloidal—				
Organic extractives, Inorganic constituents			10.9	10.8
Distribution of sulphur in per cent of total S			0.58	0.50
	A. D.	Norm.		
Fraction 4 (protein)	62.9	63.4		
Fraction 1 (lipoid)	26.2	24.0		
Fraction (neutral)	5.9	8.4		
Fraction (inorganic)	4.8	4.2		
Distribution of phosphorous in per cent of total P			1.39	1.41
	A. D.	Norm.		
Fraction (protein)	*	*		
Fractional 1 (lipoid)	75.0	76.0		

* Not estimated.

In submitting this report Dr. Koch makes no comments beyond calling attention to the fact that the neutral sulphur fraction shows a diminution, which he has hitherto found only in the brains of individuals suffering from dementia præcox.

Case 2.

PELLAGRA IN A PATIENT OF PSYCHASTHENOID PERSONALITY, ACCOMPANIED BY DISORIENTATION, PERPLEXITY AND SOME ANXIETY WITH HALLUCINOSIS. GENERALIZED ERUPTION ONE MONTH AFTER ONSET. DISAPPEARANCE OF ACTIVE PELLAGROUS SYMPTOMS AND SIMULTANEOUS MENTAL IMPROVEMENT, BUT WITHOUT GENERAL RECOVERY. DEVELOPMENT OF CENTRAL NEURITIS TWO MONTHS LATER. DEATH FOUR MONTHS AFTER ONSET.

J. V., white female, housewife, aged 57, married.

Family history meager, but showed nothing of importance.

Personal History—Information concerning her early life was not obtainable. Within one week of her marriage, at the age of 29, she was noticed to have psychasthenoid symptoms. She has had a very hard life, having to assist in earning a maintenance for her family of four children. Her husband left her in 1905 to take up some land in Wisconsin, the patient, after

much querulous hesitation, refusing to live there with him, not because there was any quarrel, but because she could not stand the desolate surroundings. During the whole of her married life she was irritable, unable to make up her mind to do things, and would worry over them when they were done. Such hesitation and indecision have characterized all her acts, even in relation to minute details, such as cooking food, etc.

She has lived in Mazon in Grundy county, Illinois, ever since her marriage, with the exception of a short visit to her husband in Wisconsin and to a daughter in Kansas City, Missouri. She returned from this latter trip about December, 1909, and has been living in Mazon since. She has been a semi-invalid for many months and was operated upon in October, 1910, for a fistula and ischio-rectal abscess. She was more irritable and unable to make up her mind during this time than before, but there was no other definite evidence of mental disturbance.

No history of any eruption suggestive of an attack of pellagra in the past could be obtained.

Present Illness—At the end of April, 1911, she developed an "eczema" of the hands, with severe diarrhœa, and about the same time she seemed to go "out of her mind." Did not know at times where she was and spoke of seeing smoke around the house. She recognized people, however, and seemed better when visiting in other homes than she did in her own. She became rapidly weaker, more fretful and seemed more dazed. No evidences of apprehension or further hallucinosis were noticed.

She was admitted to the Kankakee State Hospital on May 13, 1911, when she was found to be much emaciated, with a well marked pellagrous eruption upon the hands, severe diarrhœa and raw swelled tongue, with much gingivitis.

Physical examination revealed no signs of other disease. The reflexes were increased equally on the two sides, the plantars being of flexor type. All movements were very feeble and there was some tremor of the fingers.

Mental examination showed her to be depressed and somewhat clouded. She was very restless and seemed anxious and worried. She mistook nurses for people whom she had known before, and answered most questions with "I don't know." She performed a number of acts of perplexity, such as pulling off her bed clothing and piling it on the floor, and she wandered about in a dazed manner. The *pellagrous eruption* on the hands was of extremely dark color, some fissures were present about the knuckles and desquamation was marked at the time of admission. The eruption rapidly disappeared, desquamation being practically complete by the middle of June, leaving a pink, rather delicate looking skin. The sore mouth also improved and was well in about one week after admission. Diarrhœa was severe during May, but disappeared after that time, when she became more or less constipated, with only one day in which there were four stools, which could not be accounted for by purgatives.

On May 23, 1911, there developed a red, blotchy eruption on the arms, which rapidly extended over the whole body, including trunk and lower extremities, and was regarded as a generalized pellagrous eruption. In the course of a few days this rash turned brown and began to desquamate. Most of it had disappeared, leaving a healthy looking skin, within three or four weeks, but some desquamation was still present on the lower extremities at the time of death.

The confused, depressed, irritable state which was present on admission disappeared about the beginning of June, the period of delirium appearing to coincide with the acute pellagrous symptoms. After this time the patient became much more cheerful, talking freely, and gave a good account of her life without evidence of any mental dilapidation. There were, however, periods for two or three days at a time in which she would become depressed, entirely inaccessible, asking to be left alone, refusing food and say-

ing she wished to die, but there was no recurrence of clouding of consciousness at these times. She explained these episodes by saying she felt so ill and wanted to go home to die.

Evidences of involvement of the *nervous system* gradually increased throughout the illness. The deep reflexes became more and more exaggerated, until ankle clonus of short duration could be obtained on both sides. The Gordon paradoxical reflex appeared on both sides and finally a bilateral Babinski prenomenon. With this there was progressive weakness and wasting of muscle quite generally throughout the body.

Dizziness was a marked feature throughout the illness and she occasionally fell out of bed, apparently as the result of vertigo. In walking she was extremely unsteady and somewhat spastic, showing a constant tendency to fall towards the left.

No gross changes in skin sensibility were detected, with the exception that during the last two weeks of her life there seemed to be some blunting, but she was too ill to give much attention. At the time of the generalized eruption there was quite definitely increased tenderness of the muscles and nerve trunks which, however, disappeared in a few days.

During the last two weeks of her life there appeared *jactatoid movements*, involving at first the four extremities, which became rapidly more and more violent, extending even to the facial muscles, the lips, eyeballs and respiratory muscles. Accompanying this was an increasing tonic spasm of all muscles, with slight retraction of the head. The jactatoid movements were sometimes so severe as to raise the patient completely off the bed. During this last two weeks she seemed to be clear, to take an interest in the presence of her daughter and son, but she often complained of an extreme dizziness and sometimes of noises in the ears like "flies." There was no vomiting at any time, but the patient complained of nausea and eructations.

The blood was examined repeatedly, both fresh and stained, but no abnormal bodies were noted. Blood counts showed a moderate degree of secondary anæmia, the red cells numbering from 4,640,000 to 4,148,000 per cubic millimeter, the hemoglobin being estimated at 85 per cent. The white cells at the first examination numbered 16,920 per cubic mm., and increased to 20,480 at the end of June. All through there was an increase of Polymorphonuclear leucocytes, which comprised 75 to 79 per cent of the total. Small lymphocytes, 15 to 19 per cent; large lymphocytes, 2 to 5 per cent, and eosinophils, 1 to 2 per cent. No abnormal white cells nor red cells were observed.

Urine examination on several occasions presented no abnormalities and the stools were searched three times after administration of calomel and magnesium sulphate for the presence of protozoa. Active flagellates of the type of tricomonas intestinalis were present each time, but no amœbæ were found.

Death occurred at 8:30 a. m., Aug. 17, 1911, and an *autopsy* was performed at 10:30 a. m. the same day. At the examination the body was found to be extremely emaciated. The lungs showed nothing abnormal, with the exception of passive congestion and some scars of healed tuberculosis at both apices. The heart showed nothing abnormal. There was a moderate amount of sclerosis in the aorta.

The kidneys presented a slight amount of interstitial nephritis. Spleen was injected, but appeared otherwise normal. The suprarenal glands showed nothing abnormal.

The gastro-intestinal tract was normal, with the exception of three small ulcers in the lower part of the ileum, just above the ileo-cæcal valve. These ulcers were punched out with some heaping up at the margins, but no undermining and appeared to be healing.

The liver was engorged with blood and had a fatty appearance. Pelvic organs were normal, with the exception of a submucous fibroid. The brain weighed 1,190 g. There was microgyria of the frontal and to a less extent

of the occipital lobes. The vessels showed some slight opacities and were injected. Portions of all organs were removed for examination microscopically and one-half of the brain was placed in alcohol for chemical analysis.

MICROSCOPIC EXAMINATION.

The *lungs* show an increase of fibrous tissue with thickening of the vessels and moderate anthracosis.

Heart muscle shows some tendency to fragmentation but no fatty change. Some cells show pigmentation about the nuclei.

Kidneys—The capsule is thickened and there is some fibrous tissue between the tubules. The vessels are all engorged and a few small hemorrhages are scattered throughout. In places the arteries show marked hyaline degeneration. The glomeruli are small, the spaces about them dilated and the capsule of Bowman thickened. Some of the glomeruli show a marked increase in connective tissue nuclei. Beneath the capsule many areas show a moderate small celled infiltration. The epithelium of the tubules for the most part is well stained but in places that lining the convoluted tubules appears swollen and finely granular. Many of the tubules contain a hyaline material and a few some epithelial cells.

Spleen—Capsule thickened with corresponding increase in the fibrous trabeculae. The organ is much congested and there are several hemorrhages with dark blood pigment.

Liver—The capsule is moderately thickened and there is a general increase in fibrous tissue of the portal canals. Around some of the smaller vessels in the portal canals there is also an infiltration with small round cells. These stand out as rather widely separated islets in the section. The whole organ is markedly congested and there are a number of small hemorrhages especially beneath the capsule. The congestion of the lobules increases as the central vein is approached and here the columns of liver cells are widely separated. The liver cells stain well but there is extreme fatty degeneration of patchy distribution especially at the periphery of the lobules. Some of the cells nearer the central vein also show the fatty change but to a less extent. The patchy distribution of this fatty change and of the small celled infiltration are striking and the same may be said of the capillary engorgement of the lobules, although this latter is more constant than the other two. The bile ducts are well stained and show no increase.

Pancreas—There is moderate increase of fibrous tissue and a few small hemorrhages are seen. Islands of Langerhans normal in number and appearance.

Small Intestine—Unfortunately no sections were obtained from the ulcers observed. The tissue containing them was badly fixed and could not be cut. Sections from other parts of the small intestine showed engorgement with blood and small celled infiltration of the mucosa and submucosa in irregular patches similar to those described in the case A. D.

Thyroid Gland showed increased fibrous tissue with some epithelial hyperplasia. Marked engorgement with blood.

Nervous System—Nerve Cells—Widespread chromatolysis of axonal type with marked pigmentary changes are found involving especially the larger elements. Pigmentary changes are present even in the medium sized pyramidal cells. These changes are most marked in the rolandic regions but are present, though to a less extent, in other regions examined. Many of the cells, especially among the smaller elements, also show a diffusely dark staining which with the heaping up of satellite cells suggests the existence of a more chronic type of cell change. Similar changes are present in the Purkinje cells and the cells of the posterior root and sympathetic ganglia.

The fatty changes are very obvious in specimens stained with Scharlach both in the central system and in the sympathetic. Marchi specimens have not yet been examined.

Glia and Vessels—Contrary to the findings in the case of A. D., there is marked increase in the number of glia nuclei in all regions of the brain. In many places the satellite cells form heaps and some of the vessels are bordered by solid rows of such nuclei. Glia nuclei are present in large numbers in all layers of the brain cortex and are increased also in the white matter.

The adventitial sheaths of the arteries show multiplication of the nuclei and there is in places a proliferation of the intima. The perivascular sheaths present very slight cellular infiltration and Scharlach stains show the presence of numerous fatty granules contained within cells.

Case 3.

Pellagra in a woman suffering from a manic-depressive psychosis. Death one month after onset with symptoms of central neuritis.

A. S. White female, age 36, widow. She was a native of Scotland and but little information was available concerning her previous life. She, with her husband, adopted the religion of Dowie when in Scotland and have lived in Zion City for six or seven years. They have been in fair circumstances and succeeded in purchasing a home. In 1908 when the husband was ill the patient had an attack of excitement of manic-like character lasting a few weeks. Her husband died about the end of 1908 and she apparently had an attack of depression lasting about one month but was able to perform her housework. At the end of June, 1910, she again became restless and excited with heightened mood. When admitted to the Elgin State Hospital, July 21, 1910 she presented no evidences of somatic disease but was exalted. Her thoughts and acts were strongly colored by her religious views with some self-appreciation and she was somewhat restless. In October she became more excited, singing and dancing, interfering with others, in all this giving explanations on the basis of her religious exaltation.

A pellagrous eruption with emaciation and diarrhoea were noted in May, 1911, and she died June 20, 1911, after a period in which muscular rigidity with jactatoid movements and diarrhoea were noted.

The autopsy was performed by Dr. H. Smith about 24 hours after death. Unfortunately no record of the gross findings is available.

Microscopically—The *liver* shows no definite increase of fibrous tissue either in the capsule or interlobular septa. The vessels and intralobular capillaries are engorged, the latter especially in the region of the central veins. Numerous small extravasations of blood are present within the lobules. Marked fatty degeneration of the liver cells at the periphery of the lobules is present and there are many islets of infiltration with small round cells of low grade of intensity in the interlobular septa. *Kidneys*—The capsules are thickened and fibrous tissue is increased around the vessels, between the lobules and in Bowman's capsules. The vessels are engorged and there are small hemorrhages scattered throughout but especially in the medullary rays. The glomeruli are well stained with some increase of connective tissue nuclei and are surrounded by a widened space. The secreting tubules show some swelling of cells with diffuse staining and indistinctness of outline while many contain an albuminoid material. The *heart muscle* shows thickening of vessel walls with pigmentary changes in the muscle cells. The *spleen* presents moderate thickening of capsule and trabeculae with here and there small hemorrhages. The *lungs* show many alveoli filled with a homogeneous material staining very faintly with eosin which sometimes contains no cellular elements but frequently numerous red blood cells and here and there shed epithelium. There is no leucocytal infiltration to suggest pneumonia. In the *suprarenal glands* the vessels of the inner layers of the

cortex and of the medulla are extremely engorged with blood. The parenchyma is much degenerated and in many places the cells do not stain at all, being represented only by a granular detritus.

The *Nervous System* in this case has not yet been worked up. Sections from the cortex stain badly with the Nissl stains showing but little differentiation of the granules. Nevertheless many of the larger pyramidal cells show swelling with diffuse coloration of the nucleus which is irregular in outline and displaced to the periphery of the cell. These changes are also very marked in the cells of the dentate nucleus of the cerebellum. Pigmentary changes have not been observed in anything like the same degree seen in the other cases. There is a moderate increase of glia nuclei along the walls of the vessels but not elsewhere. The vessel walls show moderate increase of adventitial nuclei but no perivascular infiltration.

Case 4.

PELLAGRA IN A MAN SHOWING ADVANCED ARTERIO-SCLEROTIC CHANGES WITH DEMENTIA. DEATH SIX WEEKS AFTER ONSET WITH CENTRAL NEURITIS.

F. M., white male, blacksmith. Said to have been insane since 1901, and to have had a previous attack in 1886. He was admitted to the Elgin State Hospital in 1904 at the age of 67. He then showed some loss of memory and derogatory delusions. He was depressed and cried easily, refused food and threatened suicide. His physical health was poor and he suffered from haemorrhoids. He gradually failed in strength.

Pellagrous eruption with diarrhoea developed in June, 1911, which improved in July but he became worse again July 10th and died on July 16th, without further acute symptoms of pellagra but with signs of central neuritis.

At the autopsy the pellagrous pigmentation was still present and the body was much emaciated. The brain showed some atrophy of the cortex and atheroma of vessels. The lungs showed hypostatic congestion and healed tuberculosis at the right apex. The coronary vessels were sclerotic but there were no other cardiac changes. The spleen and kidneys were reported to present no changes. The liver was firmer than normal. In the large intestine were a number of circular ulcers chiefly in the transverse and descending colon. They were from ⅛ to ½ inch in diameter.

Microscopically the principle changes are: Marked engorgement of the vessels of the *liver* with moderate fatty degeneration of the cells at the periphery of the lobules. The connective tissue is but little if at all increased. Small hemorrhages are present in places. The *kidneys* show chronic interstitial nephritis with the formation of small sub-capsular cysts. Small extravasations of blood are present especially beneath the capsule. The tubules stain poorly and many contain an albuminoid material and in places epithelial cells. The pyramids are markedly congested and many vessels show hyaline change some being occuluded. The *spleen* shows some increase of fibrous tissue and there are small scattered hemorrhagic areas. The arteries show some hyaline change of the intima. The *intestinal ulcers* extend down to the submucosa and show a moderately acute small celled infiltration. No amoebae were found. Areas of infiltration with small round cells are also present apart from the ulcers and extend even into the muscularis.

Nervous System—In this case the picture is complicated by the marked changes which are present in the vessel walls. A small hemorrhage about 3 mm. in diameter was found in the crusta of the pons and another, microscopic in size, in the anterior cornu in the cervical region. Both were recent and in the latter the nerve cells lying in the midst of the extravasated blood cells still stained well showing well marked Nissl granules so that it seemed probable the extravasations were due to post mortem injury.

Chromatolysis is well marked in the giant pyramidal cells of the praecentral region and also in the larger pyramidal cells elsewhere. The Purkinje cells in the cerebellum stain faintly and some show central chromatoly-

sis with displacement of the nucleus. Similar changes are found in a few cells in the anterior horns of the cord and more extensively in the cells of Clarke's column.

Pigmentary changes of a fatty nature are widespread throughout the nervous system as shown by Scharlach staining and this involves not only those cells showing chromatolysis but also the smaller and other cells showing good Nissl staining. Similar fatty granules are present in large numbers contained within cells lying in the sheaths of the vessels.

The blood vessels show marked hyaline changes in the intima, many of the smaller vessels appearing to be almost occluded. There is also hyperplasia of the adventitial coats but no small celled infiltration of the perivascular sheaths. The glia nuclei are moderately increased both along the vessels and surrounding the nerve cells.

Case 5.

PROLONGED ATTACK OF PELLAGRA WITH ACUTE EXACERBATIONS IN A MAN SUFFERING FROM CHRONIC ALCOHOLISM WITH MARKED DILAPIDATION. DEATH SIX MONTHS AFTER ONSET.

E. J. White, male, upholsterer, 41 years of age at time of death. He was a native of Sweden and had a brother and a sister who were feeble-minded. He was a heavy drinker and was irritable and unstable. In January, 1901, at the age of 31, he was arrested for drunkenness, but continued in an excited state, preaching and expressing ideas of persecution. When admitted to the Elgin State Hospital in January, 1901, he was very restless and excited, but seemed in good health. He continued to be violent and quarrelsome for about six weeks, and then became quieter, although still quarrelsome at intervals all through his stay in the hospital. In 1908 he had an attack of acute rheumatism and is noted at that time as being "considerably demented."

Pellagrous erythema on the hands was noted in May, 1911, and reported as "very fiery" on July 31, 1911. At this time he was also emaciated and much weaker, but without any acute mental symptoms. The pellagrous eruption was still acute on Aug. 15, and he also had stomatitis, salivation and diarrhœa. On Aug. 31 the stools were examined for amœbæ with negative results and the blood is reported as showing a high color index. Diarrhœa continued with progressive exhaustion and emaciation until death on Oct. 29, at which time the eruption was still present, but of purple color, with marked desquamation. Plantar reflexes were of flexor type every day for two weeks before death.

The autopsy was performed by Dr. Wittman on Oct. 29. The body was much emaciated and the muscles generally thin and atrophic. The heart was extremely flabby, but no other abnormalities were noted in it nor in the lungs. The liver was described as dark brown, with very obscure markings. The kidneys showed some evidences of interstitial nephritis, but no other findings of importance were detected. The intestines showed no ulceration.

Microscopically the only findings of importance were: The *liver* showed moderate fatty degeneration following the outline of the lobules and there were small islets of infiltration with round cells in widely separated areas of the portal connective tissue. The capillaries were engorged, especially near the central veins. Fibrous tissue not definitely increased.

The nervous system in this case has not yet been examined.

Case 6.

PELLAGRA IN A MAN SUFFERING FROM SENILE DEMENTIA. DEATH IN THREE MONTHS WITHOUT SYMPTOMS OF CENTRAL NEUTRITIS.

A. J. B. White male, farmer, 66 years of age. Nothing is known of his previous history. He was admitted to the Peoria State Hospital from the Soldiers' Home at Quincy, Illinois, on Nov. 1, 1910. At that time he was

obese and somewhat feeble with exaggerated knee jerks, but flexor plantar reflexes. Mentally he showed complete loss of memory for recent events, was irritable and peevish. Considered to be suffering from senile dementia.

In June, 1911, he was found to have well marked pellagrous eruption on the hands, with some desquamation. From this time he rapidly lost flesh and became more and more dull, although the specific symptoms of pellagra disappeared. He died without any definite symptoms, so far as can be discovered, of central neuritis on Sept. 11, 1911.

At the autopsy evidences of healed tuberculosis in the lungs were found and the liver was described as being much engorged, its appearance suggesting almost a nutmeg condition, but its weight was only 44 oz. The heart was thin and flabby and no definite changes were noted in the kidneys. No other abnormalities were noted and there was no ulceration of the intestine.

Microscopically the *liver* shows slight increase in the amount of fibrous tissue, the capillaries are engorged, especially near the intralobular veins, and there are small scattered islets of small celled infiltration in the portal canals. Fatty degeneration is extremely marked, involving the outer layer of cells of each lobule and ceasing a little less than half way to the central vein. With osmic acid all the lobules are cleary marked out by the black stain. The *kidneys* show marked increase of fibrous tissue and a few small subcapsular cysts. The vessel walls are thickened and in many places show hyaline changes. Small hemorrhages are present in some glomeruli. In the medullary rays many of the tubules appear to have undergone a hyaline change and to be completely occluded. This material suggests a lardaceous change, but it does not show the characteristic staining reactions.

The *suprarenals* show marked fatty degeneration, especially in the zona reticularis, where every cell contains large fat droplets. Fatty changes are present, but less marked in the fasciculata, and still less so in the glomerulosa. Small hemorrhages are present in all layers and the central veins are engorged with blood. The *pancreas* shows moderate increase of fibrous tissue and a few small hemorrhages.

In the *nervous system* the changes are extreme. Similar chromatolysis involving especially the giant pyramidal cells of the præcentral cortex to those found in the other cases, as well as fatty degeneration of a most widespread character, are present. But besides this there is a marked overgrowth of glia cells, especially the satellite and perivascular cells. The arteries are markedly thickened and in this case there is a very moderate degree of small celled infiltration of the vessel sheaths, thus forming a decided contrast to the other cases examined. Further study of this nervous system is needed before expressing any opinion upon the findings, but it cannot be regarded as an uncomplicated case of pellagra.

Case 7.

PELLAGRA IN A MAN SUFFERING FROM CHRONIC ALCOHOLISM. RIGHT HEMIPLEGIA WITH PARAPHASIA AND LEFT PARAPRAXIA. LATER ALSO WEAKNESS OF LEFT SIDE.

C. C. White male, ice handler. Has been healthy, but a heavy drinker for years. In September, 1910, at the age of 51, it was noticed that his memory was defective and he seemed dazed and confused. This was thought to be due to alcoholism and he was sent to the Peoria County Poor Farm. His apparently stupid condition continued until early in January, 1911, when he became irritable, noisy and seemed to be worried. He was admitted to the Peoria State Hospital on January 25, 1911, when he was found to have arterio-sclerosis, a slight right hemiplegia, with exaggeration of reflexes on that side, paraphasia, and parapraxia of the left side.

In April, 1911, he developed pellagrous lesions of both hands, with some diarrhœa. At the same time he began to lose flesh. The eruption had disappeared by early June, but he continued to fail in general health. At the

beginning of June he became very weak and seemed to have had some further cerebral insult, the left side being said to be weakened. At this time the reflexes were markedly increased on both sides and there was a bilateral Babinski phenomenon. He continued to lose strength and weight rapidly, and died July 30, 1911, without having had any convulsive phenomena.

The autopsy was performed 17 hours after death and showed as follows: Marked atrophy of the cortex, especially in the frontal regions, but no gross lesion, even when sectioned after hardening. Dense adhesions obliterating pleural and pericardial sacs with chronic posterior mediastinitis. Hypertrophy of the left ventricle with atheroma of coronaries. Liver engorged with blood and firmer than normal. Spleen and other viscera engorged. Kidneys show no definite changes. No ulceration found in the intestines.

Microscopically the *liver* shows no thickening of the capsule, but there is a small celled infiltration of circumscribed character here and there in the portal canals in places almost outlining a lobule. The capillaries are engorged, especially towards the central veins. Fatty degeneration is slight, but where present is in the cells at the periphery of the lobules. It is less in amount than that of any of the cases so far studied, a careful search being necessary to find the areas in which it occurs. The *spleen* shows increase of fibrous tissue, with small hemorrhages. *Small intestine* shows infiltration of the mucosa and submucosa with leucoocytes and in places small hemorrhages.

Nervous System—The examination is as yet very incomplete, but the following facts are noteworthy.

Nerve Cells—These have so far been studied with thionin staining only in the anterior regions of the brain. Chromatolysis of axonal type is very marked in the giant cells of the præcentral region. Many of the larger pyramidal cells also show similar changes. This process is more marked in the sections interesting the anterior portions of the præcentral gyri, where many of the smaller elements are also affected. Pigmentary degeneration of a fatty nature, staining well with Scharlach, is extremely widespread, and involves many of the smaller cells as well as the larger ones.

Glia and Vessels—The glia nuclei are moderately increased, the satellite cells are quite numerous and there are often rows of nuclei along the walls of the vessels. The vessels themselves show considerable hyaline degeneration of the intima with hyperplasia of the adventitia. Scharlach staining shows many of the cells in this position contain fat droplets. The perivascular spaces, however, are not infiltrated with lymphocytes or plasma cells and there is nothing in the picture to suggest a parasyphilitic condition.

Case 8.

UNHAPPY MARRIAGE WITH POOR ADJUSTMENT. SPELLS OF MOPING AND MUTISM. INTESTINAL SYMPTOMS SHORTLY FOLLOWED BY MANIC EXCITEMENT, AND THREE OR FOUR WEEKS LATER BY STOMATITIS AND PELLAGROUS DERMATITIS. INCREASING RESTLESSNESS, SEVERE DIARRHŒA WITH RAPID EMACIATION AND DEATH IN TWO MONTHS.

D. S. White female, a housewife and baker by occupation; 42 years of age.

Family History—Incomplete. The mother and her relatives are said to have been weakly and to have died young. No insanity known.

Personal History—Nothing known of her earlier life. She was married in 1896 and has never been happy. According to her husband she was always shiftless and careless about her household duties, and has been cranky, nervous and dissatisfied. The patient's relatives blame the husband for the discontent and general unhappiness. She is said to have been quarrelsome with her neighbors, inclined at times to mope and refuse to talk. There have

been three children, two normal, while the third died at the age of three weeks. In 1909 the husband left her, and states that she did not succeed with the business, owing to her shiftlessness.

She has always lived in Havana, Mason County, Illinois, and has worked in the bakery business owned by her husband since marriage. There has never been any financial difficulty and the patient has always had plenty to eat.

Present Illness—In January, 1911, the patient began to suffer with gastro-intestinal disturbance. About the middle of April she is said to have become "maniacal." At the beginning of May a sore throat developed, the tongue and gums being very red and at the same time her hands became discolored and "bruised," due, as was thought, to the use of mechanical restraint.

She was admitted to the Peoria State Hospital on June 2, 1911, when she presented marked coppery pigmentation with roughness and scaly desquamation of the skin of the dorsum of the hands and forearms, extending upwards to the junction of the middle and upper thirds. This area showed a well marked line of demarcation and was entirely symmetrical on the two sides. The skin over the knuckles was rough and heaped up, but without fissures. The tongue was reddened and denuded at the tip and there was severe diarrhœa with loose, offensive stools.

The examination was rendered unsatisfactory by the extreme restlessness of the patient. She was constantly talking, clapping her hands and singing, showing marked distractibility with sound and motor speech associations. When alone she was constantly busy, tearing up her bed and bedding, jumping out of bed, showing all the appearances of a happy excitement. The excitement was readily increased by the presence of others and in answer to question she said she "felt fine," "I am an angel." Her "husband was extremely rich," had a "white automobile with gold trimmings," etc. No evidence of hallucinosis was obtained. Distractibility rendered orientation impossible.

Physical examination was incomplete, but the knee jerks were found to be exaggerated and it was suggested that the pupils did not react well, but there were no other facts upon which to base any diagnosis of general paralysis of the insane.

The extreme restlessness continued with but little sleep. Diarrhœa persisted and emaciation and exhaustion were progressive. Death occurred on July 8th, about two months after the onset of the first symptoms.

Permission for a post mortem examination was refused.

83 Cases of Pellagra said to be Typical. Peoria State Hospital.

Collected May 10, 1910, from the Hospital Records by Dr. Clifford E. Smith.

Number.	Age.	Sex.	Nativity.	Years in Illinois.	County.	County, city or institution.	Years insane.	Years in Peoria.	Other disease.	Occupation.	Number.
1	76	F	.....	.....	Massac	.....	....	8	Myocarditis	None	1
2	51	F	United States	10	.....	.....	19	6	Heart disease	..do	2
3	51	M	United States	25	Rock Island	Poor farm, country	26	1	Mitral regurgitation	..do	3
4	29	F	.....	5	Knox	.....	3	3	.....	..do	4
5	62	M	Illinois	Native	Adams	Jacksonville	19	5	Haemorrhoids	..do	5
6	78	F	New York	60	McLean	Jacksonville, Kankakee	17	2	.....	Housewife	6
7	32	M	Austria	5	Cook	.....	19	6	.....	Laborer	7
8	59	M	Illinois	Native	McLean	Boone, Ill	2	½	Cholecystitis	None	8
9	37	F	Missouri	10	Cook	Kankakee	9	3	Heart disease	Domestic	9
10	62	M	Germany	5	..do	Chicago	?	3	Mitral regurgitation	Baker	10
11	75	F	United States	25	Adams	.....	25	1	Arterio-sclerosis	Housewife	11
12	58	F	.....	15	McLean	Poor farm	5	5	Chronic eczema	None	12
13	59	M	Ohio	15	Will	Poor farm, Kankakee	19	4	.....	..do	13
14	74	M	Prussia	5	Montgomery	Poor farm	6	2	Hernia	Farmer	14
15	59	F	Illinois	10	Bureau	Watertown, City	12	5	Heart disease	Housewife	15
16	52	F	United States	5	Cook	.....	....	4	.....	None	16
17	41	M	Illinois	Native	St. Clair	Country	6	3	Heart disease	Machinist	17
18	38	F	United States	10	Cook	.....	8	7	Mitral regurgitation	None	18
19	68	F	United States	15	LaSalle	.....	16	8	Arterio-sclerosis	..do	19
20	34	F	.....	5	Cook	Chicago	3	2	Pulmonary tuberculosis	Housewife	20
21	58	F	.....	15	Woodford	.....	18	5	.....	..do	21
22	60	F	.....	.....	Peoria	Poor farm	....	½	Nephritis	.....	22
23	50	M	Illinois	Native	Piatt	.....	26	?	Mitral regurgitation	Telegraph	23
24	49	M	Connecticut	.....	Cook	Chicago, Bridewell	½	½	.....	Clerk	24
25	62	F	United States	40	.....	.....	44	6	Arterio-sclerosis	None	25
26	93	F	.....	10	Cook	.....	....	8	Apoplexy	..do	26
27	59	M	Canada	35	Kankakee	Kankakee, Jacksonville and Elgin	36	5	.....	..do	27
28	42	M	.....	.....	.....	.....	....	1	Mitral regurgitation	None (colored)	28
29	79	M	.....	25	Williamson	.....	25	8	.....	Laborer	29
30	48	M	.....	25	Cook	Dunning	23	1	Eczema	None	30
31	65	M	.....	25	Bureau	Watertown, Jacksonville	27	3	Dysentery mitral disease	..do	31
32	68	M	United States	35	Moultrie	Jacksonville and Kankakee	38	1	Dysentery	Farmer	32
33	....	F	United States	10	Piatt	Country	10	2	.....	Housewife	33
34	67	F	United States	.....	.....	.....	....	3	Heart disease	None	34

35	....	F	United States	5	.....	.....	....	5	Arterio-sclerosis	None	35
36	48	M	Germany	20	Ogle	Elgin	23	3	.....	Laborer, tramp	36
37	....	F	United States	10	Madison	Highland	12	5	Uterine trouble	None	37
38	46	F	United States	15	Cook	Chicago	14	3	Tuberculosis	Housewife	38
39	31	F	Austria	5	..do	..do	....	3	.....	Seamstress	39
40	52	F	United States	5	.....	.....	....	5	.....	None	40
41	55	F	Illinois	Native	Peoria	Peoria	5	1	Nephritis	Housewife	41
42	60	M	.....	.....	Montgomery	.....	37	1	Mitral and aortic disease	.....	42
43	47	F	.....	5	Winnebago	.....	....	3	.....	None	43
44	53	F	United States	5	Cook	.....	6	3	Myocarditis	Housewife	44
45	61	M	Illinois	Native	Sangamon	Springfield	1	1	Syphilis	Physician	45
46	46	F	Illinois	..do	Cook	Chicago	13	4	Tuberculosis	Housewife	46
47	65	F	Germany	15	Peoria	.....	17	2	.....	None	47
48	50	F	Tennessee	5	Sangamon	.....	8	3	.....	..do	48
49	47	M	.....	10	Tazewell	Fremont	....	7	.....	Mechanic	49
50	64	M	.....	15	Rock Island	Watertown, Rock Island	15	5	Mitral regurgitation	None	50
51	40	F	Illinois	Native	DeWitt	Farmer City	14	1	Pulmonary tuberculosis	Housewife	51
52	76	F	United States	10	Peoria	.....	....	8	Arterio-sclerosis	None	52
53	55	F	New York	15	Cook	Dunning, Kankakee	14	7	.....	Dressmaker	53
54	81	M	United States	25	Madison	.....	26	8	.....	None	54
55	55	F	United States	25	Coles	Poor farm, Kankakee	36	8	Myocarditis	..do	55
56	46	F	Illinois	Native	Wayne	.....	27	8	Pulmonary tuberculosis	Housewife	56
57	54	M	Illinois	..do	St. Clair	.....	29	3	.....	None	57
58	64	F	United States	25	Champaign	Poor farm	25	5	Lobar pneumonia	..do	58
59	72	F	Indiana	30	Marshall	Jacksonville, Kankakee	30	1	Arteric-sclerosis	Housewife	59
60	30	M	Illinois	Native	Woodford	Jacksonville	8	4	Pulmonary tuberculosis	Laborer	60
61	40	F	Illinois	..do	Knox	Almshouse	6	2	Hemiplegia	None	61
62	48	F	United States	15	Madison	.....	19	5	Arterio-sclerosis	..do	62
63	41	M	.....	25	McLean	Poor farm	26	6	.....	..do	63
64	33	F	United States	15	Kane	.....	16	2	.....	Housewife	64
65	54	F	Illinois	Native	Madison	.....	31	7	Arterio-sclerosis	..do	65
66	41	F	Illinois	..do	Whiteside	.....	39	7	.....	None	66
67	72	F	United States	5	.....	.....	16	7	Diabetes	Housewife	67
68	51	F	Illinois	Native	St. Clair	Poor farm, country	6	2	.....	None	68
69	34	F	Germany	25	Cook	Dunning	24	4	.....	..do	69
70	42	M	Canada	10	..do	Chicago	7	4	.....	Dentist	70
71	74	F	.....	5	..do	..do	....	2	.....	Housewife	71
72	29	F	Germany	5	..do	..do	....	3	Ankylosis of knees	..do	72
73	68	F	United States	5	Adams	Poor farm	....	3	Arterio-sclerosis	None	73
74	69	F	United States	.....	Vermilion	.....	3	3	Myocarditis, carcinoma uteri	..do	74
75	48	F	Bohemia	8	Madison	.....	16	8	Pleurisy	Housewife	75
76	83	F	.....	10	Peoria	.....	....	7	Myocarditis	None	76
77	71	F	Illinois	Native	St. Clair	Poor farm	21	2	Congen. syphilis	..do	77
78	42	M	.....	.....	Piatt	Jacksonville	....	1	.....	Laborer	78
79	66	F	United States	25	Morgan	.....	24	5	Heart disease	Housewife	79
80	27	M	Sweden	.....	Cook	Chicago, Dunning	3	1	.....	Laborer	80
81	64	M	Illinois	Native	Moultrie	Hammond, Anna, Kankakee	23	½	.....	Farmer	81
82	72	F	.....	40	Mercer	Poor farm, Jacksonville	37	5	Pulmonary tuberculosis	None	82
83	41	M	Michigan	16	McLean	.....	1	1	.....	Laborer	83

30 males; 53 females; average age, 56.3; average duration of insanity, 17.4 years.

Eighty-three Cases of Pellagra—Concluded.

Number.	Previous attacks.	Skin eruption.					Digestive tract.			Spinal tenderness.	Reflexes.						Mental condition.	Psychosis.	Living or dead.	Number.
		Hands.	Forearms.	Other parts.	Blebs.	Symmetry.	Mouth.	Diarrhoea.	Dysentery.		Knee.	Wrist.	Elbow.	Epigastric.	Plantar.	Babinski.				
1	.....	Y	Y	N	Y	Y	Y	Y	N	N	+	+	+	n	+	N	Depressed	Terminal dementia	L	1
2	1909	Y	N	Y	N	Y	N	N	N	N	++	++	++	o	+	N	.....	Dementia praecox	L	2
3	1909	Y	N	N	N	Y	N	...	...	N	++	++	++	o	—	Y	Stupid	Epileptic dementia	L	3
4	June, 1909	Y	N	N	Y	Y	N	N	N	N	n	n	n	n	n	N	.....	Paranoia	D	4
5	1904 (?)	N	N	Y	N	Y	Y	Y	Y	N	+	+	+	o	+	N	.....	Epileptic dementia	D	5
6	.....	Y	....	Y	Y	Y	Y	Y	....	....	....	....	....	....	....	....	.....	Manic depressive	L	6
7	.....	...	...	...	...	...	...	...	...	...	....	....	....	....	....	....	.....	Terminal dementia	D	7
8	August, 1909	Y	Y	N	N	Y	Y	Y	N	N	+	+	+	n	+	N	No change	Paranoia	D	8
9	October, 1909	Y	Y	Y	N	Y	Y	Y	?	N	o	n	n	—	—	N	Excited	Dementia praecox	D	9
10	November, 1909	Y	Y	Y	Y	Y	Y	Y	N	N	+	+	+	n	+	N	No change	.....	D	10
11	Probable	Y	N	N	Y	Y	Y	Y	N	...	—	o	—	o	—	N	Excited depression	Terminal dementia	D	11
12	.....	Y	Y	Y	N	Y	N	N	N	N	—	—	—	n	n	N	.....	.....	D	12
13	August, 1909	...	...	...	...	...	...	...	...	....	....	....	....	....	....	....	.....	.....	D	13
14	August, 1909	Y	Y	Y	N	Y	Y	Y	Y	....	—	—	—	....	....	Y	Excited depression	Dementia	D	14
15	1909	Y	N	N	N	Y	Y	Y	N	...	n	n	n	n	n	N	Depressed	.....	D	15
16	1909	Y	N	N	N	Y	N	Y	N	N	n	n	n	o	....	Y	.....	Dementia	L	16
17	September, 1909	Y	N	Y	Y	Y	Y	Y	Y	....	+	n	n	....	....	N	Depressed	..do	D	17
18	October, 1909	Y	N	Y	N	I	Y	Y	N	....	....	....	....	....	....	....	..do	Katatonia	D	18
19	October, 1909	Y	N	N	N	Y	Y	...	N	....	+	+	+	....	+	N	Hypomanic	Manic depressive	L	19
20	Signs	Y	N	N	N	Y	Y	N	N	....	....	....	....	....	....	....	Depressed	Melancholia	L	20
21	.....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	..do	D	21
22	.....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	Senile dementia	D	22
23	.....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	D	23
24	.....	...	...	...	...	...	...	...	...	....	....	....	....	....	....	....	.....	Dementia	D	24
25	Signs	Y	N	N	N	Y	N	N	N	N	—	—	—	....	....	Y	Depressed	Terminal dementia	L	25
26	1909	Y	Y	Y	N	Y	Y	Y	Y	....	....	....	....	....	....	....	.....	.....	D	26
27	.....	...	...	...	...	...	...	...	...	....	....	....	....	....	....	....	.....	Terminal dementia	D	27
28	Signs	Y	Y	N	N	Y	Y	Y	N	....	....	....	....	....	....	....	.....	.....	L	28
29	.....	...	...	...	...	...	...	...	...	....	....	....	....	....	....	....	.....	.....	D	29
30	.....	Y	N	N	N	Y	Y	Y	?	...	....	....	....	....	....	....	No change	Terminal dementia	L	30
31	.....	Y	N	Y	N	Y	Y	Y	Y	N	—	+	+	p	n	N	Depressed	.....	D	31
32	.....	Y	...	...	...	...	...	Y	Y	....	....	....	....	....	....	....	.....	Terminal dementia	D	32
33	October, 1909	Y	Y	Y	N	Y	Y	Y	N	....	....	....	....	....	....	....	.....	Melancholia	D	33
34	September, 1909	Y	N	Y	N	Y	Y	Y	N	....	....	....	....	....	....	....	.....	Epileptic dementia	D	34

35	Signs	Y	N	N	N	I	N	N	N	N	—	+	+	—	n	N	No change	Dementia praecox	L	35
36	1906 (?)	Y	N	?	N	Y	Y	Y	N	N	+	+	+	+	+	Y	Depressed	Paretic dementia	D	36
37																			D	37
38	July, 1909	N	N	Y	Y	Y	N	Y	N	N	+	+	+	o	*	*	Depressed	Dementia praecox, imbecile	D	38
39																		Manic depressive	D	39
40	September, 1909	Y	Y	Y	N	Y	Y	Y	N	N	n	—	—	o	n	N	Excited	Malancholia	L	40
41	Signs	Y	?	?	N	Y	N	N									Depressed	Paranoia	D	41
42	December, 1909																	Dementia	L	42
43																			D	43
44	Signs	Y	N	Y	N	Y	N	N	N	N	+	—	—	o	—	N	No change	Dementia	L	44
45																		Arterio-sclerotic dementia	D	45
46	August, 1909	Y	N	Y	N	Y	N	N	N								Depressed	Terminal dementia	L	46
47																			D	47
48	Signs	Y	N	N	N	Y	N	N	N										D	48
49	Signs	Y	N	Y	N	Y	N	Y	N	N	+	+	+	+	+	N	Depressed	Manic depressive	L	49
50		Y	N	N	Y	Y	Y	Y	N	N	+	n	n	o		Y	..do	Dementia	D	50
51		Y	?	Y	N	Y	N	Y	N	N	—	—	—	—	—	N	Restless	Epileptic dementia	D	51
52	Signs	Y	Y	Y	N	Y	N	Y	N	N	n	n	n	o	n	N		Senile dementia	L	52
53		Y	Y	Y	Y	Y	Y	Y	?	N	n	n	n	n	n	N		Dementia	D	53
54		Y	N	N	N	Y	Y	Y	N										L	54
55		Y	N	Y	N	Y	Y	Y	N	N	—	—	—	p		Y	Depressed	Dementia praecox	L	55
56		Y	N	Y	Y	Y	Y	Y	N									..do	L	56
57		Y	N	Y	N	Y	N	Y	?									Secondary dementia	L	57
58	Signs	Y	N	Y	N	Y	Y	Y	N									Dementia praecox	D	58
59		Y	Y	Y	N	Y	Y	Y	N									Melancholia	L	59
60	October, 1909	Y	N	N	N	Y	Y	Y	Y	N	o	p	p			N	Depressed	..do	L	60
61	October, 1909	Y	N	Y	Y	N	Y	Y	?	N	§	§	§	p	§	N	No change	Epileptic hemiplegic	D	61
62		Y	N	Y	N	Y	Y	Y	N	Y	+	+	+	p	+	Y	Depressed	Post-meningitis	D	62
63	September, 1909	Y	N	N	N	Y	Y	N	N										L	63
64																		Traumatic dementia	D	64
65		Y	N	Y	Y	Y	Y	Y	N									Dementia praecox	D	65
66																		Post-typhoid, idiocy	D	66
67		Y	Y	Y	Y	Y	Y	Y	Y	N	n	n	n		+	N	No change	Paranoia	D	67
68	? Twice	Y	N	Y	Y	Y	Y	Y	N									Epileptic dementia	L	68
69	September, 1909	Y	N	Y	N	Y	Y	Y	N	N	+	+	+	—	+	N		Dementia praecox, idiot	L	69
70	September, 1909	Y	N	Y	N	Y	Y	Y	N	N	+	n	n	n	n	N	Excited	Alcoholic paranoia	L	70
71	September, 1909	Y	N	N	Y	Y	Y	Y	N									Senile dementia	D	71
72	November, 1909	Y	N	Y	N	Y	N	Y	N									Epileptic dementia	D	72
73	August, 1909	Y	N	Y	N	Y	Y	Y	N	N	+	+	+	—	+	Y		Dementia	L	73
74	October, 1909	Y	N	N	N	Y	Y	Y	N	N	+	n	n	p	n	N			L	74
75		Y					Y	Y										Dementia praecox	D	75
76	November, 1909	Y	N	Y	N	Y	N	Y	N	N				o		N	Stupid	Epileptic dementia	D	76
77	October, 1909	Y	N	N	Y	Y	Y	Y	?	N	†	†	†		n	N		Epileptic hemiplegic	D	77
78	August, 1909	Y	N	Y	Y	N	Y	Y	N	Y	+	+	+	p	+	Y		Alcoholism	D	78
79	October, 1909	Y	N	N	N	Y	N	Y	N	N	+	+	+	o	n	N		Dementia praecox	L	79
80	September, 1909																	..do	L	80
81	November, 1909																	Epileptic	L	81
82	Signs	Y	N	Y	N	Y	N	Y	N	N	o	o	o	o	—	N		Senile dementia	D	82
83	October, 1909	Y	N	Y	N	Y	N	Y	N	N	+	n	n		n	?	Depressed		D	83

I, imperfect; N, no; Y, yes; n, normal; p, present; * and §, normal on left; †, diminished on left.

IV.

REPORT ON THE INVESTIGATION OF PELLAGRA IN ILLINOIS FOR THE ILLINOIS PELLAGRA COMMISSION.

(By J. F. Siler and H. J. Nichols, Captains, Medical Corps, U. S. Army.)

1. Summary of observations on pellagra at the Peoria State Hospital in 1909.
2. Investigations carried cut in 1910 at Peoria, and elsewhere in Illinois, for the Illinois Pellagra Commission.

I. Summary of Observations on Pellagra at the Peoria State Hospital in 1909.

The writers deem it advisable to summarize briefly the results of their investigations at Peoria during the summer of 1909, the full report of which appeared in the New York Record of January 15, 1910.

Of the 2,150 inmates of the Peoria State Hospital for the Insane, 175, or 8 per cent, presented symptoms of pellagra. Seventy per cent of these cases had shown evidence of the disease then unrecognized, in previous years, in some cases dated back at least four years. Clinically, the symptoms presented were typical and of variable severity, the most striking feature being symmetry of the skin lesions. Symptoms involving the intestinal tract were not present in all cases. In many cases presenting intestinal symptoms,—diarrhoeas and dysenteries—the exciting factor appeared to be an invasion of the intestinal canal by entamoebae. As many of the pellagrins had been insane for many years it was manifestly impossible to determine the extent of mental disturbance attributable to pellagra.

Stool examinations in 92 cases disclosed the fact that 84.8 of the pellagrins were infected with intestinal protozoa (Entamoebae and Flagellates); 36.8 per cent of these protozoal infections were entamoebae, and while no classification of these entamoebae was attempted they were clearly pathogenic in the large majority of these cases as was evidenced by the symptomatology and by the appearance of the intestines at necropsy. In a total of 18 autopsies 12 cases showed well marked and typical amoebic ulceration of the colon, and folliculitis was present in all. Abscess of the liver is recorded in the autopsy records for the previous year and in the following year another abscess occurred which was definitely due to amoebae. Of 107 non-pellagra patients, 50.5 per cent were infected with intestinal protozoa, of which 14 per cent were entamoebae. No organ except the colon showed any constant or striking departure from normal.

It was possible to determine quite accurately the amount of corn products consumed for the years 1908 and 1909. The amount consumed could not have exceeded 2 ounces for each patient per day. The quality of the corn products was above suspicion. The general diet was rich in carbonhydrates and poor in proteids, meat being given only twice a week.

Blood cultures and spinal fluid cultures were made from 10 living cases and cultures from the spleen were made in six cases at autopsy. In every instance the results were negative.

II. Investigations Carried Out in 1910 at Peoria and Elsewhere in Illinois, for the Illinois Pellagra Commission.

1. Prevalence of the disease at Peoria in 1910.

The cases showing active skin lesions during the summer of 1910, though still plentiful, were materially less in number than during the previous year. On September 12, 1910, 39 patients presented active skin lesions. The records of the institution show that, in addition to the number of cases cited above, 92 additional patients presented symptoms of pellagra during the spring and summer of 1910. Total, 131. The number of old, chronic cases giving evidence of acute exacerbation was approximately 30 per cent.

2. Clinical picture.

The clinical picture of the disease at Peoria in 1910 differed somewhat from that manifested in 1909. The skin symptoms, though typical, were less severe, and gastro-intestinal symptoms were not so marked.

3. Mortality.

During the summer of 1909 the death rate from the disease was approximately 25 per cent. During the summer of 1910 the death rate was a negligible factor.

4. Etiology.

a. Examinations of blood, spinal fluid, and splenic and liver smears.

The greater portion of two weeks was devoted to the examination of fresh blood and spinal fluid, and smears from the blood, spleen and liver. The smears were stained with the Leishman polychrome stain, with Giemsa's polychrome stain, and with MacNeal's polychrome stain. Nothing whatsoever suggestive of a protozoal infection was encountered.

Blood cultures were made on blood agar (trypanosome media), the results in each instance being negative.

b. Examination of stools.

The examination of stools for evidence of protozoal infection was taken up extensively. Microscopical examinations were made of both unstained and stained preparations. These examinations were carried out at Peoria, Kankakee and Dunning, and may be summarized as follows:

Peoria.

1. Protozoal infection among 50 non-pellagrous patients.

Number showing entamoebae (26), 52 per cent. Number showing flagellates (30), 60 per cent.

Of these 50 patients, 11 presented a definite and clear-cut clinical picture of amoebic dysentery. Entamoebae were demonstrated in 73 per cent of these cases giving clinical evidence of dysentery and in one case an amoebic abscess of the liver was found at necropsy.

2. Protozoal infection among 21 pellagrous patients.

Number showing entamoebae (16), 76 per cent. Number showing flagellates (16), 76 per cent.

A further analysis of these statistics and comparison with clinical symptoms exhibited by each patient demonstrated the fact that of the 21 pellagrous patients, five were suffering with clinical dysentery resembling in all respects amoebic dysentery. Entamoebae were present in all five cases. Of the remaining 16 cases, six presented diarrhoeic symptoms and in five of the cases suffering from diarrhoea, entamoebae were present. The remaining ten (10) cases gave no evidence of either diarrhoea or dysentery during the period of our stay at Peoria, but in six of these cases entamoebae were present in the stools.

An attempt was made to classify the species of entamoebae found in the patients at Peoria. The examination of fresh preparations was the routine

method for all cases. but in many instances staining methods were used. The staining methods adopted were the following: Polychrome stains (Leishman's, Wright's, MacNeal's and Giemsa's) and the Iron Haematoxylin method of Heidenhain. It was possible definitely to establish the fact that at least three and probably four species of entamoebae were present.

The *entamoebae histolytica* was found in four cases.

Entamoeba coli was present in a number of cases.

Entamoeba tetragena. An entamoeba resembling in all respects the published descriptions of *E. tetragena* was found in some cases.

A number of preparations stained with polychrome stains and Iron Haematoxylin, and material containing encysted entamoebae, was forwarded to Captain C. F. Craig, Medical Corps, U. S. A., for an expression of opinion. Captain Craig has very kindly examined this material and reports as follows:

"The faeces in the bottle, preserved in formalin, contained many cystic forms, most of which were undoubtedly the cystic stage of *entamoeba coli.* A prolonged examination showed that almost every stage in the reproduction of this species within a cyst could be found in the material, although the most common forms contained eight well defined nuclei, but some were observed containing anywhere from two to eight. The cysts were absolutely characteristic of *E. coli*, the structure of the nucleus before division and the structure of the daughter nuclei being very definite.

"In addition to cysts of *Entamoeba coli* the material contained a comparatively few cysts indistinguishable from those of *Entamoeba tetragena* (perhaps two or three to a preparation). These cysts were slightly larger than those of *E. coli* and were distinguished by the presence within them of from two to four daughter nuclei and the large mass or masses of chromatin so characteristic of *E. tetragena.* In preparations wet-fixed and stained with Heidenhain's iron haematoxylin the nucleus of the cysts prior to division showed the large karyosome containing a centriole, and surrounded by a network of chromatin, while the cysts showing division of the nucleus into four daughter nuclei also showed the presence of one or more deeply stained large masses of chromatin lying free in the protoplasm. In every respect these cysts were characteristic of *E. tetragena.*

"In the specimens labeled Lovegren, stained with Giemsa, there were numerous examples of E. histolytica, showing almost every stage in reproduction, with the exception, so far as I could see, of the budding forms. The distribution of the chromatin to the endoplasm and its collection in small loose masses in the ectoplasm, is well shown in many of the amoebae, as well as the deep staining of the ectoplasm. In this preparation a few amoebae were observed showing the characteristics of *Entamoeba coli* during the vegetative stage. No *E. tetragena* were observed in this particular specimen.

"In some of the specimens, which I presume were stained by Wright's method, there also occurred amoebae which agreed in their morphology with *E. tetragena*, the nucleus being very rich in chromatin, a large karyosome being present, and the cytoplasm being free from chromatin.

"In conclusion, I would say that in the material examined I found only amoebae which agreed in their morphology and in their life cycle, so far as it could be judged, with *E. coli*, *E. histolytica* and *E. tetragena.*"

It is quite evident that the most common form of dysentery at the Peoria State Hospital was due to amoebae, for the following reasons: The typical clinical symptoms of amoebic infection were present, pathogenic entamoebae were present in the stools, and in many of the cases going to autopsy amoebic ulceration or folliculitis was noted.

The flagellates found at Peoria were mainly *Trichomonas intestinalis.* No attempt was made by us to isolate the bacilli causing dysentery, as this phase of the subject was covered by Dr. MacNeal. At the suggestion of the Pellagra Commission a statistical study of protozoal infection of the intestinal canal was undertaken among the patients (practically all non-pellagrous) at Kankakee and Dunning, without reference to the presence or absence of diarrhoea or dysentery. The following results were obtained:

KANKAKEE.

Examination of 62 patients.

Number showing entamoebae (36), 58 per cent. Number showing flagellates (48), 77 per cent.

No attempt was made to classify the types of entamoebae encountered. The flagellatès were, in the large majority of cases, *Trichomonas intestinalis*.

DUNNING.

Examination of 50 patients.

Number showing entamoebae, 46 per cent. Number showing flagellates, 32 per cent.

At this institution also our time was limited and no attempt was made to classify the types of entamoebae. In most instances the organisms were "resting" or encysted. The flagellates were *Trichomonas intestinalis*.

The presence of entamoebae and other protozoa, pointed out by ourselves in 1909, has since been exploited by several writers, notably Long, who carries his views to the extreme of considering pellagra a complication of amoebic dysentery. We could find no support for such a view in our results at Peoria.

Careful stool examinations were made of the patients occupying two cottages in which experimental "corn" and "corn free" diets were instituted and carried out for a period of one year. A summary of the results of these examinations is as follows:

Diet.	Number of patients.	Cases showing amoebae.	Cases of pellagra showing amoebae.	Cases of pellagra without amoebae.
Corn diet	59	7	1	3
Corn free diet	58	6	.....	5

c. Experiments to demonstrate the presence of toxins in corn.

After taking some corn meal mush from a boiler just before it was served and letting it stand in a sterile Petrie dish for two days we found it covered with slimy reddish growth, which proved to be that of *Bacillus mesentericus fuscus*. This organism and strains of *Penicillium glaucum*, *Aspergillus flavus*, and *Diplodia*, recovered from musty corn, which were kindly furnished us by Professor Burrill of the University of Illinois, were used in trying to discover any evidences of toxins. Moist corn meal was put in large flasks, sterilized and inoculated with these organisms. After a rich growth was obtained it was scraped off with some of the corn meal, diluted with water, thoroughly shaken, contrifuged or filtered and the clear liquid used for injection of rabbits and guinea pigs. A large number of animals were used and injections were given subcutaneously, intraperitoneally and intravenously. The results were uniformly negative. When corn meal mush was allowed to decompose naturally and a similar extract used for injections the animals died, but the result is readily attributable to putrefactive organisms. Feeding experiments with infected corn were started, but soon given up, as it was found that the animals refused to eat the corn after the first day, and died of starvation.

d. Feeding experiments.

Two cottages with a capacity of about 60 patients were filled with non-pellagrous patients of the chronic class. Careful stool examinations were made for protozoa. One cottage was then placed on a generous corn diet—approximately 16 ounces of corn food-stuffs per day. The other cottage containing about 60 patients was placed on a corn-free diet of the same general nature. These diets were continued for one year and the patients

were placed directly in charge of Dr. Watkins of the hospital staff, who followed them with great care. Dr. Watkins reports the result of this experiment as follows:

RESULTS OF A FEEDING EXPERIMENT IN REGARD TO THE ETIOLOGY OF PELLAGRA.

(By Rachel A. Watkins, Physician, Peoria State Hospital, Peoria, Ill.)

On Sept. 15, 1909, the inmates of one cottage were put on the following corn diet:

Breakfast.	Dinner.	Supper.
	MONDAY.	
Corn flakes. Milk. Corn bread. Coffee.	Boiled beef. Steamed potato or vegetable. Corn starch pudding. White bread and oleomargarine. Coffee.	Fruit. Corn bread. Hominy. Oleomargarine. Corn syrup. Tea.
	TUESDAY.	
Corn meal mush. Milk. Corn bread. Coffee.	Boiled beef. Steamed potato or vegetable. Corn bread. Milk. Bread pudding.	Corn syrup. Corn bread. Corn fritters. Tea.
	WEDNESDAY.	
Corn flakes. Milk. Corn bread. Oleomargarine. Coffee.	Boiled beef. Baked potato. Corn bread. Oleomargarine. Coffee.	Corn starch pudding. Corn bread. Cheese. Oleomargarine. Tea. Corn syrup.
	THURSDAY.	
Hominy. Milk. Oleomargarine. Coffee.	Boiled beef. Baked potato or vegetable. Canned corn. White bread. Milk.	Corn starch pudding. Coffee cake. White bread. Oleomargarine. Corn syrup. Tea.
	FRIDAY.	
Corn flakes. Corn bread. Milk. Coffee.	Boiled beef. Baked potato or vegetable. Corn bread. Oleomargarine. Milk.	Corn bread. Corn starch pudding. Fruit. Oleomargarine. Milk. Tea. Corn syrup.
	SATURDAY.	
Corn meal mush. White bread. Oleomargarine. Coffee.	Beef and gravy. Potato. Corn bread. Corn starch pudding. Milk.	Hominy. White bread. Oleomargarine. Corn syrup. Tea.
	SUNDAY.	
Corn flakes. Corn bread and oleomargarine. Milk. Coffee.	Chicken and gravy or roast. Beef and gravy. Mashed potato. Canned corn. White bread and oleomargarine. Coffee. Pie.	Corn bread. Oleomargarine. Fruit. Tea. Corn syrup.

For comparison a second squad of the same number was selected with the same precautions in every particular, ages ranging from twenty-one to seventy-nine years, with an average age of forty-five years, from which were excluded all suspected pellagra patients, and they were placed in a nearby cottage on a strictly corn-free diet, which was as follows:

Breakfast.	Dinner.	Supper.
	MONDAY.	
Farina. Milk. Bread and oleomargarine. Coffee.	Boiled beef. Steamed potato or vegetable. Rice pudding..... Milk.	Rice. Milk. Bread and oleomargarine. Tea. Cane syrup.
	TUESDAY.	
Rice. Toast. Milk. Coffee.	Boiled beef. Potato or vegetable. Bread and oloemargarine. Coffee.	Tapioca and apple. Bread and oleomargarine. Tea. Cane syrup.
	WEDNESDAY.	
Farina. Hot milk. Toast. Coffee.	Boiled beef. Baked potato. Boiled beets. Bread and oleomargarine. Coffee.	Custard. Ginger bread. Bread and oleomargarine. Milk. Tea. Cane syrup.
	THURSDAY.	
Rice. Milk. Bread and oleomargarine. Coffee.	Beef and gravy. Steamed potato or vegetable. Tapioca pudding. Bread and oleomargarine. Coffee.	Farina. Milk. Coffee and cake. Bread and oleomargarine. Tea. Cane syrup.
	FRIDAY.	
Farina. Milk. Bread and oleomargarine. Coffee.	Boiled beef. Potato or vegetable. Bread and oleomargarine. Rice pudding. Milk.	Tapioca. Milk. Bread and oleomargarine. Tea. Cane syrup.
	SATURDAY.	
Farina. Milk. Toast. Coffee.	Boiled beef. Potato or vegetable. Mashed potato. Bread and oleomargarine. Pie. Coffee.	Rice. Milk. Bread and oleomargarine. Cane syrup.
	SUNDAY.	
Farina. Toast. Hot milk. Coffee.	Chicken and gravy or roast. Beef and gravy. Mashed potato. Bread and oleomargarine. Pie, coffee.	

A personal chart was kept for each patient, noting carefully the following points:

1. Examination of the feces.
2. Semi-monthly weights.

3. Mental conditions as to mania and stupor.
4. Physical conditions, with special attention to diarrhoea, gastritis, stomatitis and skin lesions.

This experiment was carried out during the entire year, and on Sept. 15, 1910, these facts are noted: Nearly all the patients gained gradually in both wards from September to March or April, when they gradually fell off during the hot weather until they averaged about the same weight as on the same date the preceding year. The corn diet showed 25 patients gained in weight during the year on it, 29 lost and four remained unchanged. The average loss and gain on both cottages was from two to three pounds.

There were 16 patients on the corn diet who suffered with diarrhœa during the year, while only 10 on the corn-free diet suffered from the same malady, and there were more cases of constipation on the corn-free diet cottage than on the corn diet cottage.

During the year the corn diet cottages showed four cases of pellagra, with one death from the disease. The histories of these four cases are as follows:

R. L., age 42 years. Examination of feces, Sept. 8, 1909, negative. On Jan. 19, 1910, slight diarrhoea, which persisted for a few days. Diarrhoea again from Feb. 14 to 28, 1910. March 4th severe diarrhoea, some blood and mucus in stools, which continued throughout the month and up until April 12th, with stools showing blood and mucus frequently. This patient was transferred to the hospital, as symptoms of pellagra appeared on hands and feet. The dorsum of the hands showed symmetrical, erythematous patches extending up on the wrists about two inches, with the line of demarcation very prominent; some bleb formation on the dorsum of the feet. Patient failed rapidly and died May 9, 1910, at which time the hands were peeling. Autopsy revealed ulceration of the colon, with a beginning carcinoma of the rectum.

C. H., age 57 years. Examination of stools, Sept. 10, 1909, was negative. Patient had a short attack of gastro-enteritis Sept. 16 and 17, 1909. During October and November patient suffered from constipation, losing in weight during February, at which time he was put on a special diet other than corn for two weeks. He gained some in weight during March, but during the winter he had several attacks of diarrhoea, each attack being of very short duration. On Aug. 26, 1910, erythema appeared on the dorsum of both hands, which gradually changed to a dark brown and exfoliated freely. The line of demarcation was plain on the wrist. There were no bleb formations. Patient has lost ten pounds in weight in the last three months, but during this time has not been confined to bed.

R. B., age 28 years. Examination of stools Sept. 6, 1909, was negative. Sept. 26th patient had gastro-enteritis, with some temperature. Diarrhoea was rather severe, with blood in the stools. He was kept on a special diet other than corn until Oct. 4th. Oct. 10th patient had hemorrhagic diarrhoea and during every month of this year he has had at least one, and sometimes two attacks of diarrhoea, lasting a few days. He has lost very little in weight during the year. The diarrhoea in May and June was severe. Aug. 4, 1910, the hands became erythematous. The lesion was symmetrical, covering the dorsum of the hands and extending up onto the wrist about an inch and a half. The erythema was followed by scaling. This patient's stools were examined frequently during the year and were always negative as to amoebae. He has had stomatitis since Aug. 15th, and has shown in every way a typical case of pellagra.

J. L., age 44 years. Examination of stools September 13, 1909, was negative. January 19, 1910, there was a slight erythema over the knuckles which was followed by exfoliation and lasted only a few days and did not show the symptom complex of pellagra other than the skin lesion. He had no diarrhœa during the year. September 6, 1910, symmetrical areas of scaling on the backs of both hands which were preceded by an erythema. Patient is failing in health. Examination of stools September 9, 1910, showed encysted amoeba and flagellates.

There are also three suspected cases of pellagra on the corn diet cottage. None of these cases show the complete symptom complex of pellagra. Histories of these are as follows:

J. H., age 43 years. Shows a slight erythematous patch on the dorsum of the left hand with none on the right. He has gained four pounds during the year and his general health at present is good.

H. S.,-age 54. Suspected pellagra. Had gastro-enteritis in December, at which time there was a slight erythema over the knuckles, also a mild stomatitis. The skin lesion disappeared in two weeks. He is six pounds heavier than last year and his physical condition is good at present.

J. H., age 46 years. Suspected pellagra. Has lost ten pounds during the year but has had no diarrhoea. Examination of stools negative, but on Sept. 15, 1910, had a stomatitis which looked suspicious of pellagra, with no other symptoms.

The corn free cottage shows five cases of pellagra with two deaths from the disease. Histories of these five cases are as follows:

H. R., age 34 years. Examination of stools Sept. 19, 1909, was negative, except showed encysted protozoa. August 19, 1910, losing in weight. September 5, 1910, symmetrical erythema on the back of the neck and the dorsum of hands extending from nails to two inches above the wrist line, also on the forehead.

F. G., age 58 years. Examination of stools Sept. 7, 1909, showed encysted protozoa. October 14, 1909, had severe diarrhœa which was quite persistent until death, Nov. 12, 1909. Ten days before death a typical pellagrous lesion appeared on the dorsum of the hands with bleb formation.

E. E., age 42 years. Examination of stools Sept. 7, 1909, showed encysted protozoa. Weight on September 1, 1910, identical with previous year. Has had no diarrhoea. September 11, 1910, erythema of the dorsum of the hands appeared not extending down on the wrists; was symmetrical and followed by peeling.

T. C., age 35 years. Examination of feces Sept. 7, 1909, negative. September 20, 1909, patient was stupid. Had large, watery stools in early morning. October 1st, hands showed marked erythema from wrist to finger tips followed by blebs on both hands. Small, erythematous area on both temples October 3d. November 1st, patient transferred to hospital. February 1, 1910, severe diarrhoea with hemorrhagic stools. Patient gradually failed and died Feb. 10, 1910. Post mortem revealed ulceration of the colon.

A. S., age 38 years. Examination of stools November 14th, negative. Patient was not ill during the year. September 11, 1910, dorsum of hands showed inflamed areas. There was marked pigmentation of the entire hand: Lesion does not extend down over the wrist. Inflammation has not subsided up to date and desquamation has not begun. The patient has lost 14 pounds during the year.

During the year there were four suspected cases of pellagra on the corn free diet cottage. Histories of these are as follows:

Of the four suspected cases the examination of the stools was negative as to active amoeba, but in two cases these were encysted amoeba and encysted flaggellates. One case had a mild erythema of the dorsum of the hands during January, 1910. This patient has gained seven pounds during the year and at present shows no symptoms of pellagra.

H. D., age 42 years. Slight erythema of wrists Feb. 1, 1910. Small bleb formation, suspicious but not typical of pellagra. Patient has gained in weight during the year.

I. S., age 43 years. October 25, 1909, diarrhœa with gastritis and stomatitis. Hands were rough and dry and scaly with no erythema. September 11, 1910, hands were dry and scaly. Physical condition good.

H. C., age 50 years. September 11, 1910, mild erythematous patch on the dorsum of right hand but no other pellagrous symptoms.

In conclusion, an excessive corn diet resulted in no more cases of pellagra than a corn-free diet.

A study of the food value of the diet in these cottages was made by Mr. Wussow under the direction of Professor Grindley and their result appears in another section of this report. In a general way, the results of this experiment may be summarized as follows:

Diet.	Feeding experiments in two cottages.		Duration 1 year.
	Patients.	Cases of pellagra	Suspects.
Corn diet cottage	59	4	1
Corn free diet cottage	58	5	5

It is evident from these results that an extensive corn diet did not favor the production of pellagra. Cases developed in each ward in practically the same proportion and this proportion agrees in general with that found throughout the institution which was also on a corn-free diet. It is not claimed that this experiment absolutely disposes of all forms of the corn theory of the production of pellagra, but it is difficult to reconcile the results with the ordinary theories incriminating corn as a causative factor in the production of the disease.

INOCULATION EXPERIMENTS.

Extensive experiments were carried out on monkeys. The results of these experiments are brought out in other sections of this report.

V.

CENTRAL NEURITIS AND PELLAGRA.

(By Sidney D. Wilgus.)

In an article in "Brain," 1901, Prof. Adolph Meyer described certain changes in the Betz cells of the motor cortex in a group of eight (8) patients dying from exhaustion. These changes consisted in haziness of the protoplasm, displacement of the Nissl bodies and axonal degeneration. To this condition Dr. Meyer gave the name "Central Neuritis." In addition to these changes in the central nervous system, the clinical symptoms were described in Dr. Meyer's summary as follows:

The disease usually appeared in emaciated people after an exhausting decline. Diarrhœa was a frequent accompaniment of the condition. Most of the cases appeared near the age of the climacteric in conditions suggesting toxic states. The duration of this terminal condition was given as from two to four weeks. As a rule, the knee jerks were exaggerated and occasionally ankle clonus was present. Peculiar tremors and twitchings of the hands, and contractions of the forearms and hands, and some jerking of the muscles were described in different cases. Delirium or delirious agitation and stupor were mentioned as being present commonly. The statement is made specifically that no polyneuritis was found. At times there were febrile fluctuations. This article goes on to say that the central changes mentioned above were found in eight out of two hundred autopsies where the alterations in the Betz cells were looked for.

Dr. Meyer was quite interested in this condition and mentioned it later in the course of his lectures at Manhattan State Hospital. In 1908 a further series of nine cases was described by Dr. Somers, then of the St. Lawrence State Hospital. It would seem that these cases are fairly common, although the subject has received less extensive attention than one would expect from the pronounced pathological and clinical symptoms. Some time ago it was my fortune to see some of these cases in New York State where the clinical symptoms, as noted above, were quite apparent. No cases of pellagra had then been noted in New York State and it cannot be said that symptoms of this disease were closely looked for, either by myself or other investigators.

But last year, with the striking clinical symptoms of central neuritis in mind, I was much interested in noticing exactly the same group of symptoms appear in cases of pellagra in their terminal stages. Searching the literature, it can readily be seen in articles on pellagra, such as those written by Tanzi and Bianchi and Babcock, and numerous others, that the profound cachectic state described by Meyer is frequently seen in pellagra, with the stupor and delirium, the prostration and diarrhœa and subsultus tendinum, all appearing at about the age mentioned by Meyer, namely, at the climacteric. Some of these cases within my knowledge have shown opisthotonos, jactations, etc., so well described by Meyer and Somers in their articles, and which I observed myself in cases of central neuritis. In addition to these symptoms of central neuritis, there were the undisputed symp-

toms of pellagra, such as, the gradual physical failure with diarrhœa; the bilateral symmetrical skin lesions involving usually the hands, the stomatitis; and the mental hebetude found in this disease. In my observations on more than a dozen terminal cases of pellagra these symptoms were present in the preponderance of cases.

After having seen the symptoms described under the heading of "Central Neuritis," and then witnessing the symptoms noted as occurring in the terminal stages of pellagra, it was not difficult to conclude that these terminal symptoms in pellagra were identical with those of Meyer's "Central Neuritis." In other words, pellagra has central neuritis as a terminal condition, as a rule. Of course, I am speaking here of the clinical side alone, and the pathological side is presented by the able pen of Dr. Singer.

Meyer believed this condition to be based on some toxic state, and suggested that alcoholism was frequently the basis on which central neuritis developed. After seeing cases of pellagra one can readily agree with him in his general conclusion that central neuritis is due to toxemia, but in all probability it is of a much wider origin than suspected by Meyer. Meyer had no knowledge of pellagra in Massachusetts or New York at the time he wrote, but most or all of his cases were from those states.

Pellagra is a disease recognized as endemic in the south and middle west. Those who have seen much of this disease know that many of the cases are difficult to diagnose because some of the most important symptoms may be mild or, indeed, not present at all much of the time. Where one case can be diagnosed readily by one unfamiliar with the disease, many masked cases will be passed over entirely. Plainly marked cases have been found in the New York State Hospitals and also in Massachusetts, and from this one may well suspect that the disease is as common there as in other states where it is recognized in its mild forms as well as in the fulminating type.

Perhaps it is going too far to say that pellagra is the sole cause of central neuritis, but it is safe to contend that pellagra is a more frequent cause of this syndrome than has been recognized previous to this time. One may suspect that perhaps some at least of Meyer's and Somers' cases were in pellagrins.

VI.

THE INTESTINAL BACTERIA OF PELLAGRINS.

(By W. J. MacNeal and Josephine (Kerr) Allison, assisted by Mattie A. York.)

A. Introduction.
B. Methods.
C. Results of the Bacteriological Study of the Samples of Fecal Material
D. Agglutination Tests.
E. Brief Description of Some of the Bacterial Strains.
F. Summary and Conclusions.

A. Introduction.

Digestive derangements are such a common accompaniment of the other manifestations of pellagra, even if they are not really an essential part of the symptom-complex, that no comprehensive consideration of the disease can omit a consideration of them. The remarkably frequent observation of various protozoa, and larger animal parasites as well, in the stools of pellagrins is already well known. Various kinds of bacteria have been isolated from the feces of pellagrins, and some of these have been regarded as the infectious cause of pellagra by their discoverers. It seemed to us wise to undertake some further work in this particular field, applying to the study of these stools the same methods which had previously been used in the study of the fecal bacteria of healthy men. It was hoped that in this way we might ascertain whether any definite and characteristic alterations in the relations of the normal intestinal bacteria might occur in pellagra, whether new forms of bacteria might be found in the stools in pellagra, and eventually whether it might be possible to isolate from the feces by these methods bacteria which might bear relation to the disease, either as causal agents, or as forms usually found in association with the disease.

The methods employed were those developed in our work upon the fecal bacteria of healthy men, modified to suit the conditions of this work. Certain further methods have also been employed, such as the Veillon tall-tube method of making separation cultures of anaerobes, employed by Tissier in the study of intestinal bacteria. As the methods have been described in detail elsewhere, a mere outline will suffice for our present purpose.

The stool to be examined was received directly into a sterilizd agateware basin, provided with a cover, and it was either examined at once or kept packed in ice until examined. Ordinarily a natural stool was used, but at times the material was obtained by an enema of sterile salt solution, the solid fecal masses obtained in this way being used for the examination.

The immediate examination of the stool and the preparation of a suspension of the feces for bacteriological study were performed at the hospital where the material was obtained, Peoria State Hospital, Kankakee State Hospital, or Cook County Hospital, as it happened to be. The microscopic

characters of the stool—form, consistency, mucus, pus, blood, tissue fragments, macroscopic parasites, etc., were noted. Various portions were subjected to microscopic examination for detection of blood, pus, or other tissue cells, microscopic food residues, parasitic ova, microscopic animal parasites—flagellate and ameboid protozoal forms being frequently found—and unusual bacteria. These preparations were then stained with iodine and reexamined, more particularly to gain an idea concerning the presence of starch and the number and forms of granulose bacteria. The material for the subsequent bacteriological study was sometimes selected from a particular part of the stool, and at other times was merely a portion removed after thorough mixing of the stool. In either case 0.5 gram of the feces was suspended. in a very finely divided condition, in 50cc. of sterile 0.8 per cent salt solution in a sterile graduated measuring flask. As soon as this suspension was finished it was packed in ice and transported to the University of Illinois, Urbana, where the bacteriological study was carried out.

The plan of the bacteriological study is indicated in the following outline:

I. Original 1-100 suspension prepared at hospital.

II. Dilution suspensions, accurately prepared from this as follows:

Suspension No. 2, 1-1,000.
Suspension No. 3, 1-10,000.
Suspension No. 4, 1-100,000.
Suspension No. 5, 1-1,000,000.
Suspension No. 6, 1-10,000,000.
Suspension No. 7, 1-100,000,000.
Suspension No. 8, 1-1,000,000,000.
Suspension No. 2, Spores, prepared by heating a portion of Suspension No. 2 at 80° C. for 15 minutes.

III. Direct microscopic count of the bacterial cells per milligram fresh feces by the method of Winterberg.

IV. Differential count of the morphologically different bacteria in Gram-stained preparations of the original suspension.

V. Plate cultures inoculated with mixed fecal flora.

a. Aerobic litmus lactose agar.
b. Aerobic litmus lactose gelatin.
c. Aerobic blood agar.
d. Anaerobic litmus glucose agar.
e. Anaerobic blood agar.

VI. Veillon-tube separation cultures in glucose agar, inoculated with high dilutions of the mixed flora.

VII. Plate cultures inoculated with spore material (the mixed flora heated to 80° C. for 15 minutes).

a. Aerobic litmus lactose agar.
b. Anaerobic glucose agar.
c. Anaerobic blood agar.

VIII. Fermentation tube cultures in broth inoculated with mixed fecal flora.

a. Dextrose broth.
b. Levulose broth.
c. Lactose broth.
d. Saccharose broth.

IX. Plate cultures and Veillon-tube separation cultures from the sediments in the fermentation-tube cultures.

X. Special fermentation-tube cultures.

a. Litmus milk inoculated with mixed fecal flora.
b. Litmus milk inoculated with spore material.
c. Sugar-blood broth inoculated with spore material.
d. Sugar-free broth containing coagulated egg-white inoculated with spore material.

XI. Study of the collection of pure subcultures isolated in these various procedures.

a. Agglutination tests upon the various strains of bacteria with serum of pellagrins and others.

b. More detailed study of certain strains.

The detail of the various special methods employed requires no full description here, as such will be found in the papers upon the fecal bacteria of healthy men.[1] Certain modifications and certain innovations require a brief mention.

The gravimetric estimation of the quantity of bacteria in the feces was omitted, partly because of the labor it involved, and partly because, in the absence of complete collections of the feces passed during a considerable period, the results of such determinations upon a single stool would possess little value. It seemed wiser to leave this work to be taken up at such time as accurately controlled metabolism studies on pellagrins might be undertaken. In order, however, to get some idea of the relative number of bacterial cells in the stools, the Winterberg counts were carried out. The Veillon-tube separation-culture method was not employed in our previous work. This method has been developed largely in France and has been used extensively by Tissier. Several tall tubes of glucose agar, the medium being 2 to 2½ inches deep, were steamed thoroughly to liquify the medium and expel dissolved oxygen, quickly cooled to 45° C. in a water bath, inoculated with measured portions of the higher dilutions of the mixed fecal flora, mixed thoroughly, but carefully, so as to avoid introducing much air, solidified quickly in cold water, and incubated at 37° C. in the air. Certain forms of bacteria with anaerobic tendencies are readily isolated by this method, although they are obtained with difficulty or not at all in plate cultures. The method was found by Tissier to be especially useful for isolation of *Bacillus bifidus*.

C. Results of the Bacteriological Study of the Samples of Fecal Material.

Altogether, 22 stools and two samples of intestinal contents removed at autopsy have been examined in this series.

Sample No. 1. The patient, J. N., female, was an inmate of the Kankakee State Hospital, where she had been for two years without any previously observed evidences of pellagra. Evidence of the disease was first noted on June 23, the skin lesions being treated as burns. Diarrhoea was present on July 4 and 5. She was seen by Dr. Singer on July 7, who made the diagnosis of pellagra, the skin lesions being quite typical and showing some desquamation at this time. Diet was light hospital diet. On July 11 the patient was very weak, moderately emaciated. The hands were desquamating. No stool had been passed since July 9. Enema of sterile salt solution was given and a stool obtained at 4:15 p. m. It was examined at once.

The stool consisted of several very dark green fecal lumps floating in warm salt solution. Numerous large flakes of mucus were present, one piece, 2x4 cm. Odor of the stool was mild, but putrefactive in type. Microscopic examination of the mucus revealed some cells thought to be amebae, but no flagellates. Leucocytes and epithelial cells were present. The suspension for bacteriological study was made from the interior of one of the firm fecal scybala.

The direct microscopic count of the bacterial cells in this suspension showed 336,000,000 bacteria per milligram of feces. In the hanging-drop preparation there were observed very few spores, many long slender motile rods, some cocci and short bacilli, but no spiral forms. A differential count of the Gram-stained bacterial flora gave the following result:

Gram-negative rods of *B. coli* type	36.0 percent
Other Gram-negative rods	6.4 percent
Gram-negative cocci	5.0 percent
Short, thick, Gram-positive rods	1.0 percent

[1] Journal of Infectious Diseases, 1909, vol. 6, p. 123-169; p. 571-609.

Slender, Gram-positive rods	3.0 percent
Oval, Gram-positive bacilli	0.2 percent
Gram-positive cocci	48.0 percent
Oval free spores	0.2 percent
Spherical free spores	0.2 percent
Total Gram-positive bacteria	52.2 percent
Total Gram-negative bacteria	47.4 percent
Total free spores	0.4 percent
Total Gram-negative rods	42.4 percent
Total micrococci	53.0 percent

Plate cultures on aerobic litmus lactose agar brought to development 500,000 bacteria per milligram feces. A number of colonies examined microscopically were found to consist of rods resembling *B. coli*. On plate cultures of aerobic blood agar 500,000 bacteria per milligram of feces developed into colonies. Many of these colonies appeared to be those of *B. coli*, but some of the deep colonies were surrounded by greenish zones, and these proved to be composed of diplococci. On anaerobic plates of litmus glucose agar, 470,000 bacteria per milligram of feces developed into colonies. Most of these were composed of rods resembling *B. coli*. Others were made up of large diplococci with somewhat pointed ends.

Plate cultures on aerobic litmus agar inoculated with spore material (the mixed fecal flora previously heated at 80° C. for 10 minutes) brought to development 32 spores per milligram of feces. On the anaerobic blood-agar plates, inoculated with spore material, there developed 10 colonies per milligram of feces. Most of these latter were colonies of *B. welchii*.

Fermentation-tube cultures inoculated with 0.25cc. of Suspension No. 1, equivalent to 2.5 milligrams feces, gave the following results:

Dextrose broth—Small bubble of gas; good growth.
Levulose broth—Small bubble of gas; good growth.
Lactose broth—17 percent gas in closed arm; good growth.
Saccharose broth—10 percent gas in closed arm; good growth.
Litmus milk—Small bubble of gas, reduction; acid reaction.

Similar tubes inoculated with 0.50cc. of Suspension No. 8, equivalent to 0.000,000,5mg. feces, showed no growth in any tube after 48 hours incubation.

A fermentation-tube culture in sugar-blood broth inoculated with 0.5cc. Suspension No. 2, Spores, equivalent to the spores of 0.5 milligram feces, showed no growth in 24 hours, but 50 percent gas in the closed arm after 48 hours. In litmus milk, inoculated in the same way, 100 percent gas had formed in 24 hours, with coagulation and acid reaction. In a fermentation tube culture in sugar-free broth containing coagulated egg-white, inoculated in the same way, there was no gas produced and no digestion of the albumen.

The sediments in the fermentation tubes were stained by Gram's method and examined microscopically with the following results:

"Dextrose broth sediment: Majority of bacteria are Gram-positive diplococci; many short, rather plump, Gram-positive rods; some large plump positive rods in chains.

"Levulose broth sediment: Very many Gram-positive diplococci; large numbers of Gram-positive rods, irregular in shape, with knobs and small branches, resembling *B. bifidus*, but apparently somewhat larger.

"Saccharose broth sediment: Majority of bacteria are Gram-positive cocci; a few Gram-negative rods, resembling *B. coli;* a few large plump Gram-positive rods.

"Litmus milk: Many medium sized Gram-positive diplococci; some large plump Gram-negative rods; a few irregular Gram-positive bacilli, resembling *B. bifidus*.

"Litmus milk inoculated with spores: Appears to be a pure culture of Gram-positive rods, resembling *B. welchii*.

Sugar-free broth containing egg-white, inoculated with spores: Chiefly large plump Gram-positive rods, resembling *B. welchii;* some long, slender Gram-positive rods."

Anaerobic plates of litmus glucose agar were inoculated with the fermentation-tube sediments of the sugar-broth and litmus-milk tubes inoculated with the mixed fecal flora. All these plates developed numerous colonies of diplococci and a few colonies of *B. coli.*

Veillon-tube cultures in tall glucose agar were inoculated with the sediment in the lactose-broth culture, and after four days at 37° C. numerous colonies of typical *B. bifidus* had developed.

No subcultures were preserved from the examination of this stool.

It will be noted that this sample was a formed stool obtained by enema after the active stage of the disease had subsided and six days after the diarrhœa had ceased, the patient being very weak and taking very little food at the time. Subsequently, the patient remained in a very weak condition for a considerable time and it was not expected that she would recover. After several weeks she gained in strength and has had no further signs of pellagra up to the present time, August, 1911.

Sample No. 2. The patient, N. A., male, was an inmate of the Peoria State Hospital, where he had been continuously for six years. He suffered a typical attack of pellagra in May and June, 1910, and was one of the patients shown by Dr. Zeller at the meeting of the American Medical Association at St. Louis in June, 1910. On June 22 he was selected by Dr. Zeller, Dr. Singer and Dr. MacNeal as one of the most typical cases of pellagra at the Peoria State Hospital. He had a very bad diarrhoea up to within a few days of that time. He was transferred to the Kankakee State Hospital on July 13. On July 16 he was well on the road to recovery; the deeply pigmented superficial layers had peeled off over most of the area previously involved, leaving the skin thin and white. On the forearms the deep brown desquamating epithelium was still present. He was confined to bed at this time, but not on account of physical weakness, as he was strong enough to be about. The stool was passed naturally at 7:10 p. m., July 16, 1910, and was iced at once. It was examined at 7:30 p. m., 20 minutes after passage.

The stool was small, fluid in consistency, with some formed bits in it. It was dark brown in color and possessed a fairly strong odor of normal character. Pieces of fruit pulp, probably banana, were seen. Microscopic examination revealed striated muscle cells, small pieces of fruit pulp, evidently from bananas, still containing undigested starch, numerous flagellates, but no amebae. The suspension for bacteriological study was made at 8 p. m. and packed in ice. It remained in ice until 10:30 a. m., July 18, when the bacteriological study was begun.

By direct microscopic count 98,400,000 bacterial cells per milligram feces were found. Differential count of the Gram-stained fecal bacteria gave the following results:

Gram-negative rods of *B. coli* type	64.4 percent
Other Gram-negative rods	9.0 percent
Gram-negative cocci	4.6 percent
Gram-negative spirilla	0.4 percent
Gram-negative spirochetes	0.0 percent
Thick Gram-positive rods	1.4 percent
Slender Gram-positive rods	3.0 percent
Oval Gram-positive rods	1.0 percent
Gram-positive cocci	16.2 percent
Free spores	0.0 percent
Total Gram-positive bacteria	21.6 percent
Total Gram-negative bacteria	78.4 percent
Total free spores	0.0 percent
Total negative rods	73.4 percent
Total micrococci	20.8 percent

Plate cultures on litmus lactose agar brought to development 400,000 bacteria per milligram of feces. A few strongly acid colonies were composed of diplococci, but most of the colonies appeared to be those of *B. coli.* On plate cultures of aerobic blood agar 850,000 bacteria per milligram of feces developed into colonies. All colonies examined consisted of short rods, re-

sembling *B. coli*. In aerobic litmus lactose gelatin at 18° C., 600,000 bacteria per milligram feces developed into colonies. Practically all the colonies were those of *B. coli*, but several colonies of mold were observed on each plate.

On anaerobic litmus glucose agar 450,000 bacteria per milligram feces developed into colonies. All the colonies were acid, most of them *B. coli*, but there were also many colonies of diplococci on the plates. Plate cultures on anaerobic blood agar brought to development 434,000 bacteria per milligram of feces. All colonies studied appeared to be those of *B. coli*.

Plate cultures of aerobic litmus lactose agar inoculated with spore material (the mixed fecal flora previously heated to 80° C. for 10 minutes) brought to development nine spores per milligram of feces. The colonies were all alkaline, but represented at least four different kinds of sporogenic bacilli.

Anaerobic plate cultures on blood agar, inoculated with spore material, brought to development 2,500 spores per milligram of feces. All the colonies were hemolytic and all those studied microscopically consisted of rods resembling *B. welchii*. Anaerobic plate cultures on glucose agar, inoculated with spore material, brought to development 70 spores per milligram of feces. All these colonies were of one type and those studied microscopically were composed of large plump non-motile rods containing granules, and evidently belonging to the *B. welchii* group.

Veillon deep-tube cultures in glucose agar inoculated with 0.5cc. of Dilutions No. 5, No. 6, No. 7 and No. 8, respectively, failed to bring to development any colonies of *B. bifidus*. The first two tubes of the series contained colonies of *B. coli* and the medium was torn apart by gas. Other colonies examined consisted of streptococci, diplococci and rods of *B. welchii* type. The third tube (inoculated with 0.5cc. Dilution No. 7) showed only one colony and the fourth tube remained sterile.

Fermentation tube cultures in sugar broth, inoculated with 0.25cc. of Suspension No. 1, equivalent to 2.5 milligrams feces, gave the following results.

Dextrose broth ..... 5.0 percent gas in the closed arm
Levulose broth ..... 10.0 percent gas in the closed arm
Lactose broth ..... 25.0 percent gas in the closed arm
Saccharose broth ..... 15.0 percent gas in the closed arm
Litmus milk—Small gas bubble; coagulation; acid; reduction of the litmus.

A similar set of fermentation tubes, inoculated with 0.50cc. Dilution No. 5, equivalent to 0.005 milligram feces, gave the following results:

Dextrose broth ..... 25 percent gas in the closed arm
Levulose broth ..... 5 percent gas in the closed arm
Lactose broth ..... 60 percent gas in the closed arm
Saccharose broth ..... 37 percent gas in the closed arm
Litmus milk—15 percent gas in the closed arm; coagulation; acid; reduction of litmus.

A fermentation-tube culture in sugar-blood broth, inoculated with 0.5cc. Suspension No. 2, Spores, equivalent to the spores of 0.5 milligram feces, showed 100 percent gas in the closed arm after 24 hours. A fermentation-tube culture in sugar-free broth, containing coagulated egg-white, inoculated in the same way, showed a small bubble of gas, but no digestion of the albumen.

The sediments in the fermentation tubes were stained by Gram's method and examined microscopically with the following results:

"Dextrose broth (0.25cc. Suspension No. 1): Majority of the bacteria are medium sized Gram-positive diplococci; long, plump Gram-positive rods and short Gram-negative rods (*B. coli*) are also present.

"Levulose broth (0.25cc. Suspension No. 1): Same as dextrose broth sediment.

"Lactose broth (0.25cc. Suspension No. 1): Majority of the bacteria are medium sized Gram-positive diplococci; many Gram-negative rods (*B. coli*), many long, thick Gram-positive rods, staining irregularly and many small Gram-positive diplococci are also present.

"Saccharose broth (0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci of medium size, many Gram-negative rods resembling *B. coli*, and many long, thick Gram-positive rods are also present.

"Litmus milk (0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; rods of *B. coli* and *B. welchii* types are also present.

"Dextrose broth (0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci of medium size. Numerous rods resembling *B. coli* and a few thick Gram-positive rods are also present.

"Levulose broth (0.50cc. Suspension No. 5) and lactose broth (0.50cc. Suspension No. 5): Same as dextrose broth.

"Saccharose broth (0.50cc. Suspension No. 5): Great majority of the bacteria are short plump Gram-negative rods of *B. coli* type; very few Gram-positive diplococci.

"Litmus milk (0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci of medium size. Short plump Gram-positive rods (*B. welchii*) and small Gram-positive cocci are also present.

"Sugar-blood broth (0.50cc. Suspension No. 2, spores): Majority of the bacteria are plump Gram-positive rods; others are decolorized, but may be of the same species (*B. welchii?*).

"Litmus milk (0.50cc. Suspension No. 2, spores): Apparently a pure culture of *B. welchii*.

"Sugar-free broth containing coagulated egg-white: Slender Gram-positive rods in threads; a few large, plump Gram-negative rods."

Culture strains derived from this stool were not preserved.

It will be noted that this was diarrheal stool passed naturally several weeks after the patient had begun to recover from the attack of pellagra. The desquamation of the pigmented epithelium was completed soon afterward, and there has been no further sign of pellagra up to the present time, August, 1911.

Specimen No. 3. The patient, M. R., female, was an inmate of the Peoria State Hospital, where she had been continuously for four years. She had an attack of pellagra in 1909. On June 22, 1910, she had a dark chocolate-brown discoloration on the backs of hands and forearms, but no other manifestations of pellagra. She was transferred to the Kankakee State Hospital on July 13, 1910. The stool examined was passed naturally at 2:40 a. m. on July 17th, and was packed in ice. It was examined at 8:30 a. m. on the same day.

The stool was very soft, almost mushy in consistency, with a light pinkish brown color and a normal odor. Macroscopic food remnants were not found. Microscopic examination showed some bits of broken starch, but no meat residue. On the whole the food appeared to be well digested. No protozoa were detected. The suspension for bacteriological study was prepared from the mixed feces and was packed in ice at 9:00 a. m. where it remained until July 19th, at 9:35 a. m., when the bacteriological study was begun.

By the microscopic counting method 180,000,000 bacterial cells per milligram of feces were found. Study of the hanging-drop preparation showed very few spores and no spirochetes. Differential count of 500 cells, stained by Gram's method, gave the following results:

Gram-negative rods of *B. coli* type	46.0 percent
Other Gram-negative rods	29.0 percent
Gram-negative cocci	0.0 percent
Gram-negative spirilla	0.4 percent
Thick Gram-positive rods	0.6 percent
Slender Gram-positive rods	3.2 percent
Oval Gram-positive bacilli	0.8 percent
Gram-positive cocci	20.0 percent
Spores	0.0 percent
Total Gram-positive bacteria	24.6 percent
Total Gram-negative bacteria	75.4 percent

Total free spores..... 0.0 percent
Total Gram-negative rods ..... 75.0 percent
Total micrococci ..... 20.0 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 250,000 bacteria per milligram of feces. Most of the colonies were evidently those of *B. coli*. Aerobic blood-agar plates, incubated 24 hours at 37° C., brought to development 265,000 bacteria per milligram of feces. Plate cultures on litmus lactose gelatin, incubated 6 days at 16° to 20° C., brought to development 200,000 bacteria per milligram of feces. Practically all the colonies resembled those of *B. coli*.

On anaerobic plates of litmus glucose agar, incubated six days at 37° C., there developed 230,000 colonies per milligram of feces. All these were apparently those of *B. coli*. On plates of anaerobic blood agar, incubated six days at 37° C., colonies developed representing 212,000 bacteria per milligram of feces. Most of them were hemolytic and all examined microscopically were found to consist of rods resembling *B. coli*.

Veillon-tube cultures, in tall glucose agar, were inoculated with 0.50cc. Suspension No. 6 (equivalent to 0.0001 bg. feces), 0.50cc. Suspension No. 70, 0.50cc. Suspension No. 8 (equivalent to 0.000 001 mg. feces) and with three loopfuls of Suspension No. 8, respectively. These tubes were incubated for four days at 37° C. The first tube contained several colonies of diplococci and of bacilli of the *B. welchii* type. The second tube showed a single colony of the latter kind, and the other two tubes remained free from colonies. The result would suggest that the viable diplococci and gas bacilli were at least as numerous as 20,000 per milligram of fresh feces.

Aerobic litmus-agar plates, inoculated with spore material (mixed fecal flora heated to 80° C. for 10 minutes) and incubated 24 hours, brought to development 12 colonies per milligram of feces. The colonies were all alkaline and composed of slender motile rods, but spores were not observed. Anaerobic blood-agar plates and anaerobic glucose-agar plates, inoculated with spore material and incubated six days at 37° C., failed to detect any sporogenic anaerobes.

Fermentation-tube cultures in sugar-broth, inoculated with 0.25cc. of Suspension No. 1 and incubated 24 hours at 37° C. gave the following results:

Dextrose broth ..... 40 percent gas in the closed arm
Levulose broth ..... 15 percent gas in the closed arm
Lactose broth ..... 50 percent gas in the closed arm
Saccharose broth ..... 42 percent gas in the closed arm
Litmus milk..... coagulated; acid; litmus reduced

Fermentation tubes of sugar-blood broth, litmus milk and sugar-free broth containing coagulated egg-white, were inoculated with 0.50cc. of Suspension No. 2, Spores. All remained free from growth.

The fermentation-tube sediments were stained and examined with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are of type of *B. coli;* there are also many Gram-positive diplococci and many short, slender Gram-positive bacilli.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are short plump Gram-negative rods of the type of *B. coli;* large and small Gram-positive diplococci are also present.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria resemble *B. coli;* many short slender Gram-negative rods, many Gram-positive diplococci and some large plump Gram-positive rods of the *B. welchii* type are also present.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria resemble *B. coli;* there are also many Gram-positive diplococci and a few rods of *B. welchii*.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Most numerous are the Gram-positive diplococci; short slender Gram-positive rods, and Gram-negative rods resembling *B. coli* are also present."

Veillon-tube dilution cultures in tall glucose agar were inoculated with the sediment of the lactose-broth fermentation tube. The dominant living organism was a diplococcus and no *B. bifidus* was detected.

The subcultures derived from this stool were not preserved for any further study.

It will be noted that this stool was obtained a considerable time after the attack had begun to subside, probably a month or more, and that the material was kept on ice for more than two days before the bacteriological study was undertaken. The further history of the patient was uneventful. There has been no recurrence of the pellagrous symptoms up to the present time, August, 1911.

Specimen No. 4. The patient, C. G., female, was an inmate of the Peoria State Hospital, where she had been continuously since 1902. On June 22 there was very marked desquamation on backs of hands and forearms. She was transferred to the Kankakee State Hospital on July 13. The stool was passed on July 17 at 5:30 a. m., and packed in ice. It was examined at 9:00 a. m.

The stool weighed 95 grams. It was formed, the first portion being rather firm and dark brown in color, and the last part soft, flattened, and light yellow in color. There were two large flakes of mucus on the surface. A moderate amount of gas was observed in the substance of the feces and a strong, putrefactive odor was present. No macroscopic food remains were recognized. Microscopically, the material appeared well digested. A few small bits of starch were seen. Amebae were found in the mucus, but flagellates were not. The suspension for bacteriological study was made at 10 a. m. and packed in ice. The bacteriological study of it was begun at 3 p. m. on the same day.

By direct microscopic count 300,000,000 bacterial cells per milligram feces were found. In the hanging-drop the bacteria presented nothing unusual Various bacilli and cocci were noted and also a few oval spores. There were, however, numerous masses of epithelial cells and many spherical cells, also numerous spherical, highly refractive bodies with concentric markings, about 5 microns in diameter. The differential count of 500 bacterial cells in a Gram-stained film gave the following result:

Gram-negative rods of *B. coli* type	37.6 percent
Other Gram-negative rods	41.2 percent
Gram-negative cocci	4.0 percent
Gram-negative spirilla	0.2 percent
Gram-negative spirochetes	0.6 percent
Thick Gram-positive rods	0.4 percent
Gram-positive ovals	0.4 percent
Gram-positive cocci	15.6 percent
Free spores	0.0 percent
Total Gram-positive bacteria	16.4 percent
Total Gram-negative bacteria	83.6 percent
Total free spores	0.0 percent
Total negative rods	78.8 percent
Total micrococci	19.6 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 1,400,000 bacteria per milligram of feces. Practically all the colonies were of the type of *B. coli.* On aerobic blood agar, incubated 24 hours at 37° C., 1,250,000 bacteria per milligram of feces developed into colonies. Most of the colonies were those of *B. coli.* On plate cultures of litmus lactose gelatin, incubated for six days at 37° C., 1,600,000 bacteria per milligram of feces developed into colonies. All the colonies appeared to be those of *B. coli.* On anaerobic plates of litmus glucose agar, incubated six days at 37° C., 950,000 bacteria per milligram of feces developed into colonies. The colonies all resembled those of *B. coli.* On anaerobic blood agar 1,100,000 bacteria per milligram of feces developed into colonies. Most of these were hemolytic and all examined were composed of rods resembling *B. coli.* Veillon dilution-tube cultures in tall glucose agar were inoculated

with measured amounts of the higher dilutions. There was marked production of gas in all the tubes up to and including that inoculated with 0.50cc. of Suspension No. 8 (equivalent to 0.000,000,5 mg. of feces). The colonies in this tube were composed of rods resembling *B. welchii*. It would, therefore, appear that viable bacilli of this type were at least as numerous as 2,000,000 per milligram of feces. Colonies of *B. bifidus* were not detected.

Spore material (Suspension No. 2, heated at 80. C. for 10 minutes) was plated on aerobic litmus agar, anaerobic glucose agar and anaerobic blood agar. On the aerobic litmus agar, incubated 24 hours at 37° C., 120 spores per milligram of feces developed into colonies. Most of the colonies were composed of very slender motile rods containing an elongated spore. On the anaerobic glucose agar, incubated three days at 37° C., only four spores per milligram of feces developed into colonies. These were of the type of *B. welchii*. On the anaerobic blood agar, incubated three days at 37° C., 4,250 spores per milligram of feces developed into colonies. Nearly all the colonies were hemolytic and composed of rods resembling *B. welchii*. A few colonies, spreading beneath the agar, consisted of rods resembling *B. edematis*.

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 40 percent gas in the closed arm
Levulose broth ..... 42 percent gas in the closed arm
Lactose broth ..... 55 percent gas in the closed arm
Saccharose broth ..... 35 percent gas in the closed arm
Litmus milk—Small gas bubble; coagulation; acid; litmus reduced.

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 2, Spores, and incubated at 37° C., gave the following results:

Sugar-blood broth—100 percent gas; butyric odor.

Litmus milk—100 percent gas; coagulation; acid.

Sugar-free broth containing coagulated egg-white, 5 percent gas in the closed arm; no digestion of the albumen, even after prolonged incubation.

The fermentation-tube sediments were stained by Gram's method, and examined, with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are short plump Gram-negative rods of the *B. coli* type; slender Gram-negative rods, small Gram-positive diplococci, short slender Gram-positive rods and large plump Gram-positive rods of *B. welchii* type are also present.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are of the *B. coli* type; there are also many Gram-positive diplococci, some short slender Gram-positive rods and large plump Gram-positive rods.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are of the *B. coli* type; there are many short slender Gram-negative rods, some Gram-positive diplococci, short slender Gram-positive rods, and a few large plump Gram-positive rods of the *B. welchii* type.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are of the *B. coli* type. There are also Gram-positive diplococci, short slender Gram-negative rods, and plump Gram-positive rods of the *B. welchii* type.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): This appears to be a pure culture of large plump Gram-positive rods (*B. welchii*.)

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): This appears to be a pure culture of *B. welchii*.

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): All the bacteria are long slender Gram-positive bacilli, chiefly growing in threads. Evidently these make up the aerobic growth on the surface of the culture."

Plate cultures were inoculated with the sediments in the fermentation tubes. On those from the dextrose broth sediment, there developed colonies

of diplococci, strongly acid in reaction, and also colonies of *B. coli.* The same result was obtained from the levulose broth. The plates from the lactose and saccharose broth, however, showed only colonies of the diplococci. Veillon-tube cultures in tall glucose agar were inoculated with the sediment of the lactose-broth fermentation tube. Diplococci, streptococci and large rods of the *B. welchii* type developed in these cultures. *B. bifidus* was not detected.

Bacterial strains derived from this stool were not preserved.

At the same time that the suspension in salt solution was prepared for the bacteriological study, a large flask of very dilute nutrient broth was inoculated with a large flake of the fecal mucus, in an attempt to cultivate the ameba observed. The medium was prepared by diluting 10cc. of ordinary nutrient broth with 800cc. of tap water and was sterilized in the autoclave. This was inoculated at 10 a. m. on July 17, kept at room temperature until 1:15 p. m. and then placed at 37° C. The flask was examined first on July 1. The mucus had disintegrated and there was considerable granular sediment at the bottom of the flask. Some of this was removed through a sterile capillary tube and examined microscopically. Very numerous spindle-shaped bodies were found, measuring 12 to 22 microns in length by 6 to 10 microns in width. These bodies consisted of a coarsely granular protoplasm, colorless or greenish-yellow, surrounded by a fairly thick, clearly defined hyaline wall, which was drawn out into a distinct, projecting process at each end. By careful search it was not difficult to find several of these bodies showing evidence of internal division into four protoplasmic masses, separated by hyaline walls continuous with the external envelope. When fixed in mercuric chloride and stained by iron-hematoxylin, internal structures resembling centrosome and nuclear chromatin were distinctly seen. These bodies were unquestionably living cells of some sort and the various forms observed suggested very clearly that active multiplication was going on by division of one cell into four daughter cells. Besides these spindle-shaped bodies, a smaller number of spherical cells of very similar structure were present. These were smaller and the surrounding membranes were distinctly more delicate. Some of these spheres were distinctly divided into four cells. The observation of these bodies was regarded as extremely interesting at the time and numerous attempts at sub-culture and animal inoculation by feeding and injection into the rectum were made. All these attempts led to no result and the cells in the original flask slowly disintegrated. Similar flasks of dilute broth, inoculated with mucus and with fecal material from the other stools in this series never gave any result at all resembling this one. The observation has been regarded, therefore, as of little importance, except, perhaps, as suggesting that various living things may find suitable conditions for growth in the intestine of a pellagrin.

It will be noted that this specimen was a formed stool, passed several weeks after the acute manifestations of pellagra had begun to subside. The patient has had no recurrence of pellagra up to the present time, August, 1911.

Specimen No. 5. The patient A. P., male, was an inmate of the Kankakee State Hospital. He developed a very suspicious discoloration on the backs of the hands, first noticed about July 18, 1910. The stool was passed during the night of July 25-26 and packed in ice. It was examined at 8:00 a. m. July 26th.

The stool was formed and hard, very dark green, almost black in color. No flakes of mucus were present, and only a moderate coat of mucus on the surface of the fecal cylinder. The odor was mild, resembling that of cow manure. On mixing, the material had the consistency of a firm, tough paste, and except for a small bit of connective tissue was free from macroscopic food remains. Microscopically, the stool appeared to be practically free from digestible food remnants, and no protozoa were observed. The

suspension for bacteriological study was prepared and packed in ice at 8:30 a. m. The bacteriological study of the suspension was begun at 2:00 p. m. on the same day.

By direct microscopic count 360,000,000 bacterial cells per milligram of feces were found. In the hanging drop, an excess of free bacterial spores was noted. A differential count of 600 cells gave the following results:

Gram-negative rods of *B. coli* type	42.50 percent
Other Gram-negative rods	40.00 percent
Gram-negative cocci	0.17 percent
Gram-negative spirochetes	0.17 percent
Thick Gram-positive rods	0.83 percent
Oval Gram-positive bacteria	0.83 percent
Slender Gram-positive rods	0.50 percent
Gram-positive cocci	7.67 percent
Oval free spores	7.33 percent
Spherical free spores	0.00 percent
Total Gram-positive bacteria	52.84 percent
Total Gram-negative bacteria	9.83 percent
Total free spores	7.33 percent
Total Gram-negative rods	82.50 percent
Total micrococci	7.84 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development only 40 bacteria per milligram of feces. Ninety percent of the colonies were those of diplococci. No colonies of *B. coli* were found, a rather remarkable observation. Blood-agar plates, inoculated with 0.5cc. of Suspension No. 5, and of Suspension No. 6, respectfully, remained free from colonies. The inoculations represented 0.005mg. and 0.0005mg., of feces respectively. On aerobic plates of litmus lactose gelatin, 200 bacteria per milligram of feces developed into colonies. Nearly all of these were alkaline in reaction. Plate cultures on anaerobic litmus glucose agar brought to development 52,000 bacteria per milligram of feces. A number of the colonies were studied microscopically and by subculture and all of those studied proved to be obligate anaerobes, evidently belonging to the *B. welchii* group. Plate cultures on anaerobic blood-agar, incubated three days at 37° C., brought to development 84,000 bacteria per milligram of feces. These colonies were all hemolytic and resembled those of *B. welchii*. Subcultures from a number of colonies proved them to be obligate anaerobes, and subculture in litmus milk in a fermentation tube gave rise to the typical fermentation of *B. welchii*.

Veillon tubes were inoculated with 0.5cc. of Suspension No. 6, Suspension No. 7 and Suspension No. 8, respectively. After incubating for three days at 37° C., the agar in the first two tubes was riddled with gas and the third showed no growth at all. This would indicate the presence of *B. welchii* in hundreds of thousands per milligram of feces.

Spore material (Suspension No. 2, heated to 80° C., for 10 minutes) was plated aerobically and anaerobically. On the aerobic litmus agar, 90 spores per milligram of feces developed into colonies. On the anaerobic blood-agar plates inoculated with 0.25cc. and 0.50cc. of Suspension No. 2, Spores, and incubated for three days at 37° C., the colonies were too numerous to be counted and were estimated at between 10,000 and 100,000 per milligram of feces. Three types of bacilli were represented in the colonies; first, rods of the *B. welchii* type; second, longer and more slender rods of the *B. edematis* type; and third, very slender rods with a large oval terminal spore, the *B. putrificus* or "Kopfchen-bacillus" type. On anaerobic plates of glucose agar, incubated three days at 37° C., 980 spores per milligram of feces developed into colonies. All of these appeared to be *B. welchii*.

Fermentation-tube cultures, inoculated with 0.25cc. of Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 100 percent gas in the closed arm
Levulose broth ..... 100 percent gas in the closed arm
Lactose broth ..... 100 percent gas in the closed arm
Saccharose broth ..... 35 percent gas in the closed arm
Litmus milk—100 per cent gas in the closed arm; coagulation; acid reaction; odor of butyric acid.

Fermentation-tube cultures, inoculated with 0.5 cc. of Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:
Dextrose broth ..... 100 percent gas in the closed arm
Levulose broth ..... 100 percent gas in the closed arm
Litmus milk—35 percent gas in the closed arm; no coagulation; acid reaction.

Fermentation-tubes of sugar-blood broth and of litmus milk were inoculated with 0.5cc. of Suspension No. 2, spores. After 24 hours at 37° C. each was completely filled with gas. A fermentation-tube of sugar-free broth containing coagulated egg-white, incubated in the same way, produced only a little gas, about 0.5 percent, and there was no digestion of the albumen.

The fermentation-tube sediments stained by Gram's method and examined microscopically, gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are large plump Gram-positive rods (*B. welchii*); Gram-positive diplococci are present.

"Levulose broth (inoculated with 0.25 cc. Suspension No. 1): Sediment contains many large plump Gram-positive rods, many short slender Gram-positive rods and many small Gram-positive diplococci.

"Lactose broth (inoculated with 0.25 cc. Suspension No. 1): Many large plump Gram-positive diplococci; some short slender Gram-positive rods in threads.

"Saccharose broth (inoculated with 0.25 cc. Suspension No. 1): Majority of the bacteria are large plump Gram-positive rods; Gram-positive diplococci; and slender Gram-negative rods are also present.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are short slender Gram-negative rods; large plump Gram-positive rods (*B. welchii*) and small Gram-positive diplococci are also present.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Appears to be a pure culture of large plump Gram-positive rods (*B. welchii*).

"Levulose broth and litmus milk (inoculated with 0.50cc. Suspension No. 5): These sediments appear to be pure cultures of *B. welchii*.

"Sugar-blood broth and litmus milk (inoculated with 0.50 cc. Suspension No. 2, Spores): Both appear to be pure cultures of *B. welchii*.

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Numerous slender Gram-positive rods with large oval terminal spore (drumstick); some large plump Gram-positive rods with intermediate oval spores; some large plump Gram-positive rods without spores (*B. welchii*)."

Plate cultures on anaerobic litmus glucose agar were inoculated with the fermentation tube sediments and incubated at 37° C., for five days. On the plates from the sediment of the dextrose broth, originally inoculated with 0.25cc. Suspension No. 1, the colonies were all strongly acid and all examined were composed of cocco-bacilli with pointed ends. The sediments of the levulose broth, lactose broth, saccharose broth and litmus milk in the same series of cultures, gave similar results in plate cultures. Plate cultures of the sediment in the fermentation tube of dextrose broth, originally inoculated with 0.50cc. Suspension No. 5, developed colonies of *B. coli* as well as of diplococci. Veillon dilution cultures of the sediment in the fermentation tube of lactose broth, orginally inoculated with 0.25cc. of Suspension No. 1, developed only colonies of the diplococcus with pointed ends. There was no production of gas. Evidently the cocci had, for the most part, overcome the other bacteria in the fermentation-tube cultures.

Culture strains, derived from the stool were not preserved.

It will be noted that the diagnosis of pellagra in this patient was not certain, and that the ordinary examination of the stool indicated no serious impairment of digestion. The subsequent history of the case, perhaps, renders the diagnosis of pellagra even more doubtful, as the discoloration on the hands gradually faded without desquamation. There has been no further indication of pellagra in this patient up to the present time.

Specimen No. 6. The patient, J. B., male, was an inmate of the Peoria State Hospital, where he had been continuously since 1904. He was one of the typical cases shown by Dr. Zeller at the meeting of the American Medical Association in St. Louis in June, 1910. On June 22 the backs of the hands and forearms were very brown and the epidermis was desquamating. He had no diarrhoea at the time and history of a diarrhoea was not obtained. He was transferred to the Kankakee State Hospital on July 13. The stool examined was passed at 9:10 a. m. on July 26, and examined at once. At that time the dark brown epidermis had already peeled off from the backs of the hands, but still remained in patches on the forearms.

The stool was formed, part of it quite firm, but the last two-thirds soft, almost mushy. The lower portion was dark brown, the upper light brown in color. The odor was somewhat peculiar, and rather offensive. Broken bits of grain were visible all through the mass. Microscopic examination revealed numerous active flagellates, but amebae were not detected with certainty. Considerable starch was present, and a moderate number of granulose bacteria. The suspension for bacteriological study was made from the softer portion of the stool, and was packed in ice at 10 a. m. The bacteriological study was begun at 2:00 p. m. on the same day.

By the direct microscopic method, 118,000,000 bacterial cells per milligram of feces were counted. In the hanging drop a number of flagellates were seen, but nothing else unusual was observed. Differential count of 500 cells of fecal flora, stained by Gram's method, gave the following results:

Gram-negative rods of the *B. coli* type	42.0 percent
Other Gram-negative rods	27.8 percent
Gram-negative cocci	1.0 percent
Gram-negative spirilla	0.2 percent
Gram-negative spirochetes	3.6 percent
Thick Gram-positive rods	1.6 percent
Slender Gram-positive rods	1.6 percent
Gram-positive cocci	16.8 percent
Oval free spores	4.6 percent
Spherical free spores	0.8 percent
Total Gram-positive bacteria	20.0 percent
Total Gram-negative bacteria	74.6 percent
Total free spores	5.4 percent
Total Gram-negative rods	69.8 percent
Total micrococci	17.8 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 350,000 bacteria per milligram of feces. All were apparently colonies of *B. coli.* On aerobic blood-agar 340,000 bacteria per milligram of feces developed into colonies. Many of these were hemolytic. The plate cultures on aerobic litmus lactose gelatin, incubated five days at 15° to 20° C., brought to development 345,000 bacteria per mg. of feces. All the colonies resembled *B. coli.* On aerobic litmus glucose agar, 475,000 bacteria per milligram of feces developed into colonies. Part of these colonies were strongly acid and composed of diplococci, but the majority of them were made up of bacilli of the type of *B. coli.* On anaerobic blood-agar, 610,000 bacteria per milligram of feces developed into colonies. Many of the colonies were surrounded by clear zones and some of these hemolytic colonies were made up of rods resembling *B. welchii.* Other hemolytic colonies consisted of rods of the type of *B. coli* and the non-hemolytic colonies were composed of rods of the same morphological type.

Veillon tubes of tall glucose agar were inoculated with 0.50cc. Suspension No. 6, Suspension No. 7 and Suspension No. 8, and incubated three days at 37° C. In the first two the agar was riddled with gas, and in the last tube no growth occurred. *B. bifidus* was not detected.

Spore material, plated on aerobic litmus agar, brought to development only one spore per milligram of feces. On anaerobic blood-agar, between 10,000 and 100,000 spores per milligram of feces developed into colonies, the growth being too thick to count. All the colonies resembled those of *B. welchii*. On anaerobic glucose agar 252 spores per milligram of feces developed into colonies. These were all of the same type and composed of large non-motile rods without spores, evidently belonging to the *B. welchii* group.

Fermentation tube cultures were inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37 C., with the following results:

Dextrose broth ..... 42 percent gas in the closed arm
Levulose broth ..... 45 percent gas in the closed arm
Lactose broth ..... 71 percent gas in the closed arm
Saccharose broth ..... 45 percent gas in the closed arm

Litmus milk—Small gas bubbles; coagulation; acid reaction.

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5, gave the following results:

Dextrose broth ..... 100 percent gas in the closed arm
Levulose broth ..... 35 percent gas in the closed arm
Lactose broth ..... 100 percent gas in the closed arm
Saccharose broth ..... 30 percent gas in the closed arm

Litmus milk—100 per cent gas in the closed arm; coagulation; acid reaction.

Spore material (0.50cc. Suspension No. 2, heated to 80° C., for 10 minutes), inoculated into a fermentation tube of sugar-blood broth and incubated 24 hours at 37° C., gave 100 percent gas in the closed arm, and odor of butyric acid. Similar inoculation into litmus milk gave 100 percent gas, a tough coagulum riddled with gas bubbles, and acid reaction. A fermentation tube of sugar-free broth, containing coagulated egg-white, inoculated in the same way, showed no digestion of the egg.

The sediments in the fermentation-tubes, stained by Gram's method, gave the following appearances microscopically:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria resemble *B. coli;* there are numerous Gram-positive diplococci.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Most numerous are rods of *B. coli* type; there are many small Gram-positive diplococci, some large Gram-positive rods of *B. welchii* type and some short slender Gram-positive rods.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Most numerous are Gram-negative rods of the *B. coli* type; there are many long slender Gram-negative rods of the *B. welchii* type and many small Gram-positive diplococci.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are many rods of the *B. coli* type and some large Gram-positive rods.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are of the *B. coli* type; there are also many Gram-positive diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): There are about equal numbers of Gram-negative rods of *B. coli* type and large Gram-positive rods of the *B. welchii* type; many Gram-positive diplococci are also present.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Sediment resembles that of the preceding dextrose broth in every particular.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are large Gram-positive rods; there are also many Gram-negative rods of the *B. coli* type and a few Gram-positive diplococci.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The sediment appears to be a pure culture of *B. coli.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): The sediment appears to be a pure culture of *B. coli.*

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, spores): The sediment appears to be a pure culture of *B. welchii.*"

Anaerobic plates on litmus glucose agar were inoculated with the sediments of the fermentation tubes and incubated five days at 37° C. The sediment of the dextrose-broth and levulose-broth fermentation tubes (inoculated with 0.25cc. Suspension No. 1) produced only colonies of diplococci and cocco-bacilli with pointed ends. The sediment of the lactose broth, in the same series, gave rise to colonies of *B. coli* as well as diplococci. The sediment of the saccharose broth of this series produced only colonies of the diplococci and cocco-bacilli with pointed ends. The sediment of the lactose broth (inoculated with 0.50cc. Suspension No. 5) produced colonies of *B. coli* in abundance and relatively less numerous colonies of the diplococci and cocco-bacilli.

Veillon tubes of tall glucose agar were inoculated with the sediments of the fermentation tubes of lactose broth of both series, four different dilutions being made from each. There was abundant gas production in all the tubes in which growth occurred. *B. bifidus* was not detected.

Sub-cultures derived from this stool were not preserved.

It will be noted that this stool was obtained from a very definite case of pellagra, several weeks after the attack had begun to subside. There has been no recurrence of the manifestations of the disease in this patient up to the present time, August, 1911.

Specimen No. 7. The patient, C. P., male, was an inmate of the Kankakee State Hospital. A very dark brown pigmentation on the backs of the hands and forearms was observed about the middle of July, and a tentative diagnosis of pellagra was made. The stool was passed at 7:30 a. m. August 4th and examined at once.

The stool was formed but soft, part of it flattened ribbon-like. The surface was mottled greenish and light brown. The odor was aromatic and penetrating, slightly putrefactive in character. Upon microscopic examination, the material appeared to be well digested. No amebae or flagellates were seen, nor were any unusual types of bacterial cells observed. The suspension for bacteriological study was made from the softer portion of the fecal cylinder and packed in ice at 8:30 a. m. The bacteriological study was begun at 1:30 p. m.

The direct microscopic count of bacterial cells in this stool was omitted. Differential count of 500 cells in a film of the mixed flora, stained by Gram's method gave the following results:

Gram-negative rods of *B. coli* type	70.6 percent
Other Gram-negative bacilli	11.2 percent
Gram-negative cocci	0.0 percent
Gram-negative spirochetes	0.2 percent
Thick Gram-positive rods	0.2 percent
Slender Gram-positive rods	0.8 percent
Oval Gram-positive bacteria	1.4 percent
Gram-positive cocci	15.4 percent
Oval free spores	0.2 percent
Total Gram-positive bacteria	17.8 percent
Total Gram-negative bacteria	82.0 percent
Total free spores	0.2 percent
Total Gram-negative rods	81.8 percent
Total micrococci	15.4 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 1,460,000 bacteria per milligram of feces. The colonies all resembled those of *B. coli* and a number of them examined microscopically were found to consist of rods of this type. On aerobic plates of blood-agar, incubated 24 hours at 37° C., 1,025,000 bacteria per milligram of

feces developed into colonies. The colonies all resembled those of *B. coli*. Several were examined microscopically, and in one colony the bacilli were exceptionally motile. A subculture of this was preserved for later study, Culture Strain No. 1. On aerobic plates of litmus lactose gelatin, incubated three days at 15° to 20° C., 1,470,000 bacteria developed into colonies. All were of the type of *B. coli*. On anaerobic plates of litmus glucose agar, incubated three days at 37° C., 1,250,000 bacteria per milligram of feces developed into colonies. Apparently all were of the type of *B. coli*. On anaerobic plates of blood-agar, incubated three days at 37° C., 1,050,000 bacteria per milligram of feces developed into colonies. Most of these were hemolytic and all examined consisted of rods morphologically similar to *B. coli*. Some of them were very actively motile, but subcultures in litmus milk in fermentation tubes gave about 15 percent of gas with coagulation and acid reaction. Veillon tube cultures in tall glucose agar were inoculated with 0.50cc. of Suspension No. 6, Suspension No. 7, and Suspension No. 8. After five days incubation at 37° C., all the tubes showed colonies and gas spaces. Several of the colonies were examined and found to consist of rods resembling *B. coli*. Nothing resembling *B. bifidus* was detected.

Aerobic plates on litmus agar, inoculated with spore material and incubated 24 hours at 37° C., brought to development eight spores per milligram of feces. All the colonies were alkaline in reaction. On anaerobic plates of blood-agar, incubated three days at 37° C., 17,000 spores per milligram of feces developed into colonies. Most of these were of the type of *B. welchii*. Some of the colonies were feathery in appearance and caused a greenish discoloration of the medium. These colonies were composed of large non-motile rods. A few colonies consisted of very slender, motile rods.

Fermentation-tube cultures, inoculated with 0.25cc. of Suspension No. 1, and incubated 48 hours at 37° C., gave the following results:

Dextrose broth ..... 45 percent gas in the closed arm
Levulose broth ..... 42.5 percent gas in the closed arm
Lactose broth ..... 64 percent gas in the closed arm
Saccharose broth ..... 78 percent gas in the closed arm
Litmus milk—5 percent gas in the closed arm; coagulation; acid reaction

A similar series of fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5, equivalent to 0.0005mg. of feces, and incubated 48 hours at 37° C., gave the following results:

Dextrose broth ..... 100 percent gas in the closed arm
Levulose broth ..... 40 percent gas in the closed arm
Lactose broth ..... 55 percent gas in the closed arm
Saccharose broth ..... 100 percent gas in the closed arm
Litmus milk—20 percent gas in the closed arm; coagulation; acid reaction

Fermentation-tubes of sugar-blood broth and of litmus milk, inoculated with 0.50cc. Suspension No. 2, Spores, gave rise to 100 percent gas in the closed arm together with other changes characteristic of the growth of *B. welchii*. In a fermentation tube of sugar-free broth, containing coagulated egg-white, incubated in the same way, there was only slight growth, no production of gas and no digestion of the albumen.

The sediments in the fermentation-tubes were stained by Gram's method and the results of microscopic study recorded as follows:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Many long slender Gram-negative rods; many large plump Gram-positive rods; smaller number of short, thick, Gram-negative rods resembling *B. coli*.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The sediment is the same as in the dextrose broth, above, with the addition of some Gram-positive diplococci.

Lactose broth (inoculated with 0.25cc. Suspension No. 1): The sediment is the same as that of the levulose broth, above.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are short, thick, Gram-negative rods, resembling *B. coli;*

there are numerous short and moderately thick Gram-positive rods, some Gram-positive diplococci, and some large Gram-positive rods resembling *B. welchii.*

Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are short Gram-negative rods resembling *B. coli;* there are also short, rather slender, Gram-positive rods and small Gram-positive diplococci.

Dextrose broth (inoculated with 0.50 cc. Suspension No. 5): Many large plump Gram-positive rods resembling *B. welchii;* short plump Gram-negative rods resembling *B. coli;* Gram-positive diplococci.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): The sediment appears the same as that of the dextrose broth of this series.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Many short thick Gram-negative rods resembling *B. coli;* many long slender, Gram-negative rods; large Gram-positive rods resembling *B. welchli;* a few Gram-positive diplococci.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are short, thick, Gram-negative rods resembling *B. coli;* there are some large Gram-positive rods resembling *B. welchii,* and a few Gram-positive diplococci.

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): The sediment appears to be a pure culture of *B. coli.*"

The sediments of the sugar-blood-broth and litmus-milk tubes, inoculated with spore material, both appeared to be pure cultures of *B. welchii.* The sediment of the culture in sugar-free broth containing coagulated egg-white, inoculated with spore material, showed only short slender Gram-positive rods.

Anaerobic plates on litmus glucose agar, were inoculated with the fermentation-tube sediments and incubated three days at 37° C. The plates from the dextrose, levulose, lactose and saccharose broth, inoculated with 0.25cc. Suspension No. 1, all gave the same result, namely, colonies of large diplococci with pointed ends. Similar plates from the dextrose, levulose, lactose, and saccharose broth, inoculated with 0.50cc. Suspension No. 5, gave rise to colonies of *B. coli* as well as the diplococci, there being practically no distinction in appearance of the sediments between the four tubes of this series. Veillon-tube cultures from the lactose-broth sediment (first series, inoculated with 0.25cc. Suspension No. 1) produced only colonies of diplococci without any gas.

One culture strain, derived from this stool, was preserved for further study. It was derived from a colony on the aerobic blood-agar plates, resembling *B. coli* but showing very active motion. This has been designated as Strain No. 1.

It will be noted that the diagnosis of pellagra was only tentative in this case, and the subsequent history of the case rendered the diagnosis even more doubtful. The pigmentation faded somewhat, but a rather dark brown color remained fairly permanent, and there was no desquamation. No other manifestation of pellagra has been observed in this case up to the present time, August, 1911.

Specimen No. 8. This specimen was obtained from the same case as Specimen No. 5, the provisional diagnosis of pellagra being very probably incorrect. The stool was passed on August 4 at 8 a. m. and was examined at 8:45 a. m.

It was a large formed stool, dark brown in color. Some fine strands of mucus were visible on the surface, and rather large pieces of beans were seen embedded in the fecal substance. The odor was strong, but normal in character. Microscopic examination revealed a little undigested starch, but the material seemed, on the whole, well digested. Granulose bacteria were not found. There were no amebae or flagellates seen. Many free oval bacterial spores were present. The suspension for bacteriological study was made and packed in ice at 9 a. m. The bacteriological study was begun at 1:30 p. m. on the same day.

The microscopic count of the number of bacteria in this stool was not made. A differential count of 500 bacterial cells gave the following results:

Gram-negative rods of *B. coli* type	46.2 percent
Other Gram-negative rods	35.6 percent
Gram-negative cocci	1.2 percent
Thick Gram-positive rods	0.2 percent
Slender Gram-positive rods	1.6 percent
Oval Gram-positive bacteria	0.2 percent
Gram-positive cocci	11.4 percent
Oval free spores	3.6 percent
Total Gram-positive bacteria	13.4 percent
Total Gram-negative bacteria	83.0 percent
Total free spores	3.6 percent
Total Gram-negative rods	81.8 percent
Total micrococci	12.6 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 54,000 bacteria per milligram of feces. Nearly all of these colonies resembled colonies of *B. coli* macroscopically, but the bacilli in them were non-motile and apparently encapsulated. The growth was slimy and readily drawn out into threads by the platinum wire. In a fermentation-tube of litmus milk, incubated 24 hours at 37° C., this organism produced 30 percent of gas in the closed arm, with acid reaction and coagulation. A few of the colonies on the plates were made up of diplococci with pointed ends. On aerobic plates of blood-agar, incubated 24 hours at 37° C., 1,275,000 bacteria per milligram of feces developed into colonies. Most of the colonies were composed of small diplococci. Some of the colonies consisted of non-motile bacilli, similar to those observed on the lactose-agar plates. A few colonies were made up of slender motile rods with elongated spores. On aerobic plates of litmus lactose gelatin, incubated three days at 15-18° C., 102,187 bacteria per milligram of feces developed into colonies. The colonies were all acid in reaction and did not liquify the gelatin. On anaerobic plates of litmus glucose agar, incubated three days at 37° C., 164,000 bacteria per milligram of feces developed into colonies. Most of these colonies were composed of bacilli similar to those predominating on the lactose-agar plates. There were also numerous colonies of diplococci with pointed ends and some colonies composed of slender, non-motile rods. On anaerobic plates of blood-agar, incubated three days at 37° C., 1,100,000 bacteria developed into colonies. Most of these were colonies of diplococci. Others were composed of bacilli, similar to those predominant upon the lactose-agar plates. Veillon tubes of deep glucose agar inoculated with 0.50cc. Suspension No. 6 and Suspension No. 7, and incubated six days at 37° C., were riddled with gas. The tube inoculated with Suspension No. 8, showed no growth.

Aerobic litmus agar plates, inoculated with spore material (0.25 and 0.50cc. Suspension No. 2, Spores) and incubated 24 hours at 37° C., remained sterile. Anaerobic blood-agar, incubated three days at 37° C., brought to development 28,000 spores per milligram of feces. All the colonies resembled those of *B. welchii*. Anaerobic plates on litmus glucose agar, incubated three days at 37° C., brought to development 2,020 spores per milligram of feces. Only a minority of these colonies resembled those of *B. welchii*. Most of them were made up of slender non-motile rods. Sub-cultures of these latter, in fermentation-tubes of litmus milk and of lactose broth, on inclined glucose agar, and in deep glucose agar (stab-culture), all failed to grow.

Fermentation-tube cultures, inoculated with 0.25cc. of Suspension No. 1 and incubated 48 hours at 37° C., gave the following results:

Dextrose broth	5	percent gas in the closed arm
Levulose broth	5	percent gas in the closed arm
Lactose broth	11	percent gas in the closed arm
Saccharose broth	2.5	percent gas in the closed arm

Litmus milk—25 percent gas in the closed arm; acid reaction; coagulation.

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5, and incubated 48 hours at 37° C., gave the following results:

Dextrose broth .....Small bubble of gas in the closed arm
Levulose broth .....Small bubble of gas in the closed arm
Lactose broth ..... 12 percent gas in the closed arm
Saccharose broth ..... 2.5 percent gas in the closed arm
Litmus milk—5 percent gas in the closed arm; acid reaction; coagulation.

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 48 hours at 37° C., gave the following results:

Sugar-blood broth—100 percent gas in the closed arm; odor of butyric acid.
Litmus milk—100 percent gas in closed arm; coagulation; acid reaction.
Sugar-free broth, containing coagulated egg-white—2.5 percent gas in closed arm; good growth; no digestion of albumen.

The sediments of the fermentation-tube cultures were stained by Gram's method and examined microscopically with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are also short Gram-negative rods resembling *B. coli*, large Gram-positive rods resembling *B. welchii* and short slender Gram-negative rods.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Most numerous forms are Gram-positive diplococci; many Gram-negative rods, resembling *B. coli;* many large Gram-positive rods.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are also many Gram-negative rods resembling *B. coli* and some large Gram-positive rods of the type of *B. welchii.*

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are short Gram-negative rods of the *B. coli* type; numerous Gram-positive diplococci.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are of the *B. coli* type; numerous Gram-positive diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): This appears to be a pure culture of Gram-positive diplococci.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Same as the dextrose broth.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; many large Gram-positive rods resembling *B. welchii;* some short Gram-negative rods of the *B. coli* type.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; many short Gram-negative rods resembling *B. coli.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): This appears to be a pure culture of Gram-negative rods, resembling *B. coli.*

."Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): This appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): This appears to be a pure culture of *B. welchii.*

"Sugar-free broth, containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Majority of the bacteria are short, rather thick rods, many of them bearing an oval median spore; some slender Gram-positive rods with terminal spores with enlargement (drumsticks); some large Gram-positive rods without spores (*B. welchii.*)"

Plate cultures on anaerobic litmus glucose agar, inoculated with the sediments of the fermentation-tube cultures and incubated three days at 37° C., gave the following results:

"Dextrcse broth (inoculated with 0.25cc. Suspension No. 1): Colonies are all strongly acid and there are no gas bubbles. They are made up of bacilli. Subculture from one of these, in a fermentation tube of lactose broth shows it to be a colony of *B. welchii.* Other colonies are composed of smaller non-motile rods and some of the bacterial cells are irregular in shape.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid without gas bubbles. They consist of diplococci.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are the same as those on the plates from the dextrose broth, above."

The plate cultures from the series of fermentation tubes, inoculated with 0.50cc. Suspension No. 5, all failed to show any growth.

Veillon-tube cultures in deep glucose agar, inoculated with the sediment of the lactose-broth fermentation tube of the first series (0.25cc. Suspension No. 1) brought to development lenticular colonies without production of gas. These colonies were composed of bacilli about as wide as *B. coli*, of various lengths and non-motile. Subculture proved them to be faculative anaerobes, growing in short threads. *Bacillus bifidus* was not detected.

A subculture of a colony of the bacilli dominant on the aerobic lactose-agar plates, was preserved for further study and designated as Strain No. 2.

Specimen No. 9. The patient, J. B., was the same man from which Specimen No. 6 was obtained. This stool was passed at 6 a. m. August 15th, and was packed in ice. It was examined at 8 a. m. The patient had recovered from his attack of pellagra, and only a small amount of pigmented epithelium remained on the forearms.

The stool was formed, a large cylinder, dark brown and firm on one side, softer and lighter brown in color on the other side. The last end was soft and ribbon-like. Some small flakes of mucus were visible on the lower end of the cylinder. The odor was strong, somewhat putrefactive. No macroscopic food remnants were seen. Microscopic examination showed many leukocytes and epithelial cells in the mucus, but not protozoa. Some motile spirilla were seen. The food material was well digested. The suspension for bacteriological study was made from the ribbon-like softer portion of the stool, and it was packed in ice at 9 a. m. The bacteriological study was begun the next morning, August 16, at 8 a. m.

By direct microscopic count, the number of bacterial cells was estimated at 184,000,000 per milligram of feces. In the hanging drop, numerous bits of epithelial tissue, one spirillum and a few bacterial spores were observed. None of the bacteria were motile, possibly because of the delay after preparation of the suspension and the low temperature at which it was kept. Otherwise nothing unusual was observed. The differential count of 500 bacterial cells in the Gram-stained film gave the following results:

Gram-negative rods of *B. coli* type	47.5 percent
Other Gram-negative rods	14.0 percent
Gram-negative cocci	6.0 percent
Gram-negative spirochetes	0.5 percent
Gram-negative spirilla	0.5 percent
Thick Gram-positive rods	3.0 percent
Slender Gram-positive rods	0.5 percent
Oval Gram-positive bacteria	0.5 percent
Gram-positive cocci	27.5 percent
Free spores	0.0 percent
Total Gram-positive bacteria	31.5 percent
Total Gram-negative bacteria	68.5 percent
Total free spores	0.0 percent
Total Gram-negative rods	61.5 percent
Total micrococci	33.5 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 580,000 bacteria per milligram of feces. The colonies all resembled those of *B. coli*. On aerobic litmus lactose gelatin, incubated four days at 15° to 18° C., 424,000 bacteria per milligram of feces developed into colonies. These were all acid in reaction and resembled colonies of *B. coli*. On aerobic blood-agar, incubated 24 hours at 37° C., 1,000,000 bacteria per milligram of feces developed into colonies. Most of the colonies examined were composed of rods resembling *B. coli*. Other colonies were made up of long thick, non-motile rods, and still others of short, slender, actively motile rods. A subculture from a colony of this

last type, was preserved for further study, and designated as Strain No. 3. On anaerobic plates of litmus glucose agar, incubated three days at 37° C., 470,000 bacteria per milligram of feces developed into colonies. These colonies resembled those of *B. coli*. On anaerobic plates of blood-agar, 462,000 bacteria per milligram of feces were brought to development. These colonies were not studied microscopically. Veillon-tube cultures in deep glucose agar, were inoculated with 0.50cc. Suspension No. 5, No. 6, No. 7 and No. 8 and incubated four days at 37° C. The first two tubes of the series were riddled with gas. The third contained gas bubbles and also several lenticular colonies without gas production. Several of these latter were found to consist of diplococci. The fourth tube showed no growth.

Aerobic plates of plain agar, inoculated with spore material and incubated 24 hours at 37° C., brought to development only 1 spore per milligram of feces. Anaerobic plates of blood-agar, inoculated with spore material and incubated at 37° C. for 48 hours, developed colonies too numerous to count, representing between 20,000 and 200,000 spores per milligram of feces. The nature of these colonies was not recorded. On anaerobic plates of glucose agar, incubated 48 hours at 37° C., 15 spores per milligram of feces developed into colonies.

Fermentation-tube cultures inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 10 percent of gas in the closed arm
Levulose broth.....Small bubble of gas in the closed arm
Lactose broth ..... 20 percent of gas in the closed arm
Saccharose broth ..... 20 percent of gas in the closed arm
Litmus milk—2.5 percent of gas in the closed arm; acid reaction; coagulation.

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5, and incubated 24 hours at 37° C., gave the following results:

Dextrose broth .....Small bubble of gas in the closed arm
Levulose broth .....No gas
Lactose broth ..... 5 percent of gas in the closed arm
Saccharose broth ..... 100 percent of gas in the closed arm
Litmus milk—Small bubble of gas in the closed arm; acid reaction; coagulation.

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth—100 percent of gas in the closed arm; odor of butyric acid.
Litmus milk—100 percent of gas in the closed arm; acid reaction; coagulation.
Sugar-free broth containing coagulated egg-white—No gas; growth in both arms; no digestion of the albumen.

The sediments of the fermentation-tube cultures, stained by Gram's method and examined microscopically gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Most numerous are Gram-positive diplococci; many short Gram-negative rods resembling *B. coli;* some long, slender Gram-positive rods.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears the same as in the dextrose broth above.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Most numerous are Gram-positive diplococci; many Gram-negative rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears to be the same as in the lactose broth above.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): There are about equal numbers of Gram-positive diplococci and Gram-negative rods resembling *B. coli.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Great majority of the bacteria are Gram-positive diplococci; some Gram-negative rods resembling *B. coli.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Great majority of the bacteria are Gram-positive diplococci; there are a few large Gram-positive rods resembling *B. welchii.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The sediment consists entirely of Gram-negative rods of the *B. coli* type.

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): The sediment consists entirely of Gram-negative rods of the *B. coli* type.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment consist entirely of large Gram-positive rods of the *B. welchii* type.

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): This appears to be a pure culture of *B. welchii.*

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Apparently a pure culture of *B. welchii.*"

Plate cultures on anaerobic litmus agar, inoculated with the sediments of the fermentation-tube cultures and incubated two days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Colonies are all strongly acid without gas bubbles. All examined were found to be composed of large diplococci.

"Levulose broth, lactose broth and saccharose broth of this series gave the same result as the dextrose broth.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Colonies are of two kinds, some deeply acid without gas bubbles and some less strongly acid in reaction with adjacent gas spaces in the agar. The first-mentioned colonies are composed of diplococci and the latter of rods resembling *B. coli.*

"Levulose broth, lactose broth and saccharose broth of this series show the same result as the dextrose broth."

Veillon-tube cultures in deep glucose agar, inoculated with the sediment of the lactose-broth fermentation-tube (inoculated with 0.25cc. Suspension No. 1), showed a rich growth of colonies with very little gas in the lowest dilution, good growth without gas in the second tube, and no growth in the third dilution. A number of colonies were examined microscopically and all these proved to be colonies of diplococci.

Two strains of bacteria derived from this stool were stored away for further study. One of these was taken from a colony of the short slender actively motile bacilli on the aerobic blood-agar plates, and was designated as Strain No. 3. The other was taken from a colony of the long non-motile bacilli on the same plates. This latter was designated as Strain No. 4.

It will have been noted that all the preceding specimens were obtained from patients who had been recovering from an acute attack of pellagra for some weeks, or in whom the diagnosis of pellagra was doubtful. In order to obtain material from cases in the active stage of the disease it became necessary to resort to other hospitals, as none of the cases at the Kankakee State Hospital were showing acute manifestations of pellagra at this time.

Specimen No. 10. The patient, C. H., female, was an inmate of the Peoria State Hospital, where she had been admitted in May, 1910. On August 20, 1910, blebs formed on the backs of both hands, and ulcers formed later. On October 12th, the ulcers had healed, but the patient was still confined to bed and very weak. It seemed probable that the case would terminate fatally. It was stated that she had no diarrhoea at that time, October 12th. The stool was passed at 9:45 a. m. on October 12th, and examined at 10 a. m.

It was a grayish fluid stool, of watery consistency, with pieces of vegetables in it, among which bean and tomato remnants were recognized macroscopically. The odor was mild but somewhat nauseating, putrefactive in type, suggesting putrefying epithelium. Microscopic examination revealed many unbroken vegetable cells, some containing starch. No protozoa were detected. The fluid was practically a purée of bacteria, rods and cocci, none showing very active movement. No spirilla were seen. The suspension for

bacteriological study was made from the fluid material and was packed in ice at 10:40 a. m. The bacteriological study was begun the next morning October 13th, at 9:30 a. m.

By the direct microscopic counting method, 21,500,000 bacterial cells per milligram of feces were found. Examination of the hanging-drop preparation revealed no unusual forms, only bacilli of the type of *B. coli* and diplococci being observed. Differential count of 500 bacterial cells in a Gram-stained film of the mixed fecal flora gave the following results:

Gram-negative rods of *B. coli* type	47.8 percent
Other Gram-negative rods	3.2 percent
Gram-negative diplococci	3.2 percent
Short, thick Gram-positive rods	4.6 percent
Short, slender Gram-positive rods	5.8 percent
Oval Gram-positive bacteria	0.8 percent
Gram-positive cocci	34.6 percent
Free spores	0.0 percent
Total Gram-positive bacteria	45.8 percent
Total Gram-negative bacteria	54.2 percent
Total free spores	0.0 percent
Total Gram-negative rods	51.0 percent
Total micrococci	37.8 percent

Plate cultures on aerobic litmus lactose agar brought to development 1,140 bacteria per milligram of feces. None of these colonies appeared to be of the *B. coli* type. Some were alkaline in reaction. Others were acid and composed of rods resembling *B. coli*, except that they were more actively motile, and the colonies themselves were of slower growth than those of *B. coli*. Other colonies on the plates were composed of diplococci. On aerobic blood-agar 1,200 bacteria per milligram of feces developed into colonies. Three colonies were examined microscopically. One of them consisted of large motile rods, bearing oval spores and growing in threads. Another was composed of actively motile rods, resembling *B. coli* in size and shape. The other was made up of diplococci. The plates of litmus lactose gelatin became overgrown with molds, probably to be regarded as contaminations. The bacterial colonies were, at any rate, not numerous on these plates. On anaerobic litmus glucose agar, incubated four days at 37° C., 460 bacteria per milligram of feces developed into colonies. Six colonies were examined microscopically and found to consist of large diplococci. On anaerobic blood-agar, incubated four days at 37° C., 5,500 bacteria per milligram of feces developed into colonies. All these colonies were surrounded by zones of hemolysis and some of them were tinged with green. These latter colonies were made up of diplococci. Most of the colonies surrounded by clear hemolytic zones were composed of rods of the type of *B. welchii*. A few colonies were composed of rods resembling *B. coli* in shape and size. Veillon-tube cultures were inoculated with 0.50cc. Suspension No. 5, Suspension No. 6 and Suspension No. 7, and incubated four days at 37° C. Five colonies developed in the first, two in the second and none in the third. There was no evident gas production in any of the tubes. All the colonies consisted of diplococci or cocco-bacilli with pointed ends. *B. bifidus* was not detected.

Spore material, plated on aerobic litmus lactose agar and incubated 48 hours at 37° C., showed three spores per milligram of feces capable of developing into colonies. These were alkaline in reaction and composed of plump actively motile rods. On anaerobic glucose agar, incubated four days at 37° C., no colonies developed. These plates were inoculated with 0.25cc. and 0.50cc. of Suspension No. 2, Spores. On anaerobic blood-agar, incubated four days at 37° C., 468 spores per milligram of feces developed into colonies. Nearly all these colonies were surrounded by clear areas of hemolysis and upon microscopic examination several of them were found to consist of large rods of the *B. welchii* type. A few thin spreading colonies were composed of rods of the *B. edematis* type, some of them bearing spores. A number of sub-cultures were inoculated from these colonies and all proved to be obligate anaerobes.

Fermentation-tube cultures inoculated with 0.25cc. Suspension No. 1, and incubated 24 hours at 37° C., gave the following results:

Dextrose broth .....No gas; good growth
Levulose broth .....No gas; good growth
Lactose broth ..... 0.5 percent gas in the closed arm
Saccharose broth ..... 0.5 percent gas in the closed arm
Litmus milk.. 0.5 percent gas in the closed arm; acid reaction; coagulation

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth .....No gas; good growth
Levulose broth .....No gas; good growth
Lactose broth .....No growth
Saccharose broth ..... 100 percent gas in the closed arm
Litmus milk—No gas; no coagulation; alkaline; slight growth; slight reduction of litmus.

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth .....100 percent gas in the closed arm
Litmus milk—100 percent gas in the closed arm; odor of butyric acid; coagulation; acid reaction.

The fermentation-tube cultures, stained by Gram's method, were examined microscopically with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears to be a pure culture of a Gram-positive diplococcus.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Nearly all the bacteria are Gram-positive diplococci; there are a few Gram-positive rods resembling *B. welchii* and a few Gram-negative rods resembling *B. coli.*

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears the same as in the levulose broth above.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Same as in levulose broth above.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive cocci and diplococci; there are a few Gram-negative rods resembling *B. coli.*

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive cocci and diplococci; there are a few Gram-negative rods resembling *B. coli* and a few Gram-positive rods resembling *B. welchii.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Nearly all the bacteria are Gram-positive diplococci; there are a very few Gram-positive rods resembling *B. welchii.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): No growth.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Sediment appears to be a pure culture of Gram-positive diplococci.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): Apparently a pure culture of *B. welchii.*"

Plate cultures on anaerobic litmus glucose agar, inoculated with the sediments of the fermentation-tube cultures and incubated four days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid and ten of them examined microscopically consist of diplococci with pointed ends.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid. Of the five colonies, examined microscopically, one is composed of large diplococci with pointed ends; the other four are made up of smaller diplococci more spherical in outline.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): No growth.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid. Five of them, examined microscopically, are composed of diplococci with pointed ends.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all strongly acid, and five of them, examined microscopically, are made up of large diplococci with pointed ends.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Only one colony, which is strongly acid and composed of diplococci with pointed ends.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): No growth.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): No growth."

A number of bacterial strains, isolated from this stool, were preserved for further study. One derived from an acid colony, consisting of plump motile rods, on the aerobic plates of litmus lactose agar, was designated as Strain No. 5. Strain No. 6 was derived from a greenish hemolytic colony on the surface of the aerobic blood-agar plates, which was composed of large plump motile rods, growing in threads and bearing oval spores. Strain No. 7 was derived from a hemolytic surface colony on the anaerobic blood-agar plates, resembling *B. welchii* in the characters observed. Strain No. 8 was derived from a colony on the aerobic blood-agar plates, consisting of actively motile rods about the size of *B. coli*. Strain No. 9 was taken from a deep hemolytic colony on one of the anaerobic blood-agar plates inoculated with spore material. The bacilli in this colony were of the *B. welchii* type. Strain No. 10 was taken from the same plates, from a colony made up of rods of the *B. edematis* type. Strain No. 11 was taken from the aerobic blood-agar plates inoculated with the unheated fecal bacteria. The colony was composed of large motile bacilli, growing in threads and bearing oval spores, and it was surrounded by a zone of hemolysis with greenish tinge.

It will be noted that this specimen was obtained from a patient suffering from a very severe attack of pellagra which had begun nearly two months before. At the time when the specimen was obtained, the skin lesions were practically healed. The extreme weakness still persisted. Subsequently, the patient died without rallying from the attack.

Specimen No. 11. The patient, W. N., female, was an inmate of the Peoria State Hospital. On September 27 this case was seen by Dr. Singer and Dr. MacNeal and it was noted that she was then in the subsiding stage of an acute attack of pellagra. On October 12, the eruption on the hands was bright red and suggested a moderately severe acute exacerbation. The stool was passed at 3:45 p. m. and was examined at 5:05.

It was a fluid stool of thin watery consistency and brown in color. Undigested bits of cereals were rather numerous. The odor was very strong, putrefactive in character, but did not resemble that of the previous stool (Specimen No. 10). Microscopic examination failed to reveal protozoa. The suspension for bacteriological study was prepared from the fluid stool and was packed in ice at 5:15 p. m. The bacteriological study was begun the next morning, October 13, at 9:30 a. m.

By the direct microscopic counting method, 24,120,000 bacterial cells per milligram of feces were found. The hanging-drop preparation showed nothing unusual. Large rods resembling *B. welchii*, smaller ones of the *B. coli* type, diplococci, and a few spores were observed. The differential count of 500 bacterial cells in the Gram-stained film gave the following results:

Gram-negative rods of the *B. coli* type	59.8 percent
Other Gram-negative rods	11.8 percent
Gram-negative diplococci	0.4 percent
Thick Gram-positive rods	2.6 percent
Slender Gram-positive rods	3.6 percent
Oval Gram-positive bacteria	1.4 percent
Gram-positive cocci	20.4 percent
Free spores	0.0 percent
Total Gram-positive bacteria	28.0 percent
Total Gram-negative bacteria	72.0 percent

Total free spores ..... 0.0 percent
Total Gram-negative rods ..... 70.6 percent
Total micrococci ..... 20.8 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 1,260,000 bacteria per milligram of feces. The colonies were all acid and resembled those of *B. coli*. Ten colonies were studied microscopically. Six of these were composed of non-motile rods, apparently slightly larger than *B. coli*. A subculture from one of these colonies was preserved as Strain No. 13. The other four colonies examined consisted of rods of the *B. coli* type. On aerobic blood-agar, incubated 24 hours at 37° C., 1,580,000 bacteria per milligram of feces developed into colonies. Most of these were surrounded by zones of hemolysis. Ten of these colonies were studied microscopically. They were all made up of rods of the type of *B. coli*, except that in some of the colonies the bacteria were unusually motile. A subculture from one of the latter colonies was preserved as Strain No. 14. On aerobic litmus lactose gelatin, incubated four days at 15° to 20° C., 2,270,000 bacteria per milligram of feces developed into colonies. All the colonies resembled those of *B. coli*. On anaerobic litmus glucose agar, incubated four days at 37° C., 1,840,000 bacteria per milligram of feces developed into colonies. The colonies all resembled colonies of *B. coli*. On anaerobic blood-agar, incubated four days at 37° C., 2,740,000 bacteria per milligram of feces developed into colonies. The majority of these were hemolytic and these, as well as the colonies without hemolysis, were made up of rods morphologically resembling *B. coli*. A subculture of one of the hemolytic surface colonies was preserved as Strain No. 16, and another from a hemolytic deep colony, composed of actively motile rods, was preserved as Strain No. 17. Veillon-tube cultures inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6, and 0.50cc. Suspension No. 7, and incubated four days at 37° C., were all riddled with gas and full of colonies.

Aerobic litmus-agar plates, inoculated with 0.50cc. and 0.25cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., failed to show any colonies. On anaerobic plates of blood-agar, incubated four days at 37° C., 8,640 spores per milligram of feces developed into colonies. All appeared to be colonies of *B. welchii* and several of them examined microscopically were found to consist of bacilli of the *B. welchii* type. On anaerobic plates of glucose agar, 24 spores per milligram of feces developed into colonies. Most of these colonies were composed of large rods of the *B. welchii* type but some consisted of long slender non-motile rods.

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 10 percent gas in the closed arm
Levulose broth ..... 10 percent gas in the closed arm
Lactose broth ..... 10 percent gas in the closed arm
Saccharose broth ..... 10 percent gas in the closed arm
Litmus milk.....Small gas bubble; acid reaction; coagulation

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 10 percent gas in the closed arm
Levulose broth ..... 5 percent gas in the closed arm
Lactose broth ..... 15 percent gas in the closed arm
Saccharose broth ..... 10 percent gas in the closed arm
Litmus milk ..... No gas; coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth ...100 per cent gas in the closed arm; odor of butyric acid
Litmus milk..100 percent gas in the closed arm; coagulation; acid reaction

The fermentation-tube sediments, stained by Gram's method, were examined microscopically with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are also rods resembling *B. coli.*

"*Levulose broth* (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci, there are also Gram-negative rods resembling *B. coli* and a few Gram-positive rods resembling *B. bifidus.*

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are also Gram-negative rods resembling *B. coli* and large Gram-positive rods resembling *B. welchii.*

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears the same as in the lactose broth.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria resemble *B. coli;* there are also some small Gram-positive diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; there are also Gram-negative rods resembling *B. coli* and some Gram-positive yeast cells.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): There are numerous Gram-positive diplococci and numerous Gram-negative rods resembling *B. coli;* also some Gram-negative diplococci and some large Gram-positive rods resembling *B. welchii.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; there are also many Gram-negative rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria resemble *B. coli;* there are also some small Gram-positive diplococci.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii.*"

Plate cultures on anaerobic litmus glucose agar, inoculated with the fermentation-tube sediment and incubated three days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Only one colony developed. This is acid in reaction and surrounded by a large gas bubble. It is composed of large rods of the *B. welchii* type.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): No growth on plate.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Only two colonies developed. These are strongly acid and composed of diplococci.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Only one acid colony developed. This is composed of large non-motile rods.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are several gas bubbles in the agar. Nine of ten colonies examined microscopically are composed of rods resembling *B. welchii.* The other one consists of rods of the *B. coli* type.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Colonies are very numerous and all of the same type, acid in reaction. All the colonies examined are composed of diplococci with pointed ends.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are some gas bubbles in the agar. Six of these, studied miscroscopically, are composed of rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and the agar is free fro· gas bubbles. All colonies examined are composed of diplococci."

Bacterial Strains No. 12, No. 13, No. 14, No. 15, No. 16, No. 17, and No. 18, derived from this sample of feces, were preserved for further study. Strain No. 12 was a bacillus taken from the plate culture inoculated with sediment of the saccharose-broth fermentation tube (inoculated with 0.25cc.

Suspension No. 1): Strains No. 13 and No. 18 were bacilli slightly larger than *B. coli*, taken from two colonies on the aerobic plates of litmus lactose agar, inoculated with the mixed fecal flora. Strain No. 14 was taken from a thin spreading colony on the aerobic blood-agar plates inoculated with the mixed fecal flora. Strain No. 15 was a long non-motile anaerobic bacterium taken from the anaerobic glucose-agar plates of the spore material. Strains No. 16 and No. 17 were taken from the anaerobic blood-agar plates of the mixed fecal flora. Both resembled *B. coli* morphologically.

The case from which this specimen was obtained was observed at intervals subsequently, and further specimens of feces were examined on October 19, October 26, November 3, November 14 and January 15. The recurrence of the erythema suggested by the examination of the patient on October 12 appeared more clearly evident on October 19. On this day the old dark brown pigmented epithelium was present above the middle of the forearms, but had peeled off completely over the backs of the hands and lower part of the forearms. Over the backs of the hands and wrists the skin was red. On the right temple there was a desquamating erythematous patch and a dark brown pigmentation at the corresponding place on the left side of the head. On October 26 the eruption was about the same, but desquamation and pigmentation was again noted on the hands, and a pigmented desquamating band extended across the forehead a little below the hair line and approximately parallel to it. One week later, November 3, there was noted erythema and desquamating pigmented epidermis on the backs of the hands, pigmentation and desquamation on the temples, and a deeply pigmented border of epidermis extending across the forehead below a narrow band from which the epidermis had peeled off. The patient appeared somewhat disturbed mentally, mumbling and talking incoherently during the examination. Although this latter behavior had not been observed at any previous visit it probably had no connection with the state of the pellagrous eruption, as, according to the observation of the nurse in charge, it was in no way unusual for this patient. On November 14 the condition was about the same; the complete desquamation had extended well up onto the forearms, and down over the forehead almost to the level of the eyebrows. The mental disturbance was again noted. On November 30 the condition was evidently clearing up rapidly; the pigmented epidermis had peeled off except for a very little, high on the forearms, on the back of the neck, and low on the forehead. The skin over the backs of the hands was somewhat red and very thin. Although orders were given for a stool from this patient on this day, it was not obtained, suggesting that defecation had become less frequent than before; as previously a sample of feces had been obtained from this case whenever it was wanted. On December 14 the following notes were made concerning this case: "Hands are clean with thin skin—high above wrists there is pigmented desquamating epidermis, also a small area of desquamating epidermis on the back of the neck. Patient appears to be well on the road to recovery. Again failed to obtain a stool; evidently diarrhoea is absent." At the next visit, January 15, 1911, the eruption had entirely disappeared. On February 15 the following notes were made: "Back of hands are red all over, skin atrophic. There is no definite evidence of pellagra. The nurse stated that the patient has had diarrhoea for the last six or eight weeks. There was an epidemic of diarrhoea in the whole ward (Cottage 3A) in the preceding week." On March 28 practically all signs of pellagra were absent, although a little pigmentation could still be detected high on the forearms. She appeared in better flesh than before. Diarrhoea was present. There have been no definite manifestations of a return of the disease up to the present time, August, 1911. The patient was visited on July 13 and August 1.

This case is of special interest because it was the first case from which specimens of feces were obtained while the skin eruption was still progressing, and also because of the number of such examinations which it was possible to carry out on the one individual during the progress of the eruption and afterward.

Specimen No. 12. This was obtained from the same case, W. N., on October 19, while the recurrence of the skin eruption was still in progress. It was passed at 9:30 a. m. and was examined at once. The stool was of gelatinous consistency, greenish yellow to brown in color. The odor was very strong and putrefactive in character. The material was chiefly mucus with food fragments and bits of formed feces embedded in it. Large pieces of potato and a piece of a bean were recognized. Microscopic examination revealed very numerous flagellates, some active spirilla, many large stiff progressively motile bacilli, sometimes in pairs, and many leucocytes. There were also some bits of striated muscle cells. Amebae were not found. The suspension for bacteriological study was prepared by mixing 0.5 gram of the mucus with sterile salt solution and diluting to 50cc. This was packed in ice at 9:55 a. m. The bacteriological study was begun at 10:00 a. m. on the next day, October 20.

By the direct microscopic counting method, 119,000,000 bacteria per milligram of feces were found. In the hanging-drop preservation, forms resembling *B. bifidus*, *B. welchii*, *B. coli*, diplococci and spirochetes were seen. Spirilla and free spores were not observed. A differential count of 500 bacterial cells in the Gram-stained film gave the following results:

Gram-negative rods of *B. coli* type	36.0 percent
Slender Gram-negative rods	9.0 percent
Gram-negative cocci	0.4 percent
Gram-negative spirochetes	2.2 percent
Thick Gram-positive rods	1.8 percent
Slender Gram-positive rods	1.6 percent
Gram-positive cocci	48.4 percent
Oval free spores	0.6 percent
Total Gram-positive bacteria	51.8 percent
Total Gram-negative bacteria	47.6 percent
Total free spores	0.6 percent
Total Gram-negative rods	45.0 percent
Total micrococci	48.8 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 1,100,000 bacteria per milligram of feces. The colonies were all acid in reaction and resembled colonies of *B. coli*. Ten of them were examined microscopically and found to consist of rods of the *B. coli* type. On aerobic blood-agar plates, incubated 24 hours at 37° C., 5,800,000 bacteria per milligram of feces developed into colonies. Many of the colonies were hemolytic and resembled colonies of *B. coli*. Other colonies were fairly numerous, and a microscopic study of the colonies revealed at least five different kinds. A wrinkled surface colony, composed of very slender motile rods, was transplanted and the cultures preserved as Strain No. 20. A colony of soft texture, regular in outline, was composed of slender, actively motile rods. A sub-culture from it was preserved as Strain No. 21. A third colony consisted of plump bacilli containing oval spores, and a sub-culture was preserved as Strain No. 22. Several of the colonies studied were made up of diplococci. On aerobic plates of litmus lactose gelatin, incubated five days at 15° to 20° C., 1,000,000 bacteria per milligram of feces developed into colonies. All the colonies were acid in reaction and did not liquify the gelatin. Coverglass preparations from five colonies revealed only bacilli resembling *B. coli* in shape but appearing somewhat larger. A sub-culture from one of the colonies was preserved as Strain No. 19. On anaerobic litmus glucose agar, incubated four days at 37° C., 1,050,000 bacteria per milligram of feces developed into colonies. All these colonies appeared to be those of *B. coli*, and five colonies, studied microscopically, were found to be composed of bacilli of this type. The anaerobic blood-agar plates of this series were not made. Veillon-tube cultures were inoculated with 0.50cc. Suspensions No. 5, No. 6 and No. 7. These tubes were incubated six days at 37° C. Numerous colonies developed in all the tubes and there was considerable gas in the first two, but only a

little in the last one. Five colonies in the last tube were examined and found to consist of diplococci, indicating that viable cocci were more numerous than 1,000,000 per milligram in the fresh feces.

Fermentation-tube cultures inoculated with 0.25cc. Suspension No. 1, and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 5 percent gas in the closed arm
Levulose broth ..... 5 percent gas in the closed arm
Lactose broth ..... 5 percent gas in the closed arm
Saccharose broth ..... 5 percent gas in the closed arm
Litmus milk ..... No gas; coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 36 percent gas in the closed arm
Levulose broth ..... 18 percent gas in the closed arm
Lactose broth ..... 5 percent gas in the closed arm
Saccharose broth ..... 25 percent gas in the closed arm
Litmus milk .....Result not recorded

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth..100 percent gas in the closed arm; odor of butyric acid
Litmus milk—100 percent gas in the closed arm; coagulation; acid reaction
Sugar-free broth, containing coagulated egg-white..5 percent gas in the closed arm; pellicle on aerobic surface; digestion of albumen (noted after seven days at 37° C).

Microscopic study of the Gram-stained fermentation-tube sediments gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are some Gram-negative rods resembling *B. coli* and a few large Gram-positive rods resembling *B. welchii.*

"Levulose broth (inoculated with 0.25 cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are some Gram-negative rods resembling *B. coli* and a few long slender Gram-positive rods.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears to be the same as in the dextrose broth above.

Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Nearly all of the bacteria are Gram-positive diplococci, there are some Gram-negative rods resembling *B. coli* and some short, thick Gram-positive rods.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Most numerous are small Gram-positive diplococci; there are also some Gram-negative rods resembling *B. coli* and a few, long, slender Gram-positive rods.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; there are numerous Gram-negative rods resembling *B. coli;* some large Gram-positive rods resembling *B. welchii.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are also Gram-positive diplococci and Gram-positive rods resembling *B. welchii.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are also some Gram-positive rods resembling *B. welchii.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Nearly all the bacteria are Gram-negative rods resembling *B. coli;* there are a few Gram-positive diplococci.

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Small Gram-positive diplococci and short Gram-negative rods are present in equal numbers.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of large Gram-positive rods *(B. welchii).*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii.*

"Sugar-free broth, containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii*. After incubation for a week, the albumen is almost completely digested, and the sediment now contains numerous, very large, non-motile rods.

Plate cultures on anaerobic litmus glucose agar, inoculated with the fermentation-tube sediments and incubated eight days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): There is only one colony on the plates. This is strongly acid and is composed of large diplococci.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): All the colonies are strongly acid and there are no gas bubbles in the agar. Five colonies, studied microscopically, consist of diplococci.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): All the colonies are strongly acid and composed of diplococci.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): All the colonies are strongly acid and composed of diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Colonies are all acid, some more intensely so than others, and there are several bubbles in the agar. Most of the colonies are composed of rods resembling *B. coli*. The others, more intensely acid, are made up of diplococci.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Colonies are all acid, most of them intensely so, and there is no gas in the agar. Of five colonies examined microscopically, three are composed of diplococci, and two of large rods resembling *B. welchii*.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid, but most of them only mildly so, and there are several gas bubbles in the agar. Of five colonies examined microscopically, four are composed of rods resembling *B. coli* and one of diplococci.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are a few small gas bubbles in the agar. Five colonies examined are composed of rods resembling *B. coli*."

Veillon-tube cultures inoculated with the sediments of the lactose-broth fermentation tube (of the series inoculated with 0.25cc. Suspension No. 1) brought to development numerous colonies of diplococci and some colonies composed of slender non-motile rods, but no colonies of *B. bifidus*.

The subcultures derived from this stool and preserved for further study were Strain No. 19, taken from a colony on the plates of litmus lactose gelatin; Strain No. 20, taken from a wrinkled surface colony on the plates of aerobic blood-agar; Strain No. 21 taken from another colony on the same plates, which was composed of actively motile rods; and Strain No. 22, taken from a third colony on the same plates, which consisted of spore-bearing rods.

Specimen No. 13. The patient, D. D., was an inmate of the Peoria State Hospital, where he had been continuously since June, 1909. There had been a brilliant erythema on the backs of the hands since early in the summer, accompanied by marked desquamation, blisters, fissures, and ulceration. He received a dose of salvarsan subcutaneously about the middle of August (administered by Captain H. J. Nichols) without evident influence upon the eruption. On September 19th, there appeared to be an acute exacerbation with extension of the erythema onto the distal phalanges. On October 19th the backs of the hands were still a brilliant red color and desquamating. The stool was passed at 4:30 p. m. October 19th, after an enema of salt solution. It was examined at 4:40 p. m.

The stool was formed, dark brown in color with some shreds of mucus on the surface. The odor was mild, normal in character. Microscopic examination revealed active amebae of the *histolytica* type, active flagellates and active spirilla. The finding of amebae and flagellates is noteworthy because this patient had been repeatedly examined some weeks before without finding any protozoa. (See Captain Siler's report.) The food appeared well

digested. A few bits of starch were seen, but no granulose bacteria, and no striated muscle cells. The suspension for bacteriological study was prepared from the mixed feces, and was packed in ice at 5:20 p. m. The bacteriological study was begun at 10:00 a. m. the next day, October 20th.

By the direct microscopic counting method, 172,000,000 bacteria per milligram of feces were found. In the hanging drop, rods resembling *B. coli* and *B. welchii* and free oval spores were seen. Spiral forms were not observed. The differential count of 500 bacterial cells in a Gram-stained film of the mixed flora gave the following results:

Gram-negative rods of the *B. coli* type	25.2 percent
Short slender Gram-negative rods	35.0 percent
Other Gram-negative rods	3.6 percent
Gram-negative diplococci	1.6 percent
Gram-negative spirochetes	0.6 percent
Thick Gram-positive rods	3.2 percent
Oval Gram-positive bacteria	1.0 percent
Short slender Gram-positive rods	0.4 percent
Gram-positive cocci	29.0 percent
Oval free spores	0.4 percent
Total Gram-negative bacteria	66.0 percent
Total Gram-positive bacteria	33.6 percent
Total free spores	0.4 percent
Total Gram-negative rods	63.6 percent
Total micrococci	30.6 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 62,000 bacteria per milligram of feces. Most of the colonies were acid and resembled colonies of *B. coli*. A few were alkaline in reaction. Nine acid colonies were examined microscopically. Four of these were made up of motionless rods of the same size and shape as *B. coli*, and the substance of the colonies was somewhat viscid. Three of the colonies consisted of rods resembling *B. coli;* one was made up of similar rods except that they were very actively motile, and one was composed of more slender actively motile rods. Subcultures from these colonies were preserved as Strains No. 25, No. 27, No. 28 and No. 29. On aerobic blood-agar, incubated 24 hours at 37° C., 53,000 bacteria per milligram of feces developed into colonies. The majority of the colonies were hemolytic and ten of them, studied microscopically, consisted of rods of the *B. coli* type. A subculture of one of these colonies was preserved as Strain No. 26. On aerobic litmus lactose gelatin, incubated four days at 15° to 20° C., 75,000 bacteria per milligram of feces developed into colonies. All were acid non-liquefying colonies of the *B. coli* type. On anaerobic plates of litmus glucose agar, incubated four days at 37° C., 81,000 bacteria per milligram of feces developed into colonies. The colonies were all acid in reaction and resembled colonies of *B. coli*. Of the ten colonies examined microscopically five were viscid in consistency and five were not; all consisted of rods morphologically similar to *B. coli*. On anaerobic blood-agar plates, incubated four days at 37° C., 86,000 bacteria per milligram of feces developed into colonies. Most of the colonies were hemolytic. The same kinds of bacteria as those found on the glucose-agar plates were also found here. Veillon-tube cultures, inoculated with 0.50cc. Suspension No. 5, Suspension No. 6 and Suspension No. 7, respectively, and incubated six days at 37° C., developed colonies of rods resembling *B. coli* and colonies of diplococci, with abundant gas in the first two tubes. The third tube showed no growth.

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 1, and incubated 24 hours at 37° C., gave the following results:

Dextrose broth	20 percent gas in the closed arm
Levulose broth	15 percent gas in the closed arm
Lactose broth	22 percent gas in the closed arm
Saccharose broth	20 percent gas in the closed arm
Litmus milk	Small bubble of gas; acid reaction; coagulation

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 50 percent gas in the closed arm
Levulose broth ..... 15 percent gas in the closed arm
Lactose broth ..... 30 percent gas in the closed arm
Saccharose broth ..... 22 percent gas in the closed arm
Litmus milk .....Test omitted

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth—100 percent gas in the closed are; odor of butyric acid.
Litmus milk—100 percent gas in the closed arm; acid reaction; coagulation; odor of butyric acid.
Sugar-free broth containing coagulated egg-white—5 percent gas in the closed arm; no digestion of the albumen.

Sugar-free blood-broth (inoculated with 0.25cc. Suspension No. 1 and incubated four days in hydrogen) brought to development no unusual forms of bacteria, but numerous, very actively motile flagellates were found in the culture.

Microscopic study of the Gram-stained fermentation-tube sediments gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positve diplococci; there are also short thick Gram-negative rods resembling *B. coli;* short slender Gram-positive rods; and a few large Gram-positive rods resembling *B. welchii.*

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are many Gram-positive yeasts; some short slender Gram-positive rods; many Gram-negative rods resembling *B. coli.*

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Most numerous are large Gram-positive rods; there are also many Gram-positive diplococci and many Gram-negative rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): This appears to be a pure culture of Gram-negative rods resembling *B. coli.*

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Most numerous are Gram-negative rods resembling *B. coli;* there are also many Gram-positive diplococci and some short slender Gram-positive rods.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): The sediments consists of about equal numbers of Gram-positive diplococci and Gram-negative rods resembling *B. coli.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): There are about equal numbers of Gram-positive diplococci and Gram-negative rods resembling *B. coli;* there are a few large Gram-positive rods resembling *B. welchii.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The great majority of the bacteria are Gram-positive diplococci; there are many Gram-negative rods resembling *B. coli* and a few Gram-positive yeasts.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The majority of the bacteria are Gram-positive diplococci; there are also many Gram-negative rods resembling *B. coli* and some short slender Gram-positive rods.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of large Gram-positive rods of *B. welchii* type.

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of *B. welchii.*

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): This appears to be a pure culture of *B. welchii.*"

Plate cultures on anaerobic litmus glucose agar inoculated with the fermentation-tube sediments and incubated six days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid without gas production. Of five colonies examined three are composed of rods resembling *B. coli* and two of diplococci.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid and there are no gas bubbles in the agar. A number of surface colonies examined are composed of yeasts, and several deep colonies are found to consist of diplococci.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid and there are no gas bubbles in the agar. Four of the five colonies examined are composed of diplococci and one of rods resembling *B. coli.*

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): This sediment was not plated.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are some gas bubbles in the agar. Five colonies examined are made up of rods resembling *B. coli.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are some gas bubbles in the agar. The five colonies examined consist of rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and the five examined are composed of rods resembling *B. coli.*"

Veillon-tube cultures, inoculated with the sediment of the lactose broth fermentation tube (the tube of the first series, originally inoculated with 0.25cc. Suspension No. 1), and incubated five days at 37° C., gave rise to heavy growth in all three tubes, without gas production. Several colonies in the third tube were examined. Some consisted of small diplococci and others were made up of slender non-motile rods. No bifid forms were seen. A subculture of the slender rods was preserved as Strain No. 23.

The bacterial strains derived from this examination and preserved for further study were the following: Strain No. 23, just mentioned; Strain No. 24, from a colony of yeast on the plates from the sediment of the levulose-broth fermentation tube (inoculated with 0.25cc. Suspension No. 1); Strain No. 25, from a colony of actively motile rods resembling *B. coli* on the aerobic plates of litmus lactose agar; Strain No. 26, from a hemolytic surface colony on the aerobic blood-agar plates, composed of rods resembling *B. coli;* Strain No. 27, from a viscid colony of rods resembling *B. coli* on the aerobic plates of litmus lactose agar; Strain No. 28, from another colony on the same plates which consisted of very actively motile rods otherwise resembling *B. coli;* and Strain No. 29, from an alkaline colony on the same plates, composed of slender actively motile rods.

This patient was an ambulatory case, and seemed very well except for the eruption on the hands. The eruption was very persistent, remaining as a brilliant erythema with recurring fissures and ulcers and continual desquamation during the summer and autumn; but it did not extend above the wrists. The patient was not observed again for a long time after October 19th, and he left the hospital, going home for a time. Apparently, he returned to the hospital some time during December, the eruption on the hands being much improved or even absent at that time. At any rate he was seen again at the visit to the Peoria State Hospital on January 15, 1911. At that time the backs of the hands were very red and the epidermis was still desquamating at the borders of the erythematous areas from which the epidermis had already peeled off. There were several small pustules in the desquamated areas. This pellagrous eruption was said to have appeared about January 1, 1911, since the patient's return to the hospital, but it cannot be regarded as certain that the condition had not actually persisted since October. The patient appeared much thinner than in October, and, although he had been confined to bed some days before, he was dressed and walking about on January 15th, and did not appear especially weak. About two weeks later the patient was reported to be confined to his bed and failing rapidly. He died about February 1st. Autopsy was not obtained.

Specimen No. 14. This was obtained from the patient W. N., who fur-

nished the previous specimens, No. 11 and No. 12. On October 26th the dusky red eruption with fine desquamation on the forehead was observed for the first time. The stool was passed some time between 11 a. m. and 12:30 noon. It was examined at 1:30 p. m. The stool was unformed, mushy in consistency and yellow in color. Several flakes of mucus were observed, some clear and colorless, others greenish. The odor was very foul and the whole mass was full of gas bubbles. Undigested corn kernels were visible. Microscopic examination revealed a very large number of granulose bacteria of very unusual appearance—bacilli resembling *B. coli* morphologically but staining a diffuse blue color with iodine. The majority of the bacteria present seemed to be of this type. No protozoa or spirilla were seen. The suspension for bacteriological study was made from the mixed feces and was packed in ice at 1:45 p. m. The bacteriological study was begun at 9:00 a. m. the next day, October 27th.

By the direct microscopic counting method, 64,800,000 bacteria per milligram of feces were found. Examination in the hanging drop showed numerous rods resembling *B. coli* and numerous diplococci, some free spores, but no spirilla nor spirochetes. Differential count of 500 bacterial cells in the Gram-stained film gave the following results:

Gram-negative rods of the *B. coli* type	52.0 percent
Other Gram-negative rods	9.0 percent
Gram-negative spirilla	0.2 percent
Gram-negative spirochetes	0.2 percent
Thick, Gram-positive rods	0.8 percent
Short, slender Gram-positive rods	2.0 percent
Gram-positive cocci	35.6 percent
Oval free spores	0.2 percent
Total Gram-positive bacteria	38.4 percent
Total Gram-negative bacteria	61.4 percent
Total free spores	0.2 percent
Total Gram-negative rods	61.0 percent
Total micrococci	35.6 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 3,700,000 bacteria per milligram of feces. The colonies were closely crowded on the plates and were all acid in reaction. Ten colonies, examined microscopically, were made up of rods resembling *B. coli*. On aerobic blood-agar, incubated 24 hours at 37° C., 2,950,000 bacteria per milligram of feces developed into colonies. The colonies were all hemolytic and resembled those of *B. coli*, macroscopically. Ten colonies were studied microscopically. Of these, seven were composed of rods of the *B. coli* type. One colony was viscid and made up of rods resembling *B. coli*. A subculture of one of these colonies was preserved as Strain No. 30. The other two colonies consisted of non-motile rods, single and in pairs, smaller than *B. coli*. A subculture of one of these was preserved as Strain No. 33. Aerobic plates of litmus lactose gelatin, incubated five days at 15° to 20° C., brought to development 2,170,000 bacteria per milligram of feces. All these colonies were acid and did not liquefy the gelatin. Among the nine colonies studied two consisted of diplococci. The rest were composed of rods of the *B. coli* type. On anaerobic plates of litmus glucose agar, incubated five days at 37° C., 4,000,000 bacteria per milligram of feces developed into colonies. All the colonies were acid in reaction, and, of the ten studied microscopically, nine were composed of rods resembling *B. coli* and one consisted of diplococci. Anaerobic plates of blood-agar, incubated five days at 37° C., brought to development 1,700,000 bacteria per milligram of feces. Of the ten colonies examined microscopically, four were made up of short rods about the size of *B. coli*, but somewhat irregular in shape and often in short threads. A subculture of one of these colonies was preserved as Strain No. 30. The other six colonies were composed of rods resembling *B. coli*. Veillon tubes inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6, and 0.50cc. Suspension No. 7, and incubated five days at 37° C., showed numerous colonies and gas bubbles in all three tubes. In the third tube, the colonies

were sufficiently separate to study, and five of these were examined microscopically. One of the five was composed of diplococci and the other four consisted of rods resembling *B. coli.*

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 5 percent gas in the closed arm
Levulose broth .....5 percent gas in the closed arm
Lactose broth ..... 5 percent gas in the closed arm
Saccharose broth ..... 5 percent gas in the closed arm
Litmus milk....A few small bubbles in the curd; acid reaction; coagulation

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5, and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 0.5 percent gas in the closed arm
Levulose broth ..... 5.0 percent gas in the closed arm
Lactose broth ..... 20.0 percent gas in the closed arm
Saccharose broth ..... 10.0 percent gas in the closed arm
Litmus milk ..... No gas; acid reaction; coagulation

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth..100 percent gas in the closed arm; odor of butyric acid
Litmus milk..100 percent gas in the closed arm; coagulation; acid reaction
Sugar-free broth containing coagulated egg-white..10 percent gas in the closed arm; no digestion; no digestion after incubation for seven days.

Microscopic examination of the Gram-stained sediments of the fermentation-tube cultures gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are also a few Gram-negative rods resembling *B. coli* and a few long, slender Gram-positive rods.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are many Gram-negative diplococci; some Gram-negative rods resembling *B. coli;* large Gram-positive rods resembling *B. welchii;* some short slender Gram-positive rods.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are some short, Gram-negative rods resembling *B. coli;* some Gram-negative diplococci; some short slender Gram-positive rods and some large Gram-positive rods resembling *B. welchii.*

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are many Gram-negative rods resembling *B. coli* and a few long slender Gram-positive rods.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are some Gram-positive diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; there are also some Gram-negative rods resembling *B. coli.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are also some Gram-positive diplococci.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are some Gram-positive diplococci, a few Gram-negative diplococci and a few large Gram-negative rods.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci, there are also many Gram-negative rods resembling *B. coli.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are some small Gram-positive cocci and a few large Gram-positive diplococci.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): Majority of the bacteria are slender Gram-positive rods; there are a few large Gram-positive rods of the *B. welchii* type.

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of *B. welchii*."

Plate cultures on anaerobic litmus glucose agar, inoculated with the fermentation-tube sediments and incubated five days at 37° C., gave the following results:

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid and apparently of the same type. Six of them examined microscopically are composed of diplococci.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid. Of the six examined microscopically, one is composed of rods resembling *B. coli* and five are made up of diplococci.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid in reaction and there are some gas bubbles in the agar. Of the ten colonies studied microscopically, eight are composed of rods resembling *B. coli* and the other two are made up of diplococci.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are some gas bubbles. Of ten colonies studied, nine consist of rods resembling *B. coli* and one is made up of diplococci."

The plates inoculated with the sediments of the glucose broth and lactose broth of the first series and of the glucose and levulose broth of the second series were accidentally lost.

Veillon tubes of deep glucose agar, inoculated with the sediment of the lactose-broth fermentation tube (first series) and incubated four days at 37° C., brought to development lenticular colonies of short, plump, non-motile rods, without production of gas. A subculture from one of these colonies was preserved as Strain No. 31.

Altogether four subcultures derived from this stool were kept for further study. Strain No. 30 was taken from a colony on the anaerobic blood-agar plates, consisting of rods of irregular shape and size. Strain No. 31 was taken from the Veillon tubes just mentioned in the preceding paragraph. Strain No. 32 was taken from a colony on the aerobic blood-agar plates, of viscid consistency and composed of rods resembling *B. coli*. Another colony on the same plates, consisting of small slender non-motile rods, was transplanted and preserved as Strain No. 33.

Specimen No. 15. The patient, E. P., male, was an inmate of the Peoria State Hospital, having been admitted in the summer of 1910 from Woodford county with the pellagrous eruption present. He was seen by several members of the Pellagra Commission, including Dr. Ormsby, on August 20, when the eruption was very definite. On September 27, examination showed no signs of the disease. A sample of blood for complement fixation tests was drawn on this date. On October 26 there was a recent active erythema on the backs of the hands with desquamation and pigmentation. The stool was obtained by an enema of salt solution. Through some misunderstanding the enema was not a sterile one, and a part of the formed stool which was obtained was transferred to an unsterilized bottle and sent to the laboratory. The stool was passed at 5:30 p. m. and examined at 6:45 p. m.

The bottle contained several pieces of a formed cylinder, of a brown color. The odor was strong but only slightly putrefactive. There were no macroscopic food remnants. Microscopic examination showed no protozox, but active spirilla were seen. The material appeared well digested. A moderate number of granulose bacteria of the common ellipsoidal form were present, some of them containing terminal spores. The suspension for bacteriological study was made with material from the interior of a formed piece, and it was packed in ice at 7:00 p. m. The bacteriological study was begun the next morning at 9:30 o'clock.

By the direct microscopic counting method 221,000,000 bacteria per milligram of feces were found. Study of the hanging drop revealed many free

spores but no spirilla or spirochetes. There was an unusual variety in the sizes and shapes of the bacilli and cocci present. Differential count of 600 bacterial cells in the Gram-stained film gave the following results:

Gram-negative rods of the *B. coli* type	13.5 percent
Short slender Gram-negative rods	61.0 percent
Other Gram-negative rods	2.3 percent
Gram-negative cocci	2.3 percent
Gram-negative spirochetes	0.8 percent
Thick Gram-positive rods	3.0 percent
Slender Gram-positive rods	2.0 percent
Oval Gram-positive bacteria	1.4 percent
Gram-positive cocci	10.9 percent
Oval free spores	2.8 percent
Total Gram-positive bacteria	17.3 percent
Total Gram-negative bacteria	79.9 percent
Total free spores	2.8 percent
Total Gram-negative rods	86.8 percent
Total micrococci	13.2 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 138,000 bacteria per milligram of feces. The colonies were all acid in reaction and the majority of them were composed of rods resembling *B. coli.* Others, more strongly acid, were made up of diplococci. On aerobic blood-agar, incubated 24 hours at 37° C., 139,000 bacteria per milligram of feces developed into colonies. The majority of the colonies were hemolytic. Ten colonies were studied microscopically. Three of these were composed of rods resembling *B. coli;* one of rods resembling *B. coli* but very actively motile (Strain No. 35); one of rather long thick rods growing in threads (Strain No. 34); one of large plump rods with an oval spore at one end with enlargement; and four of the ten colonies were composed of diplococci. On the aerobic litmus lactose gelatin, incubated five days at 15° to 20° C., 15,000 bacteria per milligram of feces developed into colonies. Several colonies examined were found to consist of rods resembling *B. coli.* On anaerobic litmus glucose agar, incubated four days at 37° C., 130,000 bacteria per milligram of feces developed into colonies. The colonies were all acid in reaction and there were some gas bubbles in the agar. Ten colonies were studied microscopically. Of these, four were composed of rods resembling *B. coli;* two were made up of large rods resembling *B. welchii;* three were composed of diplococci; and one consisted of large cocci grouped as sarcines. On anaerobic blood-agar, incubated four days at 37° C., 152,000 bacteria per milligram of feces developed into colonies. Nearly all the colonies were hemolytic. Ten colonies were examined microscopically, of which six were composed of large rods resembling *B. welchii* (Strain No. 36); two of rods resembling *B. coli;* and two of diplococci.

Aerobic plates of litmus agar, inoculated with 0.25cc. and 0.50cc. Suspension No. 2, Spores, and incubated three days at 37° C., brought to development 40 spores per milligram of feces. On anaerobic plates of blood-agar inoculated with 0.25cc. and 0.50cc. Suspension No. 2, Spores, 10,700 spores per milligram of feces developed into colonies. A number of colonies were examined and all were composed of large rods resembling *B. welchii.*

Veillon tubes, inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6, and 0.50cc. Suspension No. 7, developed gas even in the highest dilution. Five lenticular colonies in this third tube were examined microscopically and found to consist of diplococci.

A tube of sugar-free blood-broth, inoculated with 1cc. Suspension No. 1 and incubated four days at 37° C., aerobically, brought to development no unusual forms of bacteria. A similar tube, incubated anaerobically four days at 37° C., also failed to reveal unusual forms.

Fermentation-tube cultures inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth	0.5 percent gas in the closed arm
Levulose broth	0.5 percent gas in the closed arm

Lactose broth ..... 5.0 percent gas in the closed arm
Saccharose broth ..... 2.5 percent gas in the closed arm
Litmus milk .....No gas; coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth .....No gas; good growth
Levulose broth .....No gas; good growth
Lactose broth .....10 percent gas in the closed arm
Saccharose broth .....20 percent gas in the closed arm
Litmus milk—Small gas bubbles; only partial coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth—100 percent gas in the closed arm; odor of butyric acid
Litmus milk—100 percent gas in the closed arm; coagulation; acid reaction
Sugar-free broth, containing coagulated egg-white—Small gas bubble; no digestion. (No digestion after incubation for seven days.)

A study of the Gram-stained sediments of the fermentation-tube cultures gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): The sediment consists almost entirely of Gram-positive diplococci; there are a few Gram-negative rods resembling *B. coli.*

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The sediment consists almost entirely of Gram-positive diplococci; there are a few Gram-positive rods resembling *B. coli* and a few Gram-positive yeasts.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are a few Gram-negative diplococci; a few Gram-negative rods resembling *B. coli;* a few large plump rods resembling *B. welchii.*

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): This sediment appears to be the same as that of the lactose broth above.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are many Gram-positive diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): The sediment was not examined.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are also numerous Gram-positive diplococci.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The sediment contains about equal numbers of Gram-positive diplococci and Gram-negative rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Nearly all the bacteria are Gram-negative rods of the *B. coli* type; there are also a few small Gram-positive diplococci.

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Only small Gram-positive diplococci are found in the sediment.

Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): This also appears to be a pure culture of *B. welchii.*

"Sugar-free broth, containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Majority of the bacteria are Gram-positive rods resembling *B. welchii;* there are also many short slender Gram-negative rods."

Anaerobic plate cultures on litmus glucose agar, inoculated with the fermentation-tube sediments, and incubated five days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.24cc. Suspension No. 1): Lost by accident.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid. Of the eight colonies studied microscopically, four are composed of very short thick rods growing in threads; three are composed of diplococci; and one is a colony of yeast.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid. Of the six colonies examined microscopically, five consist of diplococci and one is made up of short rather slender rods growing in threads.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid and five of them examined are composed of diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and five of them examined are composed of diplococci.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are some gas bubbles in the agar. Of the five colonies examined, four are composed of rods resembling *B. coli* and one consists of very short and rather slender non-motile rods.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are no gas bubbles in the agar. Of the five colonies examined, three consist of diplococci and two are composed of large plump non-motile rods.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are gas bubbles in the agar. All the colonies examined are composed of rods resembling *B. coli.*"

Veillon tubes, inoculated with the sediment of the lactose-broth fermentation tube (of first series, *i. e.* inoculated with 0.25cc. Suspension No. 1), and incubated five days at 37° C., brought to development only colonies of diplococci without any production of gas.

The subcultures derived from this stool and preserved for further study were Strain No. 34, taken from a colony on the aerobic blood-agar plates, consisting of rather long thick rods, growing in short threads; Strain No. 35, taken from another colony on the same set of plates, consisting of rods resembling *B. coli* but very actively motile; Strain No. 36, taken from a colony on the anaerobic blood-agar plates, consisting of rods resembling *B. welchii.*

It will have been noted that this specimen was obtained from a recently admitted genuine case of pellagra while the eruption, apparently the autumn recurrence, was in an active state, and that the usual precautions to avoid contamination were not observed in obtaining the stool. Soon after this time the patient left the hospital and went home. He was seen again on December 14, at which time the hands were free from eruption but some pigmentation and desquamation was still present above the wrists. On January 15 the eruption had disappeared entirely, but the skin on the backs of the hands appeared very thin. The condition was the same on February 15. The patient was seen on May 12, July 13, and August 1. On May 12 there was a slight reddening on the backs of the hands, not very definite, and on July 13 and August 1 a fairly deep brown pigmentation without desquamation. There was a very considerable loss in weight in the latter part of May. He weighed 132 pounds in January and since June 1 has weighed only 115 pounds. On July 13 he appeared thin and weak and complained of occasional dizzy spells. He was practically the same on August 1. Specimen No. 21 obtained on January 15 was also from this patient.

Specimen No. 16. This was obtained from the patient, W. N. on November 3. The history of the case has been given under Specimen No. 11. On November 3 the deeply pigmented border below the desquamating line on the forehead was first noted, a dusky red zone with fine scales having been observed here the week before. The stool was passed at 10:00 a. m. and examined at 11:00 a. m.

It was a gelatinous fluid stool consisting almost wholly of mucus and muco-pus. There were only about 10 grams of it. Odor was very foul and offensive. Macroscopic food remnants were not seen. Microscopic examination showed very many leucocytes, some columnar epithelial cells, red blood cells not cremated and appearing fresh. A few active flagellates were

observed, but no amebae and no spirilla. The suspension for bacteriological study was prepared from the mixed mucus, and was packed in ice at 12:00 noon. The bacteriological study was begun at 9:30 a. m. the next day.

The direct microscopic count showed 14,000,000 bacteria per milligram of feces. Numerous leucocytes were observed in the hanging-drop preparation. Bacterial cells were less numerous than usual and no unusual forms were seen. A differential count of 500 bacteria in the Gram stained film gave the following results:

Gram-negative rods of *B. coli* type	65.4 percent
Short slender Gram-negative rods	4.6 percent
Other Gram-negative rods	0.8 percent
Gram-negative diplococci	2.4 percent
Slender Gram-positive rods	2.8 percent
Oval Gram-positive bacteria	0.2 percent
Gram-positive cocci	23.6 percent
Oval free spores	0.2 percent
Total Gram-positive bacteria	26.6 percent
Total Gram-negative bacteria	73.2 percent
Total free spores	0.2 percent
Total Gram-negative rods	70.8 percent
Total micrococci	26.0 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 125,000 bacteria per milligram of feces. The colonies were all acid and there were several gas bubbles in the agar. Of ten colonies studied microscopically, nine were composed of rods resembling *B. coli*, and one was made up of diplococci. On plates of aerobic blood-agar, incubated 24 hours at 37° C., 98,000 bacteria per milligram of feces developed into colonies. Of the ten studied microscopically, nine were composed of rods resembling *B. coli*, and one was composed of rods longer and thicker than *B. coli*. On aerobic litmus lactose agar, incubated five days at 15° to 20° C., 54,500 bacteria per milligram of feces developed into colonies. The colonies were all acid and resembled colonies of *B. coli*. Microscopic study of ten colonies showed only bacilli morphologically resembling this species. On anaerobic plates of litmus glucose agar, incubated five days at 37° C., 60,500 bacteria per milligram of feces developed into colonies. The colonies were all acid and of the ten studied microscopically, six were composed of rods resembling *B. coli;* three consisted of rods resembling *B. welchii;* and one was made up of slender non-motile rods. A subculture of this last one was designated as Strain No. 41. Plate cultures on anaerobic blood-agar, incubated five days at 37° C., brought to development 37,000 bacteria per milligram of feces. Of the ten colonies studied microscopically, seven were composed of rods resembling *B. coli;* one consisted of very slender non-motile rods; one of large diplococci; and one was made up of rods morphologically resembling *B. welchii*. A subculture of this last one gave aerobic growth and it was designated as Strain No. 40. Veillon-tube cultures inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6 and 0.50cc. Suspension No. 7, incubated six days at 37° C., showed colonies in all three tubes and gas bubbles in the first two. Several lenticular colonies were examined and found to consist of diplococci.

An aerobic litmus agar plate, inoculated with 0.50cc. Suspension No. 2, Spores and incubated five days at 37° C., failed to bring to development any spores. On anaerobic blood-agar, incubated five days at 37° C., 75 spores per milligram of feces developed into colonies. Of the ten colonies studied microscopically, three consisted of rods of the *B. welchii* type, and seven were composed of longer rods of the *B. edematis* type. A subculture was inoculated from one of these colonies and designated as Strain No. 39. Anaerobic glucose-agar plates, incubated five days at 37° C., brought to development 14 spores per milligram of feces. All the colonies were of the same kind and seven of them examined microscopically were composed of rods of the *B. welchii* type.

Fermentation tube cultures inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 10 percent gas in the closed arm
Levulose broth ..... 15 percent gas in the closed arm
Lactose broth ..... 20 percent gas in the closed arm
Saccharose broth ..... 15 percent gas in the closed arm
Litmus milk—5 percent gas in the closed arm; coagulation; acid reaction.

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5, and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 5 percent gas in the closed arm
Levulose broth .....Minute bubble of gas
Lactose broth ..... 15 percent gas in the closed arm
Saccharose broth ..... 35 percent gas in the closed arm
Litmus milk—5 percent gas in the closed arm; coagulation; acid reaction.

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth—100 percent gas in the closed arm; odor of butyric acid.
Litmus milk—5 percent gas in the closed arm; no coagulation; alkaline reaction.
Sugar-free broth, containing coagulated egg-white—5 percent gas in the closed arm; no digestion of the albumen.

Microscopic examination of the Gram-stained sediments of the fermentation-tube cultures, gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are some Gram-negative rods resembling *B. coli.*

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears the same as that of the dextrose broth above.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are many Gram-negative rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears the same as that of the dextrose broth above.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): There are approximately equal numbers of Gram-positive diplococci and Gram-negative rods resembling *B. coli.*

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; there are a few rods resembling *B. coli.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Sediment appears the same as that of the dextrose broth of this series.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Sediment appears the same as that of the dextrose broth of this series.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5) Sediment consists almost wholly of Gram-negative rods resembling *B. coli;* there are a few small Gram-positive diplococci.

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are some small Gram-positive diplococci.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii.*

"Sugar-free broth, containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Majority of the bacteria are Gram-positive rods resembling *B. welchii;* there are some slender Gram-negative rods."

Plate cultures on anaerobic litmus glucose agar, inoculated with the sediments of the fermentation-tube cultures and incubated five days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Three colonies developed, two of them consisting of cocco-bacilli with pointed ends, and the other of very granular non-motile rods of somewhat irregular shape and size. A subculture of this is preserved as Strain No. 37.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid, most of them strongly so. Of ten colonies studied, nine are composed of cocco-bacilli with pointed ends and one is made up of short, slender non-motile rods. A subculture of this last is preserved as Strain No. 38.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Plate lost.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid. Of the five studied four consist of cocco-bacilli, and one is composed of rods resembling *B. coli.*

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Plate lost.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all strongly acid. Of seven studied microscopically six consisted of cocco-bacilli, irregular in shape, and one is made up of rods resembling *B. coli.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are many gas bubbles in the agar. Of five colonies studied, two are composed of rods resembling *B. coli*, two of diplococci, and one of rods resembling *B. welchii.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there is no gas in the agar. Of six colonies studied, four are composed of rods resembling *B. coli;* one of cocco-bacilli of irregular shape, and one of diplococci."

Veillon tubes, inoculated with the sediment of the lactose-broth fermentation tube (of the first series) and incubated five days at 37° C., brought to development numerous colonies of diplococci without gas production.

The subcultures made for subsequent study were designated as follows: Strain No. 37, derived from a colony on a plate culture, inoculated with sediment of the dextrose-broth fermentation tube of the first series, consisting of plump irregular granular non-motile rods; Strain No. 38, derived from the plate inoculated with sediment of the levulose-broth fermentation tube of the same series, consisting of short slender non-motile rods; Strain No. 39, derived from a colony on the anaerobic blood-agar plates inoculated with spore material, consisting of rods of the *B. edematis* type; Strain No. 40, derived from a colony on the anaerobic blood-agar plates, inoculated with unheated fecal suspension, consisting of rods of the *B. welchii* type; Strain No. 41, derived from a colony on the anaerobic glucose-agar plates, consisting of slender non-motile rods.

Specimen No. 17. The patient, G. I., male, was an inmate of the Peoria State Hospital. He was one of the cases shown by Dr. Zeller at the St. Louis meeting of the American Medical Association in June, 1910. On June 22d, the hands were still deeply pigmented. On October 26th, the eruption was scaling off. On November 3d, the pigmentation was still present, more marked on the right hand, and the eruption was regarded as indicating an active attack rather than subsidence at that time. The stool was obtained after an enema of sterile salt solution at 2:50 p. m. and it was examined at 3:00 p. m.

The material consisted of clear watery fluid (the enema) with several small bits of formed feces, one prune stone and several pieces of prune skins. The odor was moderate but somewhat putrefactive. Microscopic examination revealed some pieces of striated muscle cells, a moderate amount of broken starch, and many oval granulose bacteria. No protozoa were detected, but one active spirillum was seen. The suspension for bacteriological study was made from the formed feces, and it was packed in ice at 3:20 p. m. The bacteriological study was begun at 10:00 a. m. the next day.

By the microscopic counting method, 128,000,000 bacteria per milligram of feces were found. In the hanging drop, a variety of bacterial forms was

noted, also free oval spores and numerous motionless spirochetes. A differential count of 600 bacterial cells in the Gram-stained preparation gave the following results:

Gram-negative rods of the *B. coli* type	44.7 percent
Short slender Gram-negative rods	22.8 percent
Other Gram-negative rods	0.7 percent
Gram-negative spirochetes with many turns	6.8 percent
Gram-negative spirochetes with few turns	3.2 percent
Thick Gram-positive rods	0.8 percent
Slender Gram-positive rods	4.5 percent
Oval Gram-positive bacteria	1.5 percent
Gram-positive cocci	13.0 percent
Oval free spores	2.0 percent
Total Gram-positive bacteria	19.8 percent
Total Gram-negative bacteria	78.2 percent
Total free spores	2.0 percent
Total Gram-negative rods	67.2 percent
Total micrococci	13.0 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 56,000 bacteria per milligram of feces. Nearly all the colonies were mildly acid in reaction, and eight of these studied microscopically were composed of rods resembling *B. coli*. There were a very few strongly acid colonies consisting of diplococci. On aerobic blood-agar, incubated 24 hours at 37° C., 97,000 bacteria per milligram of feces developed into colonies. Of ten colonies studied microscopically, six were composed of diplococci, two of rods resembling *B. coli*, one of fine filaments, apparently a streptothrix, and one consisted of very large granular non-motile rods growing in short threads. A subculture of this last mentioned colony was preserved as Strain No. 46. On aerobic plates of litmus lactose gelatin, incubated five days at 15° to 20° C., 75,000 bacteria per milligram of feces developed into colonies. The colonies were all acid in reaction but there were a few which liquefied the gelatin. Two of these liquefying colonies were found to consist of streptococci. Of eight other colonies examined, seven were composed of rods resembling *B. coli*, and the eighth of rods of the same size and shape but more actively motile. A subculture of this was preserved as Strain No. 44. On anaerobic litmus glucose agar, incubated five days at 37° C., 67,000 bacteria per milligram of feces developed into colonies. All were acid in reaction and there were some gas bubbles in the agar. Of ten colonies studied, five were composed of rods resembling *B. coli*, and five consisted of rods of the *B. welchii* type. Anaerobic plates of blood-agar, incubated five days at 37° C., brought to development 65,500 bacteria per milligram of feces. Of ten colonies studied microscopically, three were composed of rods of the *B. welchii* type; one of rods resembling *B. coli;* two of rods containing spores, resembling *B. edematis;* and four were made up of very short slender non-motile rods. A subculture taken from one of these last-mentioned colonies was designated as Strain No. 45. Veillon tubes, inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6, and 0.50cc. Suspension No. 7, incubated six days at 37° C., showed very numerous colonies and abundant gas in the first two tubes, and three lenticular colonies without gas in the third tube. One of these colonies was composed of diplococci and another consisted of branched rods of the *B. bifidus* type. A subculture of this latter gave typical growth of *B. bifidus* and it was designated as Strain No. 42. Cultures in blood-broth incubated five days at 37° C., one under anaerobic conditions and one in the air, did not bring to development any unusual forms.

Aerobic litmus-agar plates, inoculated with Suspension No. 2, Spores, and incubated five days at 37° C., brought to development 40 spores per milligram of feces. Several of the colonies were examined and found to consist of short, slender rods. Anaerobic plate cultures on blood-agar incubated five days at 37° C., brought to development 17,500 spores per milligram of feces. Of the nine colonies studied, four were composed of rods resembling *B.*

welchii, and five were made up of rods longer and more slender than these. A subculture taken from one of these latter colonies was designated as Strain No. 43. On anaerobic glucose agar plates, incubated five days at 37° C., 3,400 spores per milligram of feces developed into colonies. Seven colonies were examined and found to consist of very large non-motile granular rods growing in threads.

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., were made in the usual way and studied, but the observations upon the amounts of gas were not recorded. Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5, and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 40 percent gas in the closed arm
Levulose broth ..... 35 percent gas in the closed arm
Lactose broth ..... 50 percent gas in the closed arm
Saccharose broth ..... 47.5 percent gas in the closed arm
Litmus milk..Small gas bubble in the closed arm; coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth..100 percent gas in the closed arm; odor of butyric acid
Litmus milk .....Coagulation; gas bubbles through the clot; acid reaction
Sugar-free broth, containing coagulated egg-white....5 percent gas in the closed arm; no digestion of the albumen.

The Gram-stained sediments of the fermentation-tube cultures were described as follows:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are also large Gram-positive rods resembling *B. welchii;* and a few Gram-negative rods resembling *B. coli.*

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Sediment contains about equal numbers of Gram-positive diplococci and Gram-negative rods of the *B. coli* type; there are many large Gram-positive rods resembling *B. welchii.*

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are numerous Gram-negative rods resembling *B. coli* and a few large Gram-positive rods resembling *B. welchii.*

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears the same as that of the lactose broth above.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive cocci; there are many irregular branched rods resembling *B. bifidus* and some Gram-negative rods of the *B. coli* type.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): There are about equal numbers of Gram-positive diplococci and Gram-negative rods resembling *B. coli;* also numerous large Gram-positive rods resembling *B. welchii.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive rods resembling *B. welchii;* there are some Gram-negative rods resembling *B. coli.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are many large Gram-positive rods of the *B. welchii* type; and some Gram-positive forms resembling *B. bifidus.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are a few Gram-positive rods resembling *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Sediment appears to be a pure culture of Gram-negative rods resembling *B. coli.*

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): This appears to be a pure culture of *B. welchii.*

"Sugar-free broth, containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): This appears to be a pure culture of *B. welchii.*

Plate cultures on anaerobic litmus glucose agar, inoculated with the sediments of the fermentation-tube cultures and incubated four days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid and there is no gas in the agar. Of five colonies examined, four are composed of cocco-bacilli with pointed ends, and one is made up of small diplococci.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid. Four of the five colonies examined are composed of cocco-bacilli with pointed ends. The fifth consists of large diplococci.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all strongly acid and there is no gas in the agar. Five colonies examined are all composed of cocco-bacilli with pointed ends.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid but most of them only moderately so. There is no gas in the agar. Of six colonies examined, two are composed of rods resembling *B. coli*, and four consist of cocco-bacilli with pointed ends.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid in reaction and there is no gas in the agar. All five colonies examined are composed of large diplococci.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Plate inoculated with the sediment was accidentally lost.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid but most of them only moderately so. There are some gas bubbles in the agar. The five colonies examined are composed of rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all moderately acid in reaction. The five colonies examined are composed of rods resembling *B. coli.*"

Veillon tubes, inoculated with the sediment of the lactose broth fermentation-tube culture of the first series and incubated five days at 37° C., showed numerous colonies without gas production. Five colonies examined were composed of diplococci.

The subcultures derived from this stool and put away for further study were the following: Strain No. 42, taken from one of the colonies of *B. bifidus* which developed in the Veillon tubes inoculated with the suspension of feces; Strain No. 43, taken from a colony on the anaerobic blood-agar plates inoculated with the spore material, which was composed of rods longer and more slender than *B. welchii;* Strain No. 44, taken from a colony on the litmus lactose gelatin plates, composed of rods resembling *B. coli*, but very actively motile; Strain No. 45, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, which was composed of very short slender non-motile rods; and Strain No. 46, taken from a colony on the aerobic blood-agar plates, which consisted of large granular non-motile rods.

It will have been noted that this patient had a definite pellagrous eruption which had persisted since early in June. It was still about the same at the next visit on November 14. On December 14 the eruption was still about the same, but the patient was confined to bed in the hospital on account of asthma and a cold, apparently bronchitis or broncho-pneumonia. The patient died shortly after this date.

Specimen No. 18. This was obtained from the patient W. N. (see *Specimen No. 11*) on November 14. On this day the skin eruption appeared to be clearing up. The skin had desquamated up to the middle of the forearms, and also a considerable distance downward on the forehead. The stool was passed at 3:00 a. m. and examined at 9:00 a. m.

It was a mushy stool containing many macroscopic vegetable food remnants. The color was yellowish brown, and the odor moderate and of normal character. Microscopic examination revealed a moderate number of active flagellates, active bacilli, and rather numerous granulose bacteria.

There was very little starch and only a few bits of striated muscle cells. The suspension was prepared at 9:30 a. m. and placed out of doors, where the temperature was +2° C., until 11:10 a. m., when it was packed in ice. The bacteriological study was begun at 5:00 p. m. on the same day.

By the direct microscopic counting method 114,000,000 bacteria per milligram of feces were found. The examination of the hanging-drop preparation revealed no unusual forms of bacteria. A differential count of 500 bacterial cells in a Gram-stained film, gave the following results:

Gram-negative rods of the *B. coli* type	48.0 percent
Short slender Gram-negative rods	8.0 percent
Other Gram-negative rods	1.2 percent
Gram-negative diplococci	1.2 percent
Gram-negative spirochetes	0.2 percent
Thick Gram-positive rods	0.2 percent
Slender Gram-positive rods	3.8 percent
Oval Gram-positive bacteria	0.4 percent
Small Gram-positive diplococci	31.6 percent
Other Gram-positive cocci	5.4 percent
Free spores	0.0 percent
Total Gram-positive bacteria	41.4 percent
Total Gram-negative bacteria	58.6 percent
Total free spores	0.0 percent
Total Gram-negative rods	57.2 percent
Total micrococci	38.2 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 540,000 per milligram of feces. The colonies were all acid and some of them strongly acid. Of the ten colonies studied, five were composed of very large non-motile rods. These colonies were mildly acid. A subculture from one of them was preserved and designated as Strain No. 47. The other five colonies were composed of cocco-bacilli with pointed ends. On aerobic blood-agar 240,000 bacteria per milligram of feces developed into colonies. The majority of the colonies were slightly hemolytic. Of the ten colonies studied, eight were composed of rods resembling *B. coli*, and two colonies of tough consistency were composed of thick rods growing in long interwoven threads. On aerobic litmus lactose gelatin, incubated five days at 37° C., 187,000 bacteria per milligram of feces developed into colonies. The colonies were all acid and did not liquefy the gelatin. Of the ten studied microscopically, all were composed of rods resembling *B. coli*. Subcultures from two of these colonies were preserved for further study and designated as Strains No. 48 and No. 56. Anaerobic plates of litmus glucose agar, incubated five days at 37° C., brought to development 328,000 bacteria per milligram of feces. The colonies were all acid. Of the ten colonies studied, five were made up of rods resembling *B. coli*, and five consisted of rods of the *B. welchii* type. On anaerobic plates of blood-agar, incubated five days at 37° C., 138,000 bacteria per milligram of feces developed into colonies. Six of the ten colonies studied were composed of rods of the *B. coli* type, and the remaining four were composed of rods distinguished by their irregular shape. Subcultures taken from two colonies of the latter kind were preserved for further study and designated as Strain No. 55 and Strain No. 57. Veillon tubes inoculated with 0.50cc. Suspension No. 5, Suspension No. 6 and Suspension No. 7, respectively, and incubated five days at 37° C., showed colonies and gas bubbles in all the tubes. Four colonies were studied, of which three contained rods resembling *B. welchii* and the fourth was made up of cocci grouped as sarcines. Tubes of blood-broth inoculated with 1cc. Suspension No. 1 and incubated five days at 37° C., both in the air and in an atmosphere of hydrogen, failed to bring to development any unusual forms of microbes.

Aerobic litmus-agar plates, inoculated with 0.50cc. and 0.25cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., brought to development 81 spores per milligram of feces. The colonies were all alkaline. Of three colonies studied, two were composed of long slender non-motile rods grow-

ing in threads and containing elongated spores. A subculture taken from one of these colonies was designated as Strain No. 49. The third colony was composed of thick non-motile rods with oval spores. A subculture from this colony was designated as Strain No. 53. On anaerobic plates of blood-agar, incubated five days at 37° C., 590 spores per milligram of feces developed into colonies. Of the ten colonies studied, seven were composed of rods of the *B. welchii* type and three consisted of rods similar to these except that many of the rods contained spores. A subculture from one of the former colonies was designated as Strain No. 51, and a subculture from one of the spore-bearing colonies was designated as Strain No. 52. On anaerobic plates of glucose agar, incubated five days at 37° C., 84 spores per milligram of feces developed into colonies. Of the four colonies studied, three were composed of rods of the *B. welchii* type and one consisted of more slender and irregular rods. A subculture from a colony of the former type was designated as Strain No. 50, and the subculture from the last-mentioned colony was designated as Strain No. 54.

Fermentation-tube cultures inoculated with 0.25cc. Suspension No. 1 and incubated 36 hours at 37° C., gave the following results:

Dextrose broth ..... 5 percent gas in the closed arm
Levulose broth ..... 2.5 percent gas in the closed arm
Lactose broth ..... 10 percent gas in the closed arm
Saccharose broth ..... 5 percent gas in the closed arm
Litmus milk .....No gas; coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5 and incubated 36 hours at 37° C., gave the following results:

Dextrose broth ..... 0.5 percent gas in the closed arm
Levulose broth ..... 0.5 percent gas in the closed arm
Lactose broth ..... 20 percent gas in the closed arm
Saccharose broth ..... 15 percent gas in the closed arm
Litmus milk—Small gas bubbles distributed through the coagulum; acid reaction.

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 36 hours at 37° C., gave the following results:

Sugar-blood broth—100 percent gas in the closed arm; odor of butyric acid.
Litmus milk—100 percent gas in the closed arm; coagulation; acid reaction.
Sugar-free broth containing coagulated egg-white—10 percent gas in the closed arm; no digestion of the albumen. After incubation for seven days the egg-white is almost completely digested.

The fermentation-tube sediments were stained by Gram's method and studied microscopically with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are some Gram-negative rods resembling *B. coli* and some long slender Gram-positive rods.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-negative cocco-bacilli, irregular in shape; there are some slender Gram-positive rods some Gram-positive diplococci and some Gram-negative rods resembling *B. coli.*

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are some Gram-negative rods resembling *B. coli* and a few long slender Gram-positive rods.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-negative rods resembling *B. coli;* Gram-positive diplococci and long slender Gram-positive rods are also present.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are many Gram-negative rods of the *B. coli* type, some long slender Gram-positive rods, and some large Gram-positive rods resembling *B. welchii.*

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; there are many Gram-negative rods resembling *B. coli,* and some large Gram-positive rods of the *B. welchii* type.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative cocco-bacilli of irregular shape; there are many Gram-positive diplococci and some large Gram-positive rods resembling *B. welchii.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The great majority of the bacteria are Gram-positive diplococci; there are some Gram-negative rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): There are about equal numbers of Gram-positive diplococci and Gram-negative rods of the *B. coli* type; some very slender Gram-negative rods.

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; there are many Gram-negative rods of the *B. coli* type and some very short and very slender Gram-negative rods.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): Majority of the bacteria are large Gram-positive rods resembling *B. welchii;* there are some short slender Gram-negative rods.

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Majority of the bacteria are long slender Gram-positive rods; there are many large Gram-positive rods resembling *B. welchii.*"

Plate cultures on anaerobic litmus glucose agar, inoculated with the sediments of the fermentation-tube cultures and incubated six days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Only one colony developed and it is composed of diplococci.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): No growth.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): No growth.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Five colonies developed. One of these consists of long slender rods, and the rest are composed of diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): No growth.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): No growth.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): One colony developed. It is acid in reaction and composed of diplococci.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): One colony developed. It consists of rods resembling *B. coli.*"

The failure of the plate cultures from the sediments was probably due to the unusually long incubation of the fermentation-tube cultures themselves, namely 36 hours. On account of this, the bacteria in the sediment were exposed to the action of their acid products 12 hours longer than in the usual procedure and doubtless many of them had been killed by this exposure.

The subcultures derived from this stool were the following. Strain No. 47 from a colony on the aerobic litmus lactose agar plates, consisting of large non-motile rods; Strain No. 48, from a colony on the litmus lactose gelatin plates, consisting of rods resembling *B. coli;* Strain No. 49, from a colony on the aerobic plates inoculated with spore material, consisting of slender non-motile rods with elongated spores; Strain No. 50, from a colony on the anaerobic glucose-agar plates inoculated with spore material, consisting of rods of the *B. welchii* type; Strain No. 51, from a colony on the anaerobic blood-agar plates inoculated with spore material, consisting of rods resembling *B. welchii;* Strain No. 52, from a colony on the same plates, consisting of rods of the shape and size of *B. welchii* but bearing spores; Strain No. 53, from a colony on the aerobic plates inoculated with spore material, consisting of thick rods containing oval spores; Strain No. 54, from a colony on the anaerobic glucose-agar plates inoculated with spore material, consisting of slender rods of irregular shape; Strain No. 55, from a colony on the anaerobic blood-agar plates inoculated with unheated material, consisting of rods of irregular shape; Strain No. 56, from a colony on the

plates of litmus lactose gelatin, consisting of rods resembling *B. coli;* and Strain No. 57, from a colony on the anaerobic blood-agar plates inoculated with unheated material, consisting of rods of irregular shape.

Specimen No. 19. The patient, J. S., male, was an inmate of the Peoria State Hospital. On June 22d, a definite pellagrous eruption with desquamation was observed on the backs of the hands (Drs. Singer and MacNeal). Apparently this eruption cleared up during the summer. On October 26th, an acute erythema on the backs of the hands was observed by Drs. Singer and MacNeal, and on November 3d, it was again noted as "acute pellagra." On November 14th, both erythema and desquamation were noted but there was very little pigmentation. The stool was passed at 6:30 a. m. on November 14th, and examined at 10 a. m.

The stool was formed, of a pasty consistency. The material seemed to be well digested. Some bean skins were recognized. The odor was moderate and normal in character. Microscopic examination revealed a few bits of striated muscle cells, a moderate number of granulose bacteria and some broken bits of starch. No amebae or flagellates were detected. The suspension for bacterialogical study was made with material taken from the interior of the formed cylinder, and it was packed in ice at 11 a. m. The bacteriological study was begun at 5:30 p. m. on the same day.

By the direct microscopic counting method, 412,000,000 bacteria per milligram of feces were found. No unusual forms were seen in the hanging-drop preparation, but numerous spores and very many slender motile rods were observed. A differential count of 500 bacterial cells in the Gram-stained film gave the following results:

Gram-negative rods of the *B. coli* type	22.0 percent
Slender Gram-negative rods	48.8 percent
Other Gram-negative rods	0.8 percent
Gram-negative cocci	0.2 percent
Short thick Gram-positive rods	0.4 percent
Slender Gram-positive rods	2.2 percent
Oval Gram-positive bacteria	2.6 percent
Small Gram-positive diplococci	14.8 percent
Other Gram-positive cocci	7.0 percent
Oval free spores	1.2 percent
Total Gram-positive bacteria	27.0 percent
Total Gram-negative bacteria	71.8 percent
Total free spores	1.2 percent
Total Gram-negative rods	71.6 percent
Total micrococci	22.0 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 107,000 bacteria per milligram of feces. Of the ten colonies studied, nine consisted of rods resembling *B. coli* and one was made up of rods longer and wider than *B. coli.* On aerobic plates of blood-agar, 60,000 bacteria per milligram of feces developed into colonies. Ten colonies were studied, and, of these, three were composed of rods resembling *B. coli,* two consisted of diplococci, one was made up of cocci grouped as sarcines, one of rods resembling *B. coli* in size but actively motile, and three colonies consisted of spore-bearing rods. A subculture from the colony of motile rods of the size of *B. coli* was designated as Strain No. 67; a subculture from one of the colonies containing spores was designated as Strain No. 69; and a subculture from another spore-bearing colony was designated as Strain No. 65. On aerobic plates of litmus lactose gelatin, incubated five days at 15° to 20° C., 66,000 bacteria per milligram of feces developed into colonies. Of the ten colonies studied, eight consisted of rods resembling *B. coli,* and two were composed of rods of the same shape but very actively motile. A subculture from one of the former was designated as Strain No. 59, and one from the latter colonies was designated as Strain No. 66. On anaerobic plates of litmus glucose agar, incubated five days at 37° C., 103,000 bacteria per milligram of feces developed into colonies. Of the ten colonies examined, one was composed of cocci grouped as sarcines, and the nine were

composed of granular rods larger than *B. coli*. A subculture taken from one of these colonies was designated as Strain No. 62. On anaerobic blood-agar plates, incubated five days at 37° C., 70,000 bacteria per milligram of feces developed into colonies. Of ten colonies studied, six were composed of rods larger than *B. coli* and slightly pointed at the ends. A subculture of one of these colonies was designated as Strain No. 60. Two of the ten colonies were composed of rods resembling *B. welchii*, and a subculture of one of these was designated as Strain No. 63. One colony was composed of rods smaller than *B. coli*, and one of the ten colonies was made up almost entirely of free spores. A subculture of the latter was designated as Strain No. 70. Veillon tubes, inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6, and 0.50cc. Suspension No. 7, respectively, and incubated five days at 37° C., developed colonies in all three tubes, and gas in the first two. Of the five colonies studied, one was composed of large non-motile rods of the *B. welchii* type, and the other four consisted of diplococci. Cultures in blood-broth, inoculated with 1cc. Suspension No. 1 and incubated five days at 37° C., in the air and in atmosphere of hydrogen, did not bring to development any unusual forms of bacteria.

Plates of aerobic litmus agar, inoculated with spore material and incubated 24 hours at 37° C., brought to development 59 spores per milligram of feces. The colonies were all alkaline in reaction. Of the five colonies studied, two consisted of long thick non-motile rods growing in threads and bearing oval spores; two were composed of similar rods with oval spore situated near the end of the cell. A subculture of one of the latter was designated as Strain No. 64. The fifth colony consisted of slender rods with elongated spores, and a subculture of this was designated as Strain No. 68. On anaerobic plates of blood-agar, incubated five days at 37° C., 778 spores per millagram of feces developed into colonies. All the colonies were hemolytic and ten of them studied were found to consist of large non-motile rods of the *B. welchii* type. On anaerobic plates of litmus glucose agar, incubated five days at 37° C., 62 spores per milligram of feces developed into colonies. All the colonies examined were composed of rods resembling *B. welchii*. A subculture of one of them was preserved and designated as Strain No. 58.

Fermentation-tube cultures inoculated with 0.25cc. Suspension No. 1, and incubated 36 hours at 37° C., gave the following results:

Dextrose broth ..... 20 percent gas in the closed arm
Levulose broth ..... 20 percent gas in the closed arm
Lactose broth ..... 25 percent gas in the closed arm
Saccharose broth ..... 20 percent gas in the closed arm
Litmus milk ..... No gas; coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5 and incubated 36 hours at 37° C., gave the following results:

Dextrose broth ..... 30 percent gas in the closed arm
Levulose broth ..... 10 percent gas in the closed arm
Lactose broth ..... 30 percent gas in the closed arm
Saccharose broth ..... 45 percent gas in the closed arm
Litmus milk..Small gas bubbles in the closed arm; no coagulation; acid reaction.

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 36 hours at 37° C., gave the following results:

Sugar-blood broth..100 per cent gas in the closed arm; odor of butyric acid
Litmus milk..100 percent gas in the closed arm; coagulation; acid reaction
Sugar-free broth containing coagulated egg-white..100 percent gas in the closed arm; no digestion of the albumen. After seven days at 37° C., the albumen is almost completely digested. At this time numerous rods of the *B. edematis* type are present but nothing resembling *B. putrificus*.

The sediments of the fermentation-tube cultures were stained by Gram's method and studied microscopically with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are also many Gram-negative rods resembling *B. coli*.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are many Gram-negative rods resembling *B. coli;* some large Gram-negative rods; and a few very slender Gram-negative rods.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are also many Gram-negative rods resembling *B. coli;* a few long slender Gram-positive rods.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are small Gram-positive diplococci; there are a few Gram-negative rods resembling *B. coli;* a few Gram-positive yeasts; some short and very slender Gram-negative rods.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): There are about equal numbers of Gram-positive diplococci and Gram-negative rods resembling *B. coli;* some short and very slender Gram-negative rods; a few large plump Gram-positive rods resembling *B. welchii.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive diplococci; there are many Gram-negative rods resembling *B. coli;* rather numerous large Gram-positive rods resembling *B. welchii.*

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): There are about equal numbers of Gram-positive diplococci and Gram-negative rods resembling *B. coli;* a few large Grams positive rods resembling *B. welchii.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): There are about equal numbers of Gram-negative rods resembling *B. coli* and Gram-positive rods resembling *B. welchii.*

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): Majority of the bacteria are large Gram-positive rods resembling *B. welchii;* there are also many long slender Gram-negative rods.

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): There are about equal numbers of long slender Gram-positive rods and long slender Gram-negative rods; some short thick Gram-negative rods with oval spores; some short thick Gram-positive rods."

Plate cultures on anaerobic litmus glucose agar, inoculated with the fermentation-tube sediments and incubated five days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Only one colony developed and it is composed of diplococci.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): No growth.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Only two colonies developed and they are composed of diplococci.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): No growth.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): No growth.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): No growth.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Two colonies developed. They are composed of diplococci.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Numerous colonies developed. All are acid in reaction and resemble colonies of *B. coli.* All the colonies studied are composed of rods of the *B. coli* type."

Here, as in the case of Specimen No. 18, the incubation of the fermentation-tube cultures for 36 hours was probably the cause of the scarcity of colonies on the plate cultures inoculated with the sediments.

The subcultures derived from this stool and preserved for further study were as follows: Strain No. 58, taken from a colony on the anaerobic glucose-agar plates inoculated with spore material, which was composed of rods of the *B. welchii* type; Strain No. 59, taken from a colony on the gelatin plates, which consisted of rods resembling *B. coli;* Strain No. 60, taken from a colony on the blood-agar plates inoculated with unheated material, which consisted of rods larger than *B. coli* and somewhat pointed at the ends; Strain No. 61, taken from a colony on the anaerobic blood-agar plates inoculated with spore material, which was composed of rods resembling *B.*

welchii; Strain No. 62, taken from a colony on the anaerobic glucose-agar plates inoculated with unheated material, which consisted of granular rods larger than *B. coli;* Strain No. 63, taken from a colony on the anaerobic blood-agar plates inoculated with unheated suspension, which consisted of rods resembling *B. welchii;* Strain No. 64, taken from a colony on the aerobic spore plates, consisting of large non-motile rods with spore near one end of the cell; Strain No. 65, taken from a colony on the aerobic blood-agar plates, consisting of rods larger than *B. coli* and bearing a spore near one end of the cell; Strain No. 66, taken from a colony on the gelatin plates, consisting of actively motile rods otherwise resembling *B. coli;* Strain No. 67, taken from a colony on the aerobic blood-agar plates, consisting of actively motile rods of the size of *B. coli;* Strain No. 68, taken from a colony on the aerobic spore plates, which was composed of slender rods bearing elongated spores; Strain No. 69, taken from a colony on the aerobic blood-agar plates, which was composed of large granular spore-bearing rods; Strain No. 70, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, which was composed almost entirely of free spores.

This specimen was obtained from a definite case of pellagra about three weeks after the appearance of the autumn recurrence. On November 30 the eruption was evidently clearing up. Desquamation was still in progress. On December 14 the hands were entirely peeled off and clean, but there was still some desquamation on the wrists. On January 15 this also had disappeared.

Specimen No. 20. This was obtained from the case W. N. on January 14, 1911. At this time the eruption had entirely disappeared. The stool was passed some time after 6:00 p. m. on January 14, the exact time not being recorded. It was placed out of doors where the temperature was at the freezing point at about 6:00 p. m. and became colder in the night. At 8:30 a. m. January 15, the temperature was +11° F. The material was examined at 9:30 a. m.

The stool was unformed, mushy, yellow in color, with considerable mucus in it. The moisture of the stool was frozen. No gross food remains were recognized. Microscopic examination was not made. The suspension for bacteriological study was made at 10:00 a. m. and packed in ice at 10:30 a. m. The bacteriological study was begun on the next day, January 16, at 9:00 a. m.

By the direct counting method, 68,000,000 bacteria per milligram of feces were found. No unusual forms were observed in the hanging-drop preparation. Differential count of 500 bacterial cells in the Gram-stained film gave the following results:

Gram-negative rods of the *B. coli* type	45.6 percent
Short slender Gram-negative rods	3.6 percent
Other Gram-negative rods	1.2 percent
Gram-negative cocci	10.8 percent
Short thick Gram-positive rods	4.6 percent
Short slender Gram-positive rods	2.4 percent
Small Gram-positive diplococci	24.4 percent
Other Gram-positive cocci	5.4 percent
Oval free spores	1.8 percent
Spherical free spores	0.2 percent
Total Gram-positive bacteria	36.8 percent
Total Gram-negative bacteria	61.2 percent
Total free spores	2.0 percent
Total Gram-negative rods	50.4 percent
Total micrococci	40.6 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 70,000 bacteria per milligram of feces. The colonies were all acid in reaction and some of them strongly so. Ten of the latter were studied microscopically, and were all composed of diplococci. On aerobic plates of blood-agar, incubated 48 hours at 37° C., 103,000 bacteria

per milligram of feces developed into colonies. Of the ten colonies studied, six consisted of diplococci; one was composed of rods resembling *B. coli;* and three were composed of rods of the same size and shape but very actively motile. A subculture of one of these last mentioned colonies was designated as Strain No. 71. On aerobic plates of litmus lactose gelatin incubated five days at 15° to 20° C., 35,000 bacteria per milligram of feces developed into colonies. The colonies were all acid in reaction and did not liquefy the gelatin. Most of them were small and strongly acid. Of the ten colonies studied, seven consisted of diplococci; one was composed of rods resembling *B. coli;* and two were composed of rods of the same size and shape but more actively motile. A subculture of one of these last-mentioned colonies was preserved and designated as Strain No. 75. On anaerobic litmus glucose agar, incubated three days at 37° C., 18,000 bacteria per milligram of feces developed into colonies. These were all acid in reaction. Of the ten colonies studied, six were composed of rods resembling *B. welchii;* three consisted of diplococci; and one was made up of rods resembling *B. coli.* A subculture of this one was designated as Strain No. 74. On anaerobic plates of blood-agar, incubated three days at 37° C., 6,700 bacteria per milligram of feces developed into colonies. Of the eight colonies studied microscopically, three consisted of diplococci; one of rods resembling *B. welchii;* two of rods of the *B. coli* type; and two colonies were composed of rods of this same shape and size but very actively motile. Subcultures of these two colonies were designated as Strain No. 72 and Strain No. 73. A tube of blood-broth, inoculated with 1cc. Suspension No. 1 and incubated three days at 37° C., failed to bring to development any unusual forms of microbes.

Plate cultures on aerobic litmus agar, inoculated with spore material and incubated three days at 37° C., brought to development nine spores per milligram of feces. Several of the colonies were studied and were found to consist of slender rods with elongated spore situated near the end of the cell. On anaerobic plates of blood-agar, incubated three days at 37° C., 4,800 spores per milligram of feces developed into colonies. These colonies were apparently all of the same type, and three of them studied microscopically were composed of rods resembling *B. welchii.* On anaerobic plates of glucose agar, incubated three days at 37° C., 750 spores per milligram of feces developed into colonies. All the colonies studied microscopically were composed of rods of the *B. welchii* type.

Fermentation-tube cultures inoculated with 0.25cc. Suspension No. 1, and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... No gas in the closed arm; good growth
Levulose broth ..... No gas in the closed arm; good growth
Lactose broth ..... No gas in the closed arm; good growth
Saccharose broth ..... No gas in the closed arm; good growth
Litmus milk..Small gas bubble in the closed arm; coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... No gas in the closed arm; good growth
Levulose broth ..... No gas in the closed arm; good growth
Lactose broth ..... 55 percent gas in the closed arm
Saccharose broth ..... No gas in the closed arm; good growth

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth..100 percent gas in the closed arm; odor of butyric acid
Litmus milk .....No change; apparently no growth
Sugar-free broth containing coagulated egg-white..10 percent gas in the closed arm; no digestion of the albumen.

The sediments of the fermentation-tube cultures were stained by Gram's method and studied microscopically with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Sediment consists almost wholly of Gram-positive diplococci; there are a few long slender Gram-positive rods and a few Gram-negative rods resembling *B. coli.*

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Majority of

the bacteria are Gram-positive diplococci; there are some Gram-positive yeasts; some short slender Gram-negative rods; and some Gram-negative rods resembling *B. coli.*

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Sediment appears to be a pure culture of Gram-positive diplococci.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are a few Gram-negative rods resembling *B. coli.*

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are some Gram-negative rods resembling *B. coli;* some long thick Gram-positive rods; some thick short Gram-positive rods resembling *B. welchii.*

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Sediment appears to be a pure culture of Gram-positive diplococci.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Sediment appears to be a pure culture of Gram-positive diplococci.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are large Gram-positive rods resembling *B. welchii;* there are some Gram-positive diplococci; some Gram-negative rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): Sediment appears to be a pure culture of Gram-positive diplococci.

"Sugar-blood broth (inoculated with 0:50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of rods of *B. welchii* type.

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): No bacteria found.

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are a few large Gram-positive rods of the *B. welchii* type."

Plate cultures of the fermentation-tube sediments were not made. Veillon tube cultures, inoculated with the sediment of the lactose-broth fermentation tube of the first series, brought to development many colonies of diplococci, but nothing else.

The subcultures derived from this stool and set aside for further study were the following: Strain No. 71, taken from a colony on the aerobic blood-agar plates, consisting of actively motile rods of the size and shape of *B. coli;* Strain No. 72, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, consisting of actively motile rods of the size and shape of *B. coli;* Strain No. 73, taken from a similar colony on the same plates; Strain No. 74, taken from a colony on the anaerobic plates of litmus glucose agar inoculated with unheated suspension, which was composed of rods resembling *B. coli;* Strain No. 75, taken from a colony on the gelatin plates, which was made up of rods morphologically resembling *B. coli* but very actively motile.

Specimen No. 21. This was obtained from the patient E. P., whose history has been given in connection with the description of Specimen No. 15. On January 15 the eruption had entirely disappeared, only the thin atrophic skin remaining to indicate the previous attack of pellagra. The stool was passed some time after 6:00 p. m. on January 14 and was kept out of doors where the temperature was below the freezing point. It was examined at 9:45 a. m. on January 15.

The stool was a formed cylinder, very dark brown on the exterior, but light brown beneath the surface. It was frozen but friable as if fairly rich in fat. No macroscopic food remains were recognizable. Microscopic examination was not made. The suspension for bacteriological study was made at 10:25 a. m. and was packed in ice. The bacteriological study was begun at 10:30 a. m. the next day, January 16.

By direct microscopic count 230,000,000 bacteria per milligram of feces were found. In the hanging-drop preparation no unusual forms were observed. The differential count of 500 cells in a Gram-stained film gave the following results:

Gram-negative rods of the *B. coli* type	42.0 percent
Short slender Gram-negative rods	32.4 percent
Other Gram-negative rods	2.8 percent
Gram-negative cocci	3.6 percent
Short thick Gram-positive rods	0.6 percent
Short slender Gram-positive rods	2.0 percent
Oval Gram-positive bacteria	1.4 percent
Small Gram-positive diplococci	8.8 percent
Other Gram-positive cocci	3.4 percent
Oval free spores	2.8 percent
Spherical free spores	0.2 percent
Total Gram-positive bacteria	16.2 percent
Total Gram-negative bacteria	80.8 percent
Total free spores	3.0 percent
Total Gram-negative rods	77.2 percent
Total micrococci	15.8 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 11,040 bacteria per milligram of feces. Nearly all of the colonies were acid in reaction. Six acid colonies were found to consist of diplococci. Four alkaline colonies were studied, of which two were composed of large motile rods and two consisted of rods resembling *B. coli* in size and shape, but more actively motile. A subculture from one of the former colonies was designated as Strain No. 78, and a subculture of one of the latter was designated as Strain No. 79. On aerobic plates of blood-agar, incubated 24 hours at 37° C., 10,100 bacteria per milligram of feces developed into colonies. Nine colonies were studied, of which three consisted of diplococci, two were composed of sarcines, and one was composed of rods resembling *B. coli*. One colony was made up of non-motile rods of very irregular shape, and a subculture of it was preserved and designated as Strain No. 80. A non-hemolytic colony, which produced a brownish discoloration of the medium, was composed of large granular rods growing in long threads, and the remaining colony resembled this one in every respect except that it was surrounded by a zone of hemolysis. On aerobic plates of litmus lactose gelatin, incubated six days at 15° to 20° C., only six bacteria per milligram of feces developed into colonies. Only four colonies developed on all four plates inoculated and one of these was a gelatin-liquefying yeast and another a liquefying diplococcus. On anaerobic plates of litmus glucose agar, incubated three days at 37° C., 52,842 bacteria per milligram of feces developed into colonies. These were all of apparently the same type, and ten of them studied microscopically were found to consist of rods resembling *B. welchii*. A subculture from one of these colonies was designated as Strain No. 77. On anaerobic blood-agar plates, incubated three days at 37° C., 39,000 bacteria per milligram of feces developed into colonies. The colonies were apparently of uniform type and ten of them were found to consist of rods resembling *B. welchii*. A subculture was designated as Strain No. 76. A tube of blood-broth, inoculated with 1cc. of Suspension No. 1 and incubated three days at 37° C. in an atmosphere of hydrogen, developed many rods of irregular shape. Probably these were merely involution forms of *B. welchii*.

Aerobic plates of litmus agar, inoculated with spore material and incubated three days at 37° C., brought to development 28 spores per milligram of feces. The colonies were all of the same type and a number of them studied microscopically were composed of slender rods with elongated spore situated nearer one end. Anaerobic plates of blood-agar, incubated three days at 37° C., brought to development 28,000 spores per milligram of feces. The colonies were closely crowded on the plates. Those studied were composed of rods of the *B. welchii* type. On anaerobic plates of glucose agar, incubated three days at 37° C., 38,000 spores per milligram of feces developed into colonies. Apparently all were composed of rods of the *B. welchii* type.

Fermentation-tube cultures inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth .....No gas in the closed arm; good growth
Levulose broth .....No gas in the closed arm; good growth
Lactose broth .....10 per cent gas in the closed arm
Saccharose broth .....No gas in the closed arm; good growth
Litmus milk..Small bubble of gas in the closed arm; coagulation; acid reaction.

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth .....No gas in the closed arm; good growth
Levulose broth .....No gas in the closed arm; good growth
Lactose broth ..... 70 percent gas in the closed arm
Saccharose broth .....No growth

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth..100 percent gas in the closed arm; odor of butyric acid
Litmus milk.. 40 percent gas in the closed arm; coagulation; acid reaction
Sugar-free broth containing coagulated egg-white..No gas; no digestion of the albumen; good growth.

Microscopic study of the Gram-stained sediments of the fermentation-tube cultures gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): The sediment consists almost exclusively of Gram-positive diplococci; there are some short slender Gram-negative rods and some large Gram-positive rods resembling *B. welchii.*

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Majority of the bacteria are Gram-positive diplococci; there are some short slender Gram-negative rods; some large Gram-positive rods resembling *B. welchii.*

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Many small Gram-positive diplococci; some large Gram-positive rods resembling *B. welchii;* some large Gram-negative rods of the *B. coli* type.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Many Gram-positive diplococci; some long slender Gram-negative rods; some short slender Gram-negative rods.

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Many Gram-positive diplococci; many Gram-negative rods resembling *B. coli.*

"Dextrose broth (inoculated with 0.50 cc. Suspension No. 5): Sediment appears to be a pure culture of Gram-positive diplococci.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Sediment appears to be a pure culture of Gram-positive diplococci.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Sediment appears to be a pure culture of *B. welchii.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): No growth.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment appears to be a pure culture of *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment appears to be a pure culture of long, rather slender, Gram-positive rods.

Plate cultures were not made from the fermentation-tube sediments. Veillon tubes, inoculated with the sediment of the lactose broth of the first series of fermentation tubes, yielded only colonies of diplococci.

The subcultures preserved for further study were the following: Strain No. 76, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, consisting of rods of *B. welchii* type; Strain No. 77, taken from a colony on the anaerobic plates of litmus glucose agar inoculated with unheated material, which was composed of rods resembling *B. welchii;* Strain No. 78, taken from a colony on the aerobic litmus lactose agar plates inoculated with unheated material, which was composed of large actively motile rods; Strain No. 79, taken from a colony on the same plates, which

was alkaline in reaction and composed of actively motile rods resembling *B. coli* in size and shape; Strain No. 80, taken from a colony on the aerobic blood-agar plates, consisting of non-motile rods irregular in shape.

Specimen No. 22. The patient, A. D., female, was a patient in the Cook County Hospital. Her history is given more fully elsewhere in this report. She was perfectly sane, and had not had a previous attack of pellagra. Her hands became "chapped" about October 15, 1910, and had been sore ever since that time. Upon admission to the hospital in December, the pellagrous nature of the eruption was very evident. On January 20th, she was greatly emaciated and very weak, but her mind was clear. There was a typical severe pellagrous eruption on the hands with a very sharp line of demarcation about the wrists. Below this the skin was deep brown in color, desquamating with ulcerated surfaces over the backs of the hands. Both hands were swollen and edematous. The tongue was very red and the odor of the mouth very foul, resembling that of the stool which was examined at this time. The patient had a severe diarrhœa which had been checked somewhat by opium in the preceding 24 hours. The stool was passed at 9 p. m. and packed in ice. It was examined at 10:20 a. m.

The stool consisted of a brown-colored fluid with blood-tinged flakes in it. The odor was very offensive and penetrating, although not very strong. Microscopic examination of the mucous flakes revealed epithelial cells, red blood cells, leucocytes, and active flagellates. Amebae were not found. Bacteria appeared only moderately numerous. Spirilla were present. There was a little broken starch, but no granulose bacteria were observed. The suspension for bacteriological study was prepared and packed in ice at 10:45 p. m., and the bacteriological study was begun at 2 p. m., the next day, January 21st.

By the direct counting method 20,600,000 bacteria per milligram of feces were found. A considerable number of spirilla were observed in the hanging-drop preparation. The differential count of 600 bacterial cells in a Gram-stained film gave the following results:

Gram-negative rods of the *B. coli* type	14.8 percent
Short slender Gram-negative rods	69.7 percent
Other Gram-negative rods	3.0 percent
Gram-negative cocci	0.7 percent
Gram-negative spirilla	0.5 percent
Short slender Gram-positive rods	0.7 percent
Oval Gram-positive bacteria	0.5 percent
Large Gram-positive cocci	0.2 percent
Small Gram-positive cocci	9.6 percent
Oval free spores	0.3 percent
Total Gram-positive bacteria	11.0 percent
Total Gram-negative bacteria	88.7 percent
Total free spores	0.3 percent
Total Gram-negative rods	87.5 percent
Total micrococci	10.5 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 114,000 bacteria per milligram of feces. Nearly all the colonies were acid in reaction. Fourteen were studied microscopically, of which ten were composed of non-motile rods otherwise resembling *B. coli*. A subculture from one of these colonies was designated as Strain No. 84. One colony among the fourteen was composed of actively motile rods resembling *B. coli* in size and shape. A subculture of this was designated as Strain No. 81. One colony was composed of diplococci. Two alkaline colonies were composed of actively motile small rods. A subculture from one of these was designated as Strain No. 90. On aerobic plates of blood agar, incubated 24 hours at 37° C., 107,000 bacteria per milligram of feces developed into colonies. Of the ten colonies studied, six were composed of rods

resembling *B. coli*. A subculture from one of these colonies was designated as Strain No. 88. The other four colonies were strongly hemolytic and were composed of very actively motile rods resembling *B. coli* in size and shape. A subculture was designated as Strain No. 85. The gelatin plates were omitted. On anaerobic plates of glucose agar, incubated 48 hours at 37° C., 87,000 bacteria per milligram of feces developed into colonies. These were all acid in reaction. Of ten colonies studied, nine were composed of rods resembling *B. welchii* and one consisted of rods resembling *B. coli*. A subculture from one of the former colonies was designated as Strain No. 86. On anaerobic plates of blood-agar, incubated 48 hours at 37° C., 116,000 bacteria per milligram of feces developed into colonies. Of the ten colonies studied, six consisted of rods resembling *B. coli*. A subculture of one of these was designated as Strain No. 83. Two of the other colonies consisted of rods resembling *B. welchii*. The other two colonies were composed of actively motile rods, otherwise resembling *B. coli*. Subcultures of these were designated as Strain No. 87 and Strain No. 89. Veillon tubes inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6 and 0.50cc. Suspension No. 7, incubated four days at 37° C., showed gas in the first two tubes and no growth in the third. Several colonies examined were composed of rods of the *B. coli* type. Tubes of blood-broth were inoculated with 1cc. Suspension No. 1 and incubated two days in the air and in hydrogen. The aerobic culture developed numerous non-motile rods of irregular shape and the anaerobic culture produced numerous small diplococci and a considerable number of rods with large terminal spores (drumsticks).

Aerobic litmus agar inoculated with spore material and incubated 24 hours at 37° C., brought to development 17 spores per milligram of feces. All the colonies were alkaline in reaction. On anaerobic blood-agar plates, incubated three days at 37° C., 12,000 spores per milligram of feces developed into colonies. The colonies were too closely crowded on the plates for careful study but those examined were composed of rods resembling *B. welchii*. On anaerobic plates of litmus glucose agar, incubated two days at 37° C., 177 spores per milligram of feces developed into colonies. A number of colonies examined consisted of rods of the *B. welchii* type. A subculture from one of these was designated as Strain No. 82.

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 42 percent gas in the closed arm
Levulose broth ..... 76 percent gas in the closed arm
Lactose broth ..... 42 percent gas in the closed arm
Saccharose broth ..... 50 percent gas in the closed arm
Litmus milk..100 percent gas in the closed arm; coagulation; acid reaction

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 58 percent gas in the closed arm
Levulose broth ..... 50 percent gas in the closed arm
Lactose broth ..... 45 percent gas in the closed arm
Saccharose broth ..... 5 percent gas in the closed arm
Litmus milk..... 5 percent gas in the closed arm; no coagulation

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth..100 percent gas in the closed arm; odor of butyric acid
Litmus milk..100 percent gas in the closed arm; coagulation; acid reaction
Sugar-free broth containing coagulated egg-white..15 percent gas in the closed arm; no digestion of the albumen.

The fermentation-tube sediments were stained by Gram's method and studied microscopically with the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): Many Gram-negative rods resembling *B. coli;* some Gram-positive diplococci; some large Gram-positive rods resembling *B. welchii*.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): Many Gram-negative rods resembling *B. coli;* some Gram-positive diplococci; some large Gram-positive rods.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): Many Gram-negative rods resembling *B. coli;* some Gram-positive diplococci; some large Gram-positive rods.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Many Gram-negative rods resembling *B. coli;* some Gram-positive diplococci; many Gram-positive rods resembling *B. welchii.*

"Litmus milk (inoculated with 0.25cc. Suspension No. 1): Many Gram-negative rods resembling *B. coli;* some slender Gram-negative rods; some Gram-positive diplococci; some large Gram-positive rods resembling *B. welchii.*

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are some large Gram-positive rods of the *B. welchii* type.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-negative rods resembling *B. coli;* there are some large Gram-positive rods.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are large Gram-positive rods; there are some Gram-negative rods of the *B. coli* type.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): There are many Gram-negative rods resembling *B. coli;* some Gram-positive diplococci; a few Gram-positive rods resembling *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 5): Majority of the bacteria are Gram-positive rods of the *B. welchii* type; there are some Gram-negative rods of the *B. coli* type.

"Sugar-blood broth (inoculated with 0.50cc. Suspension No. 2, Spores): The sediment consists of large Gram-positive rods resembling *B. welchii.*

"Litmus milk (inoculated with 0.50cc. Suspension No. 2, Spores); The sediment consists of large Gram-positive rods resembling *B. welchii.*

"Sugar-free broth containing coagulated egg-white (inoculated with 0.50cc. Suspension No. 2, Spores): Sediment consists of Gram-positive rods of the *B. welchii* type."

Plate cultures on glucose litmus agar inoculated with the sediments of the fermentation-tube cultures, incubated three days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid. Five of them studied microscopically consist of rods resembling *B. coli.*

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid, and of the five studied, one consists of diplococci and four appear to be colonies of *B. coli.*

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): The colonies all resemble colonies of *B. coli,* and the five examined microscopically are composed of rods of this type.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): Sediment was not plated.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): Colonies all resemble those of *B. coli* and the five examined microscopically are composed of rods of this type.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): Sediment was not plated.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): Colonies are all acid, some of them strongly so. Of the five colonies studied, four appear to consist of *B. coli* and one is composed of slender non-motile rods.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies all resemble colonies of *B. coli,* and five examined are composed of rods of this type."

Veillon tubes, inoculated with the sediment of the lactose broth fermentation-tube culture of the first series, developed numerous colonies and abundant gas in the first two tubes, but no growth in the third tube even after incubation for one week.

The subcultures preserved for further study were the following: Strain No. 81, taken from a colony on the aerobic plates of litmus lactose agar, which consisted of actively motile rods resembling *B. coli* in size and shape; Strain No. 82, taken from a colony on the anaerobic plates of glucose agar inoculated with spore material, which was composed of rods of the *B. welchii* type; Strain No. 83, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, which was made up of rods resembling *B. coli;* Strain No. 84, taken from a colony on the aerobic plates of litmus lactose agar, which consisted of non-motile rods otherwise resembling *B. coli;* Strain No. 85, taken from a colony on the aerobic blood-agar plates composed of actively motile rods of the size and shape of *B. coli;* Strain No. 86, taken from a colony on the anaerobic plates of litmus glucose agar, which consisted of rods resembling *B. welchii;* Strain No. 87, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, which was composed of actively motile rods otherwise resembling *B. coli;* Strain No. 88, taken from a colony on the aerobic blood-agar plates, composed of rods of the *B. coli* type; Strain No. 89, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, which was composed of actively motile rods otherwise resembling *B. coli;* Strain No. 90, taken from an alkaline colony on the aerobic plates of litmus lactose agar, which consisted of small actively motile rods.

The patient died on January 22 at 2:00 p. m. and the autopsy was performed at 10:15 a. m. on January 23, by Dr. Singer. The two following specimens were obtained at the autopsy.

Specimen No. 23. This was obtained from the cecum at 11:00 a. m., January 23. There was rather foul odor in the peritoneal- cavity. The intestine was dilated with gas and contained very little else. The sample was obtained by thrusting the capillary of a sterile Pasteur bulb pipette through the seared wall of the cecum. The gas escaping from the opening was offensive and contained an appreciable amount of hydrogen sulphide.

The material obtained was a brown colored opaque fluid free from macroscopic particles. Microscopic examination revealed rather numerous cells, apparently leucocytes. Bacteria were fairly numerous, bacilli, cocci, and spirilla being represented. When stained with iodine, a few small fragments of starch were seen, and some of the slender bacilli assumed a very brown color. Ordinary granulose bacteria were not found. The suspension for bacteriological study was prepared at 1:30 p. m. and packed in ice. The bacteriological study was begun at 10:00 a. m. on the next day, January 24.

By the direct microscopic counting method 53,000,000 bacteria per milligram of material were found. No unusual microbic forms were observed in the hanging-drop preparation. Differential count of 500 cells in the Gram-stained film gave the following results:

Gram-negative rods of the *B. coli* type	26.2 percent
Short slender Gram-negative rods	30.6 percent
Long slender Gram-negative rods	11.4 percent
Other Gram-negative rods	0.2 percent
Gram-negative diplococci	1.2 percent
Short, slender Gram-positive rods	1.8 percent
Oval Gram-positive bacteria	1.2 percent
Small Gram-positive diplococci	25.6 percent
Other small Gram-positive cocci	1.6 percent
Oval free spores	0.2 percent
Total Gram-positive bacteria	30.2 percent
Total Gram-negative bacteria	69.6 percent
Total free spores	0.2 percent
Total Gram-negative rods	68.4 percent
Total micrococci	28.4 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 330,000 bacteria per milligram of intestinal con-

tents. Most of the colonies were acid in reaction but some were alkaline. Eleven colonies were studied microscopically. One was a colony of mold; two were alkaline colonies composed of small actively motile rods; and the remaining eight appeared to be colonies of *B. coli*. A subculture from one of the alkaline colonies was designated as Strain No. 91. A subculture of one of the colonies resembling *B. coli* was designated as Strain No. 105, and a subculture of the mold was designated as Strain No. 106. On aerobic plates of blood agar, incubated 24 hours at 37° C., 315,000 bacteria per milligram of intestinal contents developed into colonies. Of the ten colonies studied, eight were composed of rods resembling *B. coli*, one consisted of small very actively motile rods, and one was composed of long motile rods with oval spore near the end of the cell. A subculture from the colony of small rods was designated as Strain No. 98, and a subculture from the colony containing spores was designated as Strain No. 104. On aerobic plates of litmus lactose gelatin, incubated four days at 15° to 20° C., 250,000 bacteria per milligram of intestinal contents developed into colonies. Most of the colonies were acid and resembled colonies of *B. coli*. Five colonies were studied. One of them, an alkaline liquefying colony, was composed of large motile rods growing in long threads. A subculture of it was designated as Strain No. 92. Another one, slightly alkaline and non-liquefying, consisted of rods resembling *B. coli*. A subculture from it was designated as Strain No. 97. A third alkaline colony, which liquefied the gelatin, was composed of very actively motile rods resembling *B. coli* in size and shape. A subculture of it was designated as Strain No. 99. The other two colonies studied appeared to be colonies of *B. coli*. On anaerobic plates of litmus glucose agar, incubated three days at 37° C., 260,000 bacteria per milligram of intestinal contents developed into colonies. The colonies were all acid in reaction. Nine of them were studied microscopically, and seven of these were composed of large granular rods. A subculture of one of these was designated as Strain No. 95. One of the nine colonies was composed of rods resembling *B. coli* and a subculture of it was designated as Strain No. 93. The other colony consisted of slender non-motile rods, and a subculture from it was designated as Strain No. 103. On anaerobic blood-agar plates, incubated three days at 37° C., 265,000 bacteria per milligram of intestinal contents developed into colonies. Of the ten colonies studied, five were composed of rods resembling *B. coli*, three of rods of the *B. welchii* type, and two of diplococci. A subculture from one of the first-mentioned colonies was designated as Strain No. 100 and a subculture from one of the colonies containing rods of the *B. welchii* type was designated as Strain No. 102. Veillon tubes of glucose agar, inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6 and 0.50cc. Suspension No. 7, respectively, and incubated three days at 37° C., showed abundant colonies and gas in the first two tubes, and only one colony without any gas in the third tube. This colony was composed of large non-motile rods. A subculture from it was designated as Strain No. 94.

Aerobic plates of litmus agar, inoculated with spore material and incubated 24 hours at 37° C., brought to development only four spores per milligram of intestinal contents. On anaerobic plates of blood-agar, incubated three days at 37° C., 3,200 bacteria per milligram of intestinal contents developed into colonies. All of the colonies studied were composed of rods resembling *B. welchii*. A subculture from one of them was designated as Strain No. 101. On anaerobic plates of glucose agar, incubated three days at 37° C., 20 spores per milligram of intestinal contents developed into colonies. These appeared to be of the same type and consisted of rods resembling *B. welchii*.

Tubes of blood-broth, inoculated with 1cc. Suspension No. 1 and incubated six days at 37° C., in the air and in an atmosphere of hydrogen, failed to bring to development any unusual microbic forms. Some "drumstick" forms were seen in the anaerobic culture.

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 32 percent gas in the closed arm
Levulose broth ..... 35 percent gas in the closed arm
Lactose broth ..... 35 percent gas in the closed arm
Saccharose broth ..... 57 percent gas in the closed arm
Litmus milk..10 percent gas in the closed arm; coagulation; acid reaction

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 47 percent gas in the closed arm
Levulose broth ..... 50 percent gas in the closed arm
Lactose broth ..... 47 percent gas in the closed arm
Saccharose broth ..... 20 percent gas in the closed arm
Litmus milk....5 percent gas in the closed arm; coagulation; acid reaction

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth..100 percent gas in the closed arm; odor of butyric acid
Litmus milk..10 percent gas in the closed arm; coagulation; acid reaction
Sugar-free broth containing coagulated egg-white.....No growth

The sediments of the fermentation-tube cultures were not studied microscopically.

Plate cultures on anaerobic litmus glucose agar, inoculated with the sediments of the fermentation-tube cultures and incubated five days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid, many of them strongly so. Of the ten colonies studied, six are composed of diplococci and four consist of rods resembling *B. coli*.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid, some strongly so. Of the ten colonies studied, seven are composed of rods resembling *B. coli*, and three consist of diplococci.

"Lactose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid in reaction some of them strongly so. Of the ten colonies studied eight are composed of rods resembling *B. coli*, and two consist of diplococci.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): There are only a few colonies Of the two studied, one is composed of large rods resembling *B. welchii*, and the other consists of rods of the *B. coli* type.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid, some of them strongly so. All of the ten colonies studied are composed of rods of the *B. coli* type.

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and there are many gas bubbles in the agar. All of the ten colonies studied are composed of rods resembling *B. coli*.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid, some of them strongly so. All of the ten colonies studied are composed of rods resembling *B. coli*.

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and all of the ten colonies studied are composed of rods resembling *B. coli*.

The subcultures preserved for further study were the following: Strain No. 91, taken from an alkaline colony on the aerobic litmus lactose agar plates, which was composed of small motile rods; Strain No. 92, taken from an alkaline liquefying colony on the aerobic gelatin plates, which consisted of large motile rods; Strain No. 93, taken from a colony on the anaerobic plates of litmus glucose agar, which was composed of rods of the *B. coli* type; Strain No. 94, taken from a colony in the Veillon tubes inoculated with suspensions of the original material, which was composed of large non-motile rods; Strain No. 95, taken from a colony on the anaerobic plates of litmus glucose agar, which consisted of large granular rods; Strain No. 96, taken from an alkaline colony on the aerobic plates of litmus lactose agar; which was composed of small motile rods; Strain No. 97, taken from a slightly alkaline non-liquefying colony on the gelatin plates, which was composed of rods resembling *B. coli;* Strain No. 98, taken from a colony on the aerobic blood-agar plates, which was made up of small very actively motile rods;

Strain No. 99, taken from an alkaline liquefying colony on the gelatin plates, composed of very actively motile rods of the size and shape of *B. coli;* Strain No. 100, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, which was composed of rods of the *B. coli* type; Strain No. 101, taken from a colony on the anaerobic blood-agar plates inoculated with spore material, which consisted of rods resembling *B. welchii;* Strain No. 102, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, which was composed of rods resembling *B. welchii;* Strain No. 103, taken from a colony on the anaerobic plates of litmus glucose agar, which consisted of slender non-motile rods; Strain No. 104, taken from a colony on the aerobic blood-agar plates, which was composed of long motile rods with oval spores; Strain No. 105, taken from a colony on the aerobic plates of litmus lactose agar, which was composed of rods resembling *B. coli;* Strain No. 106, taken from a colony of mold on the aerobic plates of litmus lactose agar.

Specimen No. 24. This specimen was obtained at the same autopsy from the small intestine by puncturing the seared intestinal wall at a point two and one-half feet above the ileocecal valve with a sterile Pasteur bulb pipette. The material was removed from the intestine at 11 a. m.

It was an opaque fluid, yellow in color, and free from macroscopic particles. The odor was not particularly offensive. Microscopic examination revealed many cells evidently from vegetable tissue. Bacteria were moderately numerous, chiefly small slender bacilli, but a few micrococci and spirilla were also found. Staining with iodine showed only a minute amount of starch, and no granulose bacteria. The suspension for bacteriological study was prepared at 1:15 p. m. and packed in ice at 1:30 p. m. The bacteriological study was begun at 10 a. m. the next day, January 24th.

By the direct microscopic counting method, 33,600,000 bacteria per milligram of intestinal contents were found. No unusual forms of microbes were observed in the hanging-drop preparation. A differential count of 500 cells in the Gram-stained preparation gave the following results:

Gram-negative rods of the *B. coli* type	30.0 percent
Short slender Gram-negative rods	25.4 percent
Long slender Gram-negative rods	3.2 percent
Other Gram-negative rods	0.8 percent
Short thick Gram-positive rods	0.8 percent
Slender Gram-positive rods	1.2 percent
Oval Gram-positive bacteria	0.8 percent
Small Gram-positive diplococci	37.6 percent
Other Gram-positive cocci	0.2 percent
Free spores	0.0 percent
Total Gram-positive bacteria	40.6 percent
Total Gram-negative bacteria	59.4 percent
Total free spores	0.0 percent
Total Gram-negative rods	59.4 percent
Total micrococci	37.8 percent

Plate cultures on aerobic litmus lactose agar, incubated 24 hours at 37° C., brought to development 1,020,000 bacteria per milligram of intestinal contents. All the colonies resembled colonies of *B. coli*, and ten of them studied were composed of rods of the *B. coli* type. A subculture from one of them was designated as Strain No. 112. On aerobic plates of blood-agar, incubated 24 hours at 37° C., 1,120,000 bacteria per milligram of intestinal contents developed into colonies. The ten colonies examined were composed of rods of the *B. coli* type. A subculture from one of them was designated as Strain No. 108. On aerobic plates of litmus lactose gelatin, incubated four days at 15° to 20° C., 1,070,000 bacteria per milligram of intestinal contents developed into colonies. The colonies all resembled colonies of *B. coli*, and the six which were studied microscopically were composed of rods resembling this organism. On anaerobic plates of litmus glucose agar, incubated three days at 37° C., 880,000 bacteria per milligram of intestinal contents developed into colonies. The ten colonies studied were composed

of rods resembling *B. coli*. A subculture of one of these was designated as Strain No. 107. On anaerobic blood-agar plates, incubated three days at 37° C., 1,140,000 bacteria per milligram of intestinal contents developed into colonies. The ten colonies studied consisted of rods of the *B. coli* type. A subculture of one of these was designated as Strain No. 109. Veillon tubes of glucose agar were inoculated with 0.50cc. Suspension No. 5, 0.50cc. Suspension No. 6, and 0.50cc. Suspension No. 7, respectively, and incubated three days at 37° C. The agar of the first two tubes was riddled with gas. The third one contained bubbles of gas, but there were some lenticular colonies without adjacent gas spaces. Some of these were examined and found to be composed of large non-motile rods. Tubes of blood-broth, inoculated with 1cc. Suspension No. 1 and incubated six days at 37° C., both in the air and in hydrogen, brought to development no unusual forms. Some bacilli with terminal spores, "drumsticks," were observed in the anaerobic culture.

On anaerobic litmus agar, inoculated with spore material and incubated 24 hours at 37° C., 2 spores per milligram of intestinal contents developed into colonies. These were alkaline in reaction. On anaerobic blood-agar plates, incubated three days at 37° C., 1,800 spores per milligram of intestinal contents developed into colonies. All of the ten colonies studied were composed of rods resembling *B. welchii*. A subculture of one of them was designated as Strain No. 113. On anaerobic plates of glucose agar, incubated three days at 37° C., 7 spores per milligram of intestinal contents developed into colonies. All appeared to be colonies of bacteria belonging to the *B. welchii* group. A subculture of one of them was designated as Strain No. 110.

Fermentation-tube cultures, inoculated with 0.25cc. Suspension No. 1 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 40 percent gas in the closed arm
Levulose broth ..... 30 percent gas in the closed arm
Lactose broth ..... 10 percent gas in the closed arm
Saccharose broth ..... 72 percent gas in the closed arm
Litmus milk..30 percent gas in the closed arm; coagulation; acid reaction

Fermentation-tube cultures, inoculated with 0.50cc. Suspension No. 5 and incubated 24 hours at 37° C., gave the following results:

Dextrose broth ..... 42 percent gas in the closed arm
Levulose broth ..... 62 percent gas in the closed arm
Lactose broth ..... 45 percent gas in the closed arm
Saccharose broth ..... 20 percent gas in the closed arm
Litmus milk...5 percent gas in the closed arm; coagulation; acid reaction

Fermentation-tube cultures inoculated with 0.50cc. Suspension No. 2, Spores, and incubated 24 hours at 37° C., gave the following results:

Sugar-blood broth...100 percent gas in the closed arm; odor of butyric acid
Litmus milk..100 percent gas in the closed arm; coagulation; acid reaction
Sugar-free broth containing coagulated egg-white.....No growth

The sediments of the fermentation-tube cultures were not studied microscopically.

Plate cultures on anaerobic litmus glucose agar, inoculated with the fermentation-tube sediments and incubated five days at 37° C., gave the following results:

"Dextrose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid and there are some gas bubbles. Of the ten colonies studied, eight are composed of diplococci and two consist of rods resembling *B. coli*.

"Levulose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid and the majority of them strongly so. Of the nine colonies studied, seven consist of diplococci and two are composed of rods resembling *B. coli*.

"Lactose broth (inoculated with 0.25cc Suspension No. 1): The colonies are all acid, most of them strongly so. Of the five colonies studied, one is composed of diplococci, three of rods resembling *B. coli*, and one is composed of slender non-motile rods. A subculture from this last colony is designated as Strain No. 114.

"Saccharose broth (inoculated with 0.25cc. Suspension No. 1): The colonies are all acid, the majority of them strongly so. All of the five studied are composed of diplococci.

"Dextrose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid and the five of them studied are composed of rods resembling *B. coli.*

"Levulose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid, and all of the five colonies studied consist of rods of the *B. coli* type.

"Lactose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid. Of the five colonies studied, two are composed of diplococci and three consist of rods resembling *B. coli.*

"Saccharose broth (inoculated with 0.50cc. Suspension No. 5): The colonies are all acid. Of the five colonies studied, one is composed of diplococci and four consist of rods resembling *B. coli.*"

The subcultures preserved for further study were the following: Strain No. 107, taken from a colony on the anaerobic plates of litmus glucose agar, which consisted of rods resembling *B. coli;* Strain No. 108, taken from a colony on the aerobic blood-agar plates, which was composed of rods of the *B. coli* type; Strain No. 109, taken from a colony on the anaerobic blood-agar plates inoculated with unheated material, which was composed of rods resembling *B. coli;* Strain No. 110, taken from a colony on the plates of anaerobic glucose agar inoculated with spore material, which consisted of rods of the *B. welchii* type; Strain No. 111, taken from a colony in the Veillon tubes inoculated with sediment of the fermentation-tube cultures in lactose broth of the first series, which consisted of slender actively motile rods; Strain No. 112, taken from a colony on the aerobic plates of litmus lactose agar, which was composed of rods of the *B. coli* type; Strain No. 113, taken from a colony on the anaerobic blood-agar plates inoculated with spore material, which was composed of rods resembling *B. welchii;* Strain No. 114, taken from a colony on the anaerobic plates inoculated with the sediment of the fermentation-tube culture of lactose broth of the first series, which was composed of slender non-motile rods.

D. Agglutination Tests.

The various strains of bacteria, isolated during the bacteriological study of the stools and samples of intestinal contents, and preserved for subsequent study, were first subjected to agglutination tests. Cultures grown on inclined agar for 24 hours at 37° C., were employed for the tests. The anaerobic forms were incubated in an atmosphere of hydrogen. The growth was suspended in 0.8 percent salt solution and the heavier particles allowed to settle out. The supernatant suspension was diluted with salt solution until it was translucent, corresponding approximately to an empirical standard of density. The bacterial suspension was then mixed with an equal volume of a dilution of the serum in a small tube about 4mm. in diameter. Several bacterial strains and several sera were always employed in each test, and among these there were usually at least one control bactrial strain and one control serum, the behavior of which had been previously ascertained. The tubes containing the mixtures of bacterial suspension and diluted serum, were set up in a rack in parallel rows, each rank being made up of tubes containing precisely the same serum, and each file being made up of tubes containing the same bacterial suspension. The tubes were placed at 37° C. and observed at frequent intervals for 24 hours or longer. The general scheme of procedure may be illustrated by the test carried out on December 8, 1910, which is tabulated on page 125. In the earlier tests, higher dilutions of serum (1:50) were employed. On December 8th a test was performed with suspension of *B. typhosus* in different dilutions of serum from a guinea-pig immunized to *B. typhosus.* As a result of this test, it

was decided to employ a bacterial suspension of moderate density and to use the serum in a dilution of 1:10 for the preliminary tests of the various strains.

The results of these tests are indicated in the following tables, the tests recorded in any one table being performed simultaneously in the same rack and being mutually comparable. The sera employed were derived from healthy people; from pellagrins, some in the active stage of the eruption and others without any existing manifestations of the disease; from inmates of the State Hospitals for the insane who had shown no signs of pellagra; from sane individuals suffering from other disease, such as typhoid fever, pneumonia and syphilis; and from experimental animals. There are some evident inconsistencies in the tables clearly suggesting errors in these preliminary tests. For example it appears fairly certain that the Strain No. 3 of the test on October 4th was the Strain No. 2 of the test on October 5th. Evidently there was some confusion in labeling the rows, which might have occurred because the various strains were not designated by serial numbers until after these two tests. Such inconsistencies seem not to be of serious import.

AGGLUTINATION TEST NO. 1. OCTOBER 4, 1910.

Serum dilution 1:50.	Strain No. 1.	Strain No. 2.	Strain No. 3.	Strain No. 4.	Hours.
L. R., pellagrin, Peoria.	0	0	.....	.....	2
	0	0	Not tested...	Not tested...	4
	0	0	Slight.....	Slight.....	16
N. N., pellagrin, Peoria.	0	0	Marked.....	0	2
	0	0	Complete	0	4
	0	0	Complete	0	16
M. N., pellagrin, Peoria.	0	0	Marked.....	0	2
	0	0	Complete....	0	4
	0	0	Complete	0	16
M. Y., pellagrin, Peoria.	0	0	Marked.....	0	2
	0	0	Complete	0	4
	0	0	Complete	0	16
W. S., insane,[1] Peoria.	0	0	Marked.....	0	2
	0	0	Complete	0	4
	0	0	Complete	0	16

[1] Not a pellagrin.

AGGLUTINATION TEST NO. 2. OCTOBER 5, 1910.

Serum dilution 1:50.	Strain No. 1.	Strain No. 2.	Strain No. 3.	Strain No. 4.	Hours.
W. N., pellagrin, Peoria.	Marked.....	Slight.....	0	0	3½
	Marked.....	Marked.....	0	0	16
C. H., pellagrin, Peoria.	Marked.....	Slight.....	0	0	3½
	Marked.....	Marked.....	0	0	16
M. G., pellagrin, Peoria.	Marked.....	Slight.....	0	0	3½
	Marked.....	Marked.....	0	0	16
R. P., pellagrin, Peoria.	Marked.....	Slight.....	0	0	3½
	Marked.....	Marked.....	0	0	16
S. E., insane[1], Peoria.	Marked.....	Slight.....	0	0	3½
	Marked.....	Complete	0	0	16

[1] Not a pellagrin.

AGGLUTINATION TEST NO. 3. DECEMBER 2, 1910.

Serum dilution 1:50.	Strain No. 1.	Strain No. 3.	Strain No. 5.	Strain No. 6.	Strain No. 8.	Strain No. 11.	Hours.
Kerr, normal, Urbana.	0	0	0	*Sediment.	0	0	2
	0	0	0	Sediment..	0	0	17
Mac Neal, normal, Urbana.	0	0	0	Sediment..	0	0	2
	0	0	0	Sediment..	0	0	17
P. E., pellagrin, Peoria.	0	0	0	Sediment..	0	0	2
	0	0	0	Sediment..	0	0	17
M. Y., pellagrin, Peoria.	0	0	0	Sediment..	0	0	2
	0	0	0	Sediment..	0	0	17
M. G., pellagrin, Peoria.	Slight.....	0	0	Sediment..	0	0	2
	Slight.....	0	0	Sediment..	0	0	17
G. I., pellagrin, Peoria.	Slight.....	0	0	Sediment..	0	0	2
	Slight.....	0	0	Sediment..	0	0	17
T. E., pellagrin, Peoria.	0	0	0	Sediment..	0	0	2
	0	0	0	Sediment..	0	0	17

* The salt solution itself seemed slightly to agglutinate this growth.

AGGLUTINATION TEST NO. 4. DECEMBER 3, 1910.

Serum dilution 1:50.	Strain No. 13.	Strain No. 14.	Strain No. 16.	Strain No. 17.	Hours.
Kerr, normal, Urbana.	0	0	0	0	2
	0	0	0	0	5
	0	0	0	0	46
MacNeal, normal, Urbana.	0	0	0	0	2
	0	0	0	0	5
	0	0	0	0	46
P. E., pellagrin, Peoria.	0	0	0	0	2
	0	0	0	0	5
	0	0	0	0	46
M. Y., pellagrin, Peoria.	0	0	0	0	2
	0	0	0	0	5
	0	0	0	0	46
M. G., pellagrin, Peoria.	0	Very marked.	0	0	2
	0	Very marked.	0	0	5
	0	Very marked.	0	0	46
G. I., pellagrin, Peoria.	0	0	0	0	2
	0	0	0	0	5
	0	0	0	0	46
T. E., pellagrin, Peoria.	0	0	0	0	2
	0	0	0	0	5
	0	0	0	0	46

AGGLUTINATION TEST NO. 5. DECEMBER 6, 1910.

Serum dilution 1:50.	Strain No. 18.	Strain No. 19.	Strain No. 20.	Strain No. 21.	Strain No. 22.	Strain No. 25.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	17½
Mac Neal, normal, Urbana.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	17½
P. E., pellagrin, Peoria.	0	0	0	0	0	0	Slight....	2
	0	0	0	0	0	0	Slight....	4
	0	0	0	0	0	0	Slight....	17½
M. Y., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	17½
M. G., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	17½
G. I., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	17½
T. E., Pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	17½
Guinea-pig typhoid.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	Slight....	4
	0	0	0	0	0	0	Slight....	17½

AGGLUTINATION TEST NO. 6. DECEMBER 8, 1910.

Serum.	B. typhosus heavy suspension.	B. typhosus medium suspension.	B. typhosus dilute suspension.	Hours.
Guinea-pig, typhoid, dilution 1:100.	0	0	0	40 min.....
	0	0	0	1 hr. 45 min...
	0	0	Slight.....	5 hrs.....
Guinea-pig, typhoid, dilution 1:50.	0	0	0	40 min.....
	Very marked ..	Very marked...	Slight.....	1 hr. 45 min...
	Very marked ..	Very marked ..	Slight.....	5 hrs.....
Guinea-pig, typhoid, dilution 1:25.	0	0	0	40 min.....
	Very marked ..	Very marked ..	Very marked ..	1 hr. 45 min...
	Very marked ..	Very marked ..	Very marked ..	5 hrs.....
Guinea-pig, typhoid, dilution 1:10.	Very marked ..	Very marked ..	0	40 min.....
	Very marked ..	Complete.....	Very marked ..	1 hr. 45 min...
	Very marked ..	Complete.....	Very marked ..	5 hrs.....
Kerr, normal, dilution 1:10.	0	0	0	40 min.....
	0	0	0	1 hr. 45 min...
	0	0	0	5 hrs.....

AGGLUTINATION TEST NO. 7. DECEMBER 8, 1910.

Serum dilution 1:10.	Strain No. 1.	Strain No. 5.	Strain No. 6.	Strain No. 8.	B. typhosus.	Hours.
Kerr, normal, Urbana	Slight.....	0	0	0	0	1
	Slight.....	0	0	0	0	2
	Slight.....	0	0	0	0	4
	Marked.....	0	0	0	0	20
Mac Neal, normal Urbana.	Slight.....	0	0	0	0	1
	Slight.....	0	0	0	0	2
	Slight.....	0	0	0	0	4
	Marked.....	0	0	0	0	20
P. E., pellagrin, Peoria.	0	0	0	0	Partial.....	1
	0	0	0	0	Partial.....	2
	0	0	0	0	Very marked.	4
	0	0	0	0	Very marked.	20
M. Y., pellagrin, Peoria.	0	0	0	0	0	1
	0	0	0	0	0	2
	0	0	0	0	0	4
	0	0	0	0	0	20
M. G., pellagrin, Peoria.	Slight.....	0	0	0	0	1
	Slight.....	0	0	0	0	2
	Slight.....	0	0	0	0	4
	Marked.....	0	0	0	0	20
G. I., pellagrin, Peoria	Slight.....	0	0	0	0	1
	Slight.....	0	0	0	0	2
	Slight.....	0	0	0	0	4
	Marked.....	0	0	0	0	20
T. E., pellagrin, Peoria.	0	0	0	0	0	1
	0	0	0	0	0	2
	0	0	0	0	0	4
	0	0	0	0	0	20
Guinea-pig, typhoid.	0	0	0	0	Partial.....	1
	0	0	0	0	Partial.....	2
	0	0	0	0	Very marked.	4
	0	0	0	0	Very marked.	20

AGGLUTINATION TEST NO. 8. DECEMBER 13, 1910.

Serum dilution 1:10.	Strain No. 2.	Strain No. 3.	Strain No. 11.	Strain No. 13.	Strain No. 14.	Strain No. 16.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	5
	0	0	0	0	0	0	0	21
Mac Neal, normal, Urbana.	0	0	Slight....	0	0	0	0	1
	0	0	Slight....	0	0	0	0	3
	0	0	Slight....	0	0	0	0	5
	0	0	Slight....	0	0	0	0	21
P. E., pellagrin, Peoria.	0	0	0	0	0	0	Slight.....	1
	0	0	Slight....	0	0	0	Very marked.	3
	0	0	Slight....	0	Slight....	0	Very marked.	5
	0	0	Slight....	0	Marked...	0	Very marked.	21
M. Y., pellagrin, Peoria.	0	0	0	0	0	0	0	1
	0	0	Slight....	0	Slight....	0	0	3
	0	0	Slight....	0	Slight....	0	0	5
	0	0	Slight....	0	Slight....	0	0	21
M. G., pellagrin, Peoria.	0	0	Slight....	0	Slight....	0	0	1
	0	0	Marked...	0	Marked...	Slight....	0	3
	0	0	Marked...	0	Marked...	Slight....	0	5
	0	0	Marked...	0	Marked...	Slight....	0	21
G. I., pellagrin, Peoria.	0	0	Slight....	0	Slight....	0	0	1
	0	0	Marked...	0	Marked...	0	0	3
	0	0	Marked...	0	Marked...	0	0	5
	0	0	Marked...	o	Marked...	0	0	21
T. E. pellagrin, Peoria.	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	5
	0	0	0	0	0	0	0	21
Guinea-pig, typhoid.	0	0	0	0	0	0	Marked.....	1
	0	0	0	0	0	0	Very marked.	3
	0	0	0	0	0	0	Very marked.	5
	0	0	0	0	0	0	Complete	21

AGGLUTINATION TEST NO. 9. DECEMBER 15, 1910.

Serum dilution 1:10.	Strain No. 17.	Strain No. 18.	Strain No. 19.	Strain No. 20.	Strain No. 21.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	1
	0	0	0	0	0	0	2
	0	0	0	0	Complete ..	0	6
	0	0	0	0	Complete ..	0	19
Mac Neal, normal, Urbana.	0	0	0	0	0	0	1
	0	0	0	0	0	0	2
	0	0	0	0	Complete ..	0	6
	0	0	0	0	Complete ..	0	19
P. E., pellagrin, Peoria.	0	0	0	0	0	Slight.....	1
	0	0	0	0	0	Marked.....	2
	0	0	0	0	Complete ..	Complete ..	6
	0	0	Slight....	Partial...	Complete ..	Complete ..	19
M. Y., pellagrin, Peoria.	0	0	0	0	0	0	1
	0	0	0	0	0	0	2
	0	0	0	0	Marked.....	0	6
	0	0	0	0	Complete ..	0	19
M. G., pellagrin, Peoria.	0	0	0	0	0	0	1
	Slight....	0	0	0	0	0	2
	Slight....	0	0	0	Complete ..	0	6
	Partial...	0	0	0	Complete ..	0	19
G. I., pellagrin, Peoria.	Slight....	0	0	0	0	0	1
	Slight....	0	0	0	0	0	2
	Partial...	0	Partial...	0	Complete ..	0	6
	Partial...	0	Partial...	0	Complete ..	0	19
T. E., pellagrin, Peoria.	0	0	0	0	0	0	1
	0	0	0	0	0	0	2
	Slight....	0	0	0	Complete ..	0	6
	Slight....	0	0	0	Complete ..	0	19
Guinea-pig, typhoid.	0	0	0	0	Marked....	Marked....	1
	0	0	0	0	Marked....	Complete ..	2
	0	0	0	0	Complete ..	Complete ..	6
	0	0	0	0	Complete ..	Complete ..	19

AGGLUTINATION TEST NO. 10. DECEMBER 17, 1910.

Serum dilution 1:10.	Strain No. 22.	Strain No. 23.	Strain No. 25.	Strain No. 26.	Strain No. 27.	Strain No. 28.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	0	1½
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
Mac Neal, normal, Urbana.	0	0	0	0	0	0	0	1½
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
P. E., pellagrin, Peoria.	0	0	0	0	0	0	Partial.....	1½
	0	0	0	0	0	0	Partial	3
	0	0	0	0	0	0	Very marked.	4
	0	0	0	0	0	0	Very marked.	5
M. Y., pellagrin, Peoria.	0	0	Slight....	0	0	0	0	1½
	0	0	Partial...	0	0	0	0	3
	0	0	Partial...	0	0	0	0	4
	0	0	Partial...	0	0	0	0	5
M. G., pellagrin, Peoria.	0	0	0	0	0	0	0	1½
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
G. I., pellagrin, Peoria.	0	0	0	0	0	0	0	1½
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
T. E., pellagrin, Peoria.	0	0	0	0	0	0	0	1½
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	Slight....	0	5
Guinea-pig,typhoid.	0	0	0	0	0	0	Partial.....	1½
	0	0	Partial...	0	0	0	Partial.....	3
	0	0	Partial...	0	0	0	Very marked.	4
	0	0	Partial...	0	0	0	Very marked.	5

AGGLUTINATION TEST NO. 11. DECEMBER 20, 1910.

Serum dilution 1:10.	Strain No. 29.	Strain No. 30.	Strain No. 32.	Strain No. 33.	Strain No. 34.	Strain No. 35.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3½
	0	0	0	Slight....	0	0	0	5½
MacNeal, normal, Urbana.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3½
	0	0	0	0	0	0	0	5½
P. E., pellagrin, Peoria.	0	0	0	0	0	0	Partial.....	2
	0	0	0	0	0	0	Partial.....	3½
	0	0	0	0	0	Slight....	Very marked.	5½
M. Y., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3½
	0	0	0	0	0	Slight....	0	5½
M. G., pellagrin, Peoria.	0	Slight..	0	0	0	0	0	2
	0	Partial.	0	0	0	0	0	3½
	0	Partial.	0	0	0	Slight....	0	5½
G. I., pellagrin, Peoria.	Slight..	0	0	0	0	0	0	2
	Slight..	0	0	0	0	0	0	3½
	Slight..	0	0	0	0	Slight....	0	5½
T. E., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3½
	0	0	0	0	0	Slight....	0	5½
Guinea-pig, typhoid.	0	0	0	0	0	0	Partial.....	2
	0	0	0	0	0	0	Partial.....	3½
	0	0	0	0	0	Slight....	Very marked.	5½

AGGLUTINATION TEST NO. 12. DECEMBER 23, 1910.

Serum dilution 1:10.	Strain No. 37.	Strain No. 38.	Strain No. 44.	Strain No. 46.	Strain No. 47.	Strain No. 48.	B. typhosus.	Hours.
Kerr, normal, Urbana.	Sediment* .	0	0	Sediment* .	0	0	0	2
	Sediment . .	0	0	Sediment . .	0	0	0	4
	Sediment . .	0	0	Sediment . .	0	0	0	20
Mac Neal, normal, Urbana	Sediment* .	0	0	Sediment* .	0	0	0	2
	Sediment . .	0	0	Sediment . .	0	0	0	4
	Sediment . .	0	0	Sediment . .	0	0	0	20
P. E., pellagrin, Peoria.	Sediment* .	0	Slight	Sediment* .	0	0	Marked	2
	Sediment . .	0	Slight	Sediment . .	0	0	Very marked.	4
	Sediment . .	0	Complete	Sediment . .	0	0	Complete	20
M. Y., pellagrin, Peoria.	Sediment* .	0	Slight	Sediment* .	0	0	0	2
	Sediment . .	0	Slight	Sediment . .	0	0	0	4
	Sediment . .	0	Complete	Sediment . .	0	0	0	20
M. G., pellagrin, Peoria.	Sediment* .	0	0	Sediment* .	0	0	0	2
	Sediment . .	0	0	Sediment . .	0	0	0	4
	Sediment . .	0	Very marked.	Sediment . .	0	0	0	20
D. E., pellagrin, Peoria.	Sediment* .	0	0	Sediment* .	0	0	0	2
	Sediment . .	0	0	Sediment . .	0	0	0	4
	Sediment . .	0	0	Sediment . .	0	0	0	20
T. E., pellagrin, Peoria.	Sediment* .	0	0	Sediment* .	0	0	0	2
	Sediment . .	0	0	Sediment . .	0	0	0	4
	Sediment . .	0	0	Sediment . .	0	0	0	20
Guinea-pig typhoid.	Sediment* .	0	0	Sediment* .	0	0	Marked	2
	Sediment . .	0	0	Sediment . .	0	0	Very marked.	4
	Sediment . .	0	0	Sediment . .	0	0	Very marked.	20

* This settling takes place also in salt solution and is, therefore, not attributable to any agglutinins in the sera.

AGGLUTINATION TEST NO. 13. DECEMBER 31, 1910.

Serum dilution 1:10.	Strain N0. 49.	Strain N0. 53.	Strain No. 55.	Strain No. 56.	Strain N0. 57.	Strain N0. 59.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
Mac Neal, normal, Urbana.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
P. E., pellagrin, Peoria.	0	0	0	0	0	0	Slight.....	2
	0	0	0	0	0	0	Marked.....	3
	0	0	0	0	0	0	Very marked.	4
	0	0	0	0	0	0	Very marked.	5
W. N., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
M. G., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
D. E. pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	Q	0	0	0	0	0	0	5
T. E., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	9	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
Guinea-pig, typhoid.	0	0	0	0	0	0	Slight.....	2
	0	0	0	0	0	0	Marked.....	3
	0	0	0	0	0	0	Very marked.	4
	0	0	0	0	0	0	Very marked.	5

AGGLUTINATION TEST NO. 14. JANUARY 4, 1911.

Serum dilution 1:10.	Strain No. 60.	Strain No. 62.	Strain No. 64.*	Strain No. 65.	Strain No. 66.	Strain No. 67.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	Sediment..	0	0	0	0	1½
	0	0	Sediment..	0	0	0	0	2½
	0	0	Sediment..	0	0	0	0	4½
	0	0	Sediment..	0	0	0	0	21
Mac Neal, normal, Urbana.	0	0	Sediment..	0	0	0	0	1½
	0	0	Sediment..	0	0	0	0	2½
	0	0	Sediment..	0	0	0	0	4½
	0	Slight..	Sediment..	0	0	0	0	21
P. E., pellagrin, Peoria.	0	0	Sediment..	0	0	Slight.....	Slight.....	1½
	0	0	Sediment..	0	0	Slight.....	Marked.....	2½
	0	0	Sediment..	0	0	Marked.....	Marked.....	4½
	0	Slight..	Sediment..	0	0	Complete ...	Complete	21
W. N., pellagrin, Peoria.	0	0	Sediment..	0	0	Slight.....	0	1½
	0	Slight..	Sediment..	0	0	Slight.....	0	2½
	0	Slight..	Sediment..	0	0	Marked.....	0	4½
	0	Slight..	Sediment..	0	0	Complete	0	21
M. G., pellagrin, Peoria.	0	0	Sediment..	0	0	Marked.....	0	1½
	0	Slight..	Sediment..	0	0	Very marked.	0	2½
	0	Slight..	Sediment..	0	0	Complete....	0	4½
	0	Slight..	Sediment..	0	0	Complete	0	21
D. E., pellagrin, Peoria.	0	0	Sediment..	0	0	0	0	1½
	0	Slight..	Sediment..	0	0	0	0	2½
	0	Slight..	Sediment..	0	0	Slight.....	0	4½
	0	Slight..	Sediment..	0	0	Slight.....	0	21
T. E., pellagrin. Peoria.	0	0	Sediment..	0	0	Slight.....	0	1½
	0	0	Sediment..	0	0	Marked.....	0	2½
	0	0	Sediment..	0	0	Marked.....	0	4½
	0	0	Sediment..	0	0	Complete	0	21
Guinea-pig, typhoid.	0	0	Sediment..	0	0	0	Very marked.	1½
	0	0	Sediment..	0	0	0	Complete	2½
	0	0	Sediment..	0	0	0	Complete	4½
	0	0	Sediment..	0	Slight..	0	Complete	21

* It is impossible to suspend this culture. The growth settles out almost as soon as it is mixed.

Agglutination Test No. 15. January 6, 1911.

Serum dilution 1:10.	Strain No. 68.	Strain No. 69.	Strain No. 70.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	Sediment....	0	0	3
	0	Sediment....	0	0	5
	0	Sediment....	0	0	7
	0	Sediment....	0	0	22
Mac Neal, normal, Urbana.	0	Sediment....	0	0	3
	0	Sediment....	0	0	5
	0	Sediment....	0	0	7
	0	Sediment....	0	0	22
P. E., pellagrin, Peoria.	0	Sediment....	0	Marked.....	3
	0	Sediment....	0	Very marked.	5
	0	Sediment....	0	Very marked.	7
	0	Sediment....	0	Complete	22
W. N., pellagrin, Peoria.	0	Sediment....	0	0	3
	0	Sediment....	0	0	5
	0	Sediment....	0	0	7
	0	Sediment....	0	0	22
M. G., pellagrin, Peoria.	0	Sediment....	0	0	3
	0	Sediment....	0	0	5
	0	Sediment....	0	0	7
	0	Sediment....	0	0	22
D. E., pellagrin, Peoria.	0	Sediment....	0	0	3
	0	Sediment....	0	0	5
	0	Sediment....	0	0	7
	0	Sediment....	0	0	22
T. E., pellagrin, Peoria.	0	Sediment....	0	0	3
	0	Sediment....	0	0	5
	0	Sediment....	0	0	7
	0	Sediment....	0	0	22
Guinea-pig, typhoid.	0	Sediment....	0	Complete	3
	0	Sediment....	0	Complete	5
	0	Sediment....	0	Complete	7
	0	Sediment....	0	Complete	22

AGGLUTINATION TEST NO. 16. JANUARY 10, 1911.

Serum dilution 1:10.	Strain No. 14.	Strain Nc. 17.	Strain No. 21.	Strain No. 35.	Strain No. 44.	Strain No. 62.	Strain No. 67.	Hours.
Kerr, normal, Urbana	0	0	Slight	0	0	0	0	1½
	0	0	light	0	0	0	0	2½
	0	0	Complete	0	0	0	0	3½
	0	0	Complete	0	0	0	0	5½
	0	0	Complete	Complete	0	0	Slight	21
Mac Neal, normal, Urbana.	0	0	Marked	0	0	0	0	1½
	0	0	Marked	0	0	0	0	2½
	0	0	Complete	0	0	0	0	3½
	0	0	Complete	0	0	0	0	5½
	0	0	Complete	Complete	0	0	0	21
P. E., pellagrin, Peoria.	Slight	0	Marked	0	Slight	0	Very marked ..	1½
	Slight	0	Marked	0	Slight	0	Very marked ..	2½
	Slight	0	Complete	0	Marked	0	Very marked ..	3½
	Slight	0	Complete	0	Very marked ..	Slight	Complete	5½
	Marked	0	Complete	Complete	Complete	Marked	Complete	21
W. N., pellagrin, Peoria.	Marked	0	Marked	0	Very marked ..	Very marked ..	Very marked ..	1½
	Marked	0	Marked	0	Complete	Very marked ..	Very marked ..	2½
	Marked	0	Complete	0	Complete	Very marked ..	Very marked ..	3½
	Marked	0	Complete	0	Complete	Very marked ..	Complete	5½
	Marked	0	Complete	Complete	Complete	Very marked ..	Complete	21
M. G., pellagrin, Peoria.	Marked	Marked	Marked	0	Marked	Very marked ..	Very marked ..	1½
	Marked	Marked	Marked	0	Marked	Very marked ..	Very marked ..	2½
	Marked	Marked	Complete	0	Marked	Very marked ..	Very marked ..	3½
	Very marked ..	Marked	Complete	0	Marked	Very marked ..	Complete	5½
	Very marked ..	Marked	Complete	Complete	Marked	Very marked ..	Complete	21
D. E., pellagrin, Peoria.	Marked	0	Marked	0	Marked	Very marked ..	0	1½
	Marked	0	Marked	0	Marked	Very marked ..	0	2½
	Marked	Slight	Complete	0	Marked	Very marked ..	0	3½
	Very marked .	light	Complete	0	Marked	Very marked ..	0	5½
	Very marked .	Marked	Complete	Complete	Very marked ..	Very marked ..	0	21
T. E., pellagrin, Peoria.	0	0	Marked	0	0	0	Slight	1½
	0	0	Marked	0	0	0	Very marked ..	2½
	0	0	Complete	0	0	0	Very marked ..	3½
	0	0	Complete	0	0	0	Complete	5½
	0	0	Complete	Complete	0	0	Complete	21

Guinea-pig, typhoid.	0	0	Slight.....	0	0	0	0	1½
	0	0	Slight.....	0	0	0	0	2½
	0	0	Marked.....	0	0	0	0	3½
	0	0	Marked.....	0	0	0	0	5½
	0	0	Marked.....	Complete.....	0	0	0	21

AGGLUTINATION TEST NO. 17. JANUARY 13, 1911.

Serum dilution 1:10.	Strain No. 11.	Strain No. 16.	Strain No. 19.	Strain No. 25.	Strain No. 30.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	1
	0	0	0	0	0	0	2
	0	0	0	0	0	0	3
	0	0	0	0	0	0	5
	0	0	0	0	0	0	22
Mac Neal, normal, Urbana.	0	0	0	0	0	0	1
	Slight....	0	0	0	Marked...	0	2
	Marked...	0	0	0	Marked...	0	3
	Marked...	0	0	0	Marked...	0	5
	Marked...	0	0	0	Marked...	0	22
P. E., pellagrin, Peoria.	0	0	0	0	0	Slight.....	1
	0	0	0	0	0	Very marked.	2
	0	0	0	0	0	Complete	3
	Slight....	0	0	Slight....	0	Complete	5
	Slight....	0	0	Slight....	0	Complete	22
W. N., pellagrin, Peoria.	0	0	0	0	0	0	1
	0	0	0	0	Marked...	0	2
	0	0	0	0	Marked...	0	3
	Slight....	Slight....	0	0	Marked...	0	5
	Slight....	Slight....	0	0	Marked...	0	25
M. G., pellagrin, Peoria.	0	0	0	0	0	0	1
	Marked...	0	0	0	Marked...	0	2
	Marked...	0	0	0	Marked...	0	3
	Marked...	Slight....	0	0	Marked...	0	5
	Marked...	Slight....	0	0	Marked...	0	22
D. E., Pellagrin, Peoria.	0	0	0	0	0	0	1
	Marked...	0	0	0	Marked...	0	2
	Marked...	0	0	0	Marked...	0	3
	Marked...	Slight....	0	0	Marked...	0	5
	Marked...	Slight....	0	0	Marked...	0	22
T. E., pellagrin, Peoria.	0	0	0	0	0	0	1
	0	0	0	0	0	0	2
	0	0	0	0	0	0	3
	0	0	0	0	0	0	5
	0	0	0	0	0	0	22
Guinea-pig, typhoid.	0	0	0	0	0	Very marked.	1
	0	0	0	0	0	Complete	2
	0	0	0	0	0	Complete	3
	0	0	0	0	0	Complete	5
	0	0	0	0	0	Complete	22

AGGLUTINATION TEST NO. 18. JANUARY 31, 1911.

Serum dilution 1:10.	Strain No. 14a.	Strain No. 14b.	Strain No. 17.	Strain No. 35.	Strain No. 44.	Strain No. 62.	Strain No. 67.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	0	1¾
	Marked...	0	0	0	0	0	0	3
	Marked...	Slight....	0	0	0	0	0	6
	Marked...	Marked...	Slight....	0	0	Slight....	0	21
Mac Neal, normal, Urbana.	0	Slight....	0	0	Slight..	Marked...	0	1¾
	0	Slight....	0	0	Slight..	Marked...	0	3
	0	Slight....	Slight....	0	Slight..	Marked...	0	6
	0	Marked...	Slight....	0	Marked	Marked...	0	21
J. S., pellagrin, Peoria.	0	Slight....	0	0	0	0	0	1¾
	Slight....	Slight....	0	0	0	0	0	3
	Marked...	Slight....	0	0	Slight..	0	0	6
	Marked...	Marked...	Slight....	0	Slight..	Slight....	Complete	21
E. P., pellagrin, Peoria.	0	Slight....	0	0	0	0	0	1¾
	Slight....	Slight....	0	0	0	Marked...	0	3
	Marked...	Slight....	0	0	Slight..	Marked...	0	6
	Marked...	Marked...	Slight....	0	Slight..	Marked...	Complete	21
D. D.*, pellagrin, Peoria.	Complete	Slight....	0	0	0	0	Marked.....	1¾
	Complete	Slight....	0	0	0	0	Very marked.	3
	Complete	Slight....	0	0	0	Slight....	Complete	6
	Complete	Marked...	Slight....	0	0	.....	Complete	21
A. D., pellagrin, Chicago.	0	Slight....	0	0	0	0	0	1¾
	Slight....	Slight....	0	0	0	0	0	3
	Marked...	Slight....	0	0	0	Marked...	0	6
	Marked...	Marked...	Slight....	0	0	Marked...	Very marked.	21
Guinea-pig, typhoid.	0	0	0	0	0	0	0	1¾
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	6
	0	Slight....	Slight....	0	0	Slight....	0	21

* Severe acute exacerbation resulting in death.

Agglutination Test No. 19. February 2, 1911.

Serum dilution 1:10.	Strain No. 71.	Strain No. 72.	Strain No. 73.	Strain No. 75.	Strain No. 78.	Strain No. 79.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
	0	0	0	0	Sediment.....	0	0	21
Mac Neal, normal, Urbana.	0	0	0	0	Marked.....	0	0	2
	0	0	0	0	Marked.....	0	0	3
	0	0	0	0	Marked.....	0	0	4
	0	0	0	0	Complete.....	0	0	5
	0	0	0	0	Sediment.....	0	0	21
M. G., pellagrin, Peoria.	0	0	0	0	Slight.....	0	0	2
	0	0	0	0	Slight.....	0	0	3
	0	0	0	0	Slight.....	0	0	4
	0	0	0	0	Very marked ..	0	0	5
	0	0	0	0	Sediment.....	Complete.....	0	21
A. D., pellagrin, Chicago.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
	0	0	0	0	Sediment.....	0	0	21
W. N., pellagrin, Peoria.	0	0	0	0	Complete.....	Very marked ..	Complete.....	2
	0	0	0	0	Complete.....	Very marked ..	Complete.....	3
	0	0	0	0	Complete.....	Complete.....	Complete.....	4
	0	0	0	0	Complete.....	Complete.....	Complete.....	5
	0	Very marked ..	Very marked ..	Very marked ..	Complete.....	Complete.....	Complete.....	21
D. E., pellagrin, Peoria.	0	0	0	0	0	0	0	2
	0	0	0	0	0	0	0	3
	0	0	0	0	0	0	0	4
	0	0	0	0	0	0	0	5
	0	Very marked ..	0	Very marked ..	Sediment.....	0	0	21
T. E., pellagrin, Peoria.	0	0	0	0	0	Very marked ..	0	2
	0	0	0	0	0	Very marked ..	0	3
	0	0	0	0	0	Complete.....	0	4
	0	0	0	0	0	Complete.....	0	5
	0	0	0	0	Sediment.....	Complete.....	Complete.....	21

Guinea-pig, typhoid.										
		0		0		0	Marked	0	Complete	2
		0		0		0	Marked	0	Complete	3
		0		0		0	Marked	0	Complete	4
		0		0		0	Marked	0	Complete	5
		0		0		0	Sediment	0	Complete	21

Agglutination Test No. 20. February 4, 1911.

Serum dilution 1:10.	Strain No. 80.	Strain No. 81.	Strain No. 83.	Strain No. 84.	Strain No. 85.	Strain No. 87.	Strain No. 88.	B. typhosus.	Hours.
Kerr, normal, Urbana.	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	6½
	0	0	0	0	0	0	0	0	22
Mac Neal, normal, Urbana.	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	6½
	0	0	0	0	0	0	0	0	22
M. G., pellagrin, Peoria.	0	0	0	0	0	0	0	0	1
	Marked.....	0	0	0	0	0	0	0	6½
	Marked.....	0	0	0	Complete.....	0	0	0	22
A. D., pellagrin, Chicago.	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	6½
	0	0	Marked.....	0	0	0	0	0	22
D. E., pellagrin, Peoria.	0	0	Very marked ..	0	0	0	Very marked ..	0	1
	0	0	Complete.....	0	0	0	Very marked ..	0	6½
	0	0	Complete	0	Marked.....	0	Very marked ..	0	22
E. P., pellagrin, Peoria.	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	6½
	0	0	0	0	Marked.....	0	0	0	22
T. E., pellagrin, Peoria.	0	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	6½
	Complete.....	0	0	0	Marked.....	0	0	0	22
Guinea-pig, typhoid.	0	0	0	0	0	0	0	Very marked ..	1
	0	0	0	0	0	0	0	Complete.....	6½
	0	0	0	0	Marked.....	0	0	Complete.....	22

AGGLUTINATION TEST NO. 21. MARCH 2, 1911.

Serum dilution 1:10.	Strain No. 28.	Strain No. 35.	Strain No. 67.*	Strain No. 34.	Strain No. 14.	Strain No. 8.	Strain No. 67.*	Hours.
A. D., pellagrin, Chicago.	0	0	Complete ..	0	Slight.....	0	Marked....	3
	Slight....	0	Complete ..	0	Marked....	0	Complete ..	16
M. L., insane, Peoria.	0	0	Complete ..	0	Complete ..	0	Complete ..	3
	Slight....	0	Complete ..	Slight..	Complete ..	0	Complete ..	16
M. G., pellagrin, Peoria.	0	0	Complete ..	0	Complete ..	0	Complete ..	3
	Slight....	0	Complete ..	Slight..	Complete ..	0	Complete ..	16
B. N., insane, Peoria.	0	0	Complete ..	0	Complete ..	0	Marked....	3
	Slight....	0	Complete ..	Slight..	Complete ..	0	Complete ..	16
T. E., pellagrin, Peoria.	0	0	Complete ..	0	Complete ..	0	Complete ..	3
	Slight....	0	Complete ..	Slight..	Complete ..	0	Complete ..	16
S. E., pellagrin, Peoria.	0	0	Complete ..	0	Complete ..	0	Complete ..	3
	Slight....	0	Complete ..	Slight..	Complete ..	Slight..	Complete ..	16
J. N., pellagrin, Kankakee.	0	0	Complete ..	Slight..	Marked....	0	Complete ..	3
	Marked...	0	Complete ..	Slight..	Complete ..	Slight..	Complete ..	16
Mac Neal, normal, Urbana.	0	0	Slight....	0	0	0	0 ..	3
	0	0	Partial.....	0	Slight.....	0	Slight.....	16

* Duplicate cultures of the same strain.

After March 2, 1911, no further agglutination tests were performed until July 7, 1911. The tests recorded in the following tables were carried out between July 7 and August 15. The exact date of each test was not recorded.

AGGLUTINATION TEST NO. 22.

Serum dilution 1:10.	Strain No. 67.	Strain No. 51.	Strain No. 21.	Hours.
Mac Neal, normal, Urbana.	0	0	0	½
	0	0	0	1
	0	0	0	22
A. D., pellagrin, Chicago.	0	0	0	½
	Slight....	0	0	1
	Slight....	0	0	22

AGGLUTINATION TEST NO. 23.

Serum dilution 1:10.	Strain No. 86.	Strain No. 30.	Strain No. 67.	Hours.
Mac Neal, normal, Urbana.	0	0	Slight.....	1
	0	0	Slight.....	17
	0	Slight.....	Slight.....	40
A. D., pellagrin, Chicago.	0	0	Slight.....	1
	Slight.....	0	Very marked.	17
	Slight.....	Slight.....	Complete	40
C. C. H., pellagrin, Chicago.	0	0	Very marked.	1
	Very marked.	0	Complete	17
	Complete	Slight.....	Complete	40

Agglutination Test No. 24.

Serum dilution 1:10.	Strain No. 67.	Strain No. 12.	Strain No. 51.	Strain No. 52.	Strain No. 78.	Hours.
Mac Neal, normal, Urbana.	0	0	0	0	0	½
	Slight.....	0	0	0	Marked.....	2
	Slight.....	0	Slight.....	Slight.....	Very marked.	5
	Slight.....	0	Complete ..	Complete ..	Complete	21
A. D.,[1] pellagrin, Chicago.	0	0	0	0	0	½
	Slight.....	0	Slight.....	Slight.....	Slight.....	2
	Marked.....	0	Slight.....	Slight.....	Very marked.	5
	Marked.....	Complete ..	Complete ..	Complete ..	Complete	21
M. G., pellagrin, Peoria.	0	0	0	0	0	½
	Slight.....	0	Slight.....	Slight.....	Slight.....	2
	Marked.....	0	Slight.....	Slight.....	Very marked.	5
	Marked.....	Complete ..	Complete ..	Complete ..	Complete	21
C. C. H.,[2] pellagrin, Chicago.	0	0	0	0	0	½
	Very marked.	0	Slight.....	Slight.....	Complete	2
	Complete	0	Slight.....	Slight.....	Complete	5
	Complete	Complete ..	Complete ..	Complete ..	Complete	21

[1] Serum preserved in refrigerator for six months.
[2] Fresh serum from pellagrin with active eruption.

Agglutination Test No. 25.

Serum dilution 1:10.	Strain No. 103.	Strain No. 89.	Strain No. 90.	Strain No. 67.	Hours.
Mac Neal, normal, Urbana.	0	Slight.....	0	Slight.....	1
	0	Slight.....	0	Slight.....	4
	0	Slight.....	0	Slight.....	19
York, normal, Urbana.	0	Slight.....	0	Slight.....	1
	0	Slight.....	0	Very marked.	4
	0	Very marked.	0	Very marked.	19
A. D.,[1] pellagrin, Chicago.	0	Slight.....	0	Slight.....	1
	0	Slight.....	0	Very marked.	4
	0	Very marked.	0	Very marked.	19
C. C. H.,[2] pellagrin, Chicago.	0	Slight.....	0	Slight.....	1
	0	Slight.....	0	Very marked.	4
	0	Very marked.	0	Complete	19

[1] Serum preserved in refrigerator six months.
[2] Fresh serum from pellagrin with active eruption.

Agglutination Test No. 26.

Serum dilution 1:10.	Strain No. 91.	Strain No. 92.	Strain No. 93.	Strain No. 94.	Strain No. 97.	Hours.
Mac Neal, normal, Urbana.	0	Very marked.	0	0	Slight.....	1
	0	Complete	0	0	Complete	4
	0	Complete	0	0	Complete	19
York, normal, Urbana.	0	Very marked.	0	0	Slight.....	1
	0	Complete	0	0	Complete	4
	0	Complete	0	0	Complete	19
M. G., pellagrin, Peoria.	0	Very marked.	0	0	Slight.....	1
	0	Complete	0	0	Complete	4
	0	Complete	0	0	Complete	19
C. C. H., pellagrin, Chicago.	0	Very marked.	0	0	Slight.....	1
	0	Complete	0	0	Complete	4
	0	Complete	0	0	Complete	19

Agglutination Test No. 27.

Serum dilution 1:10.	Strain No. 95.	Strain No. 96.	Strain No. 98.	Strain No. 99.	Strain No. 100.	Hours.
Mac Neal, normal, Urbana.	0	0	0	0	0	1
	0	0	0	0	0	4
	0	0	0	0	0	19
York, normal, Urbana.	0	0	0	0	0	1
	0	0	0	0	0	4
	0	0	0	0	0	19
M. G., pellagrin, Peoria.	0	0	0	0	0	1
	0	0	0	0	0	4
	0	0	0	0	0	19
C. C. H., pellagrin, Chicago.	0	0	0	0	0	1
	0	0	0	0	0	4
	0	0	0	0	0	19

Agglutination Test No. 28.

Serum dilution 1:10.	Strain No. 104.	Strain No. 105.	Strain No. 106.	Strain No. 107.	Strain No. 108.	Hours.
Mac Neal, normal, Urbana.	0	0	0	0	0	2
	0	0	0	0	0	6
	Complete	Very marked.	Very marked.	0	0	45
York, normal, Urbana.	0	0	0	0	0	2
	0	0	0	0	0	6
	Complete	Very marked.	Very marked.	Slight.....	Slight.....	45
M. G., pellagrin, Peoria.	0	0	0	0	0	2
	0	0	0	Very marked.	0	6
	Complete	Very marked.	Very marked.	Very marked.	Very marked.	45
C. C. H., pellagrin, Chicago.	0	0	0	0	0	2
	0	0	0	0	0	6
	Complete	Slight.....	Very marked.	Very marked.	Very marked.	45

Agglutination Test No. 29.

Serum dilution 1:10.	Strain No. 109.	Strain No. 110.	Strain No. 111.	Strain No. 112.	Strain No. 114.	Hours.
Mac Neal, normal, Urbana.	0	Slight.....	0	0	0	2
	Slight.....	Very marked.	0	0	0	6
	Slight.....	Complete	0	Slight.....	Slight.....	45
York, normal, Urbana.	0	Slight.....	0	0	0	2
	Slight.....	Very marked.	0	0	0	6
	Slight.....	Complete	Slight.....	Slight.....	Slight.....	45
M. G., pellagrin, Peoria.	0	Slight.....	0	0	0	2
	Slight.....	Very marked.	0	0	0	6
	Slight.....	Complete	Slight.....	Slight.....	Slight.....	45
C. C. H., pellagrin, Chicago.	0	Slight.....	0	0	0	2
	Slight.....	Very marked.	0	0	0	6
	Slight.....	Complete	Slight.....	Slight.....	Slight.....	45

Agglutination Test No. 30.

Serum dilution 1:10.	Strain No. 67.	Hours.
D. Y., pellagrin, Chicago.	Very marked...	2
	Complete	6
G. M., pellagrin, Chicago.	Very marked ..	2
	Complete.....	6
S.E., pellagrin, (diagnosis doubtful) Kankakee.	0	2
	0	6
M. N., pellagrin, Kankakee.	Very marked ..	2
	Complete.....	6
D. E., pellagrin, Peoria.	0	2
	0	6
S. N., pellagrin, Peoria.	Very marked ..	2
	Complete	6
E. P., pellagrin, Peoria.	Very marked ..	2
	Complete.....	6
B. N., pellagrin, Peoria.	Very marked ..	2
	Complete.....	6
C. N., pellagrin, Peoria.	Very marked ..	2
	Complete	6
Mac Neal, normal, Urbana.	0	2
	0	6
York, normal, Urbana.	Very marked ..	2
	Complete.....	6

Agglutination Test No. 31.

Serum dilution 1:10.	Strain No. 67.	Strain No. 12.	Strain No. 51.	Strain No. 52.	Hours.
Mac Neal, normal, Urbana.	0	0	Slight.....	Slight.....	1
	0	0	Complete ..	Complete ..	3
York, normal, Urbana.	Very marked.	0	Slight.....	Slight.....	1
	Complete	0	Complete ..	Complete ..	3
B. N., pellagrin, Peoria.	Very marked.	0	Slight.....	Slight.....	1
	Complete	0	Complete ..	Complete ..	3
M. N., pellagrin, Kankakee.	Very marked.	0	Slight.....	Slight.....	1
	Complete	0	Complete ..	Complete ..	3

Agglutination Test No. 32.

Serum dilution 1:10.	Strain No. 67.	Hours.
York, normal, Urbana.	Complete.....	1
	Complete.....	3
D. Y., pellagrin, Chicago.	Complete.....	1
	Complete.....	3
S. E., pellagrin, (diagnosis doubtful) Kankakee.	0	1
	0	3
D. E., pellagrin, Peoria.	0	1
	0	3
Plain salt solution.	0	1
	0	3

AGGLUTINATION TEST NO. 33.

Only Strain No. 67 was employed and the serum of York, Normal, Urbana, and of M. N., Pellagrin, Kankakee were tested in various dilutions. All observations were made after one hour at 37° C.

	Serum dilution.				
	1:10.	1:20.	1:50.	1:100.	1:500.
York	Very marked.	Very marked.	Slight	Slight	Slight
M. N	Complete	Very marked.	Slight	Slight	Slight

Agglutination Test No. 34.

Serum dilution 1:10.	Strain No. 78.	Strain No. 86.	Strain No. 89.	Strain No. 92.	Strain No. 67.	Strain No. 104.	Strain No. 105.	Strain No. 103.	Strain No. 107.	Hours.
Mac Neal, normal, Urbana.	Very marked.	0	0	Slight.....	Slight.....	Slight.....	0	0	0	1
	Complete	0	0	Very marked.	Slight.....	Slight.....	0	0	0	4½
	Complete	Marked.....	Very marked.	Very marked.	Slight.....	Slight.....	Slight.....	Slight.....	Slight.....	23
York, normal, Urbana.	Very marked.	0	0	Slight.....	Complete	Slight.....	0	Slight.....	0	1
	Complete	0	0	Very marked.	Complete	Slight.....	0	Slight.....	0	4½
	Complete	Marked.....	Very marked.	Very marked.	Complete	Slight.....	Slight.....	Slight.....	Slight.....	23
G. M., pellagrin, Chicago.	0	0	0	Slight.....	Slight.....	Slight.....	0	0	0	1
	Slight.....	Slight.....	0	Very marked.	Complete	Slight.....	0	0	Slight.....	4½
	Complete	Marked.....	Very marked.	Very marked.	Complete	Slight.....	Slight.....	Slight.....	Slight.....	23
B. N., pellagrin, Peoria.	Slight.....	0	0	Marked.....	Slight.....	Slight.....	0	0	0	1
	Very marked.	Slight.....	0	Very marked.	Very marked.	Slight.....	Slight.....	Slight.....	Slight.....	4½
	Complete	Marked.....	Very marked.	Very marked.	Complete	Slight.....	Slight.....	Slight.....	Slight.....	23

Agglutination Test No. 35.

Serum dilution 1:10.	Strain No. 108.	Strain No. 109.	Strain No. 110.	Strain No. 111.	Strain No. 112.	Strain No. 114.	Strain No. 67.	Hours.
Mac Neal, normal Urbana.	0	0	Slight.....	0	0	0	0	2
	Slight..	0	Very marked.	0	0	0	0	17
	Slight..	0	Very marked.	0	0	0	0	25
York, normal, Urbana.	0	0	0	0	0	0	Complete ..	2
	Slight..	0	Very marked.	0	0	0	Complete ..	17
	Slight..	0	Very marked.	0	0	0	Complete ..	25
H. E., normal, Urbana.	0	0	0	0	0	0	Complete ..	2
	Slight..	Slight..	Very marked.	0	0	0	Complete ..	17
	Slight..	Marked	Very marked.	0	0	0	Complete ..	25
C. N., pellagrin, Peoria.	0	0	0	0	0	0	Slight.....	2
	Slight..	Slight..	Very marked.	Very marked.	0	Slight..	Complete ..	17
	Slight..	Slight..	Very marked.	Complete	0	Slight..	Complete ..	25
M. N., pellagrin, Kankakee.	0	0	Slight.....	0	0	0	Complete ..	2
	Slight..	Slight..	Very marked.	Slight.....	0	0	Complete ..	17
	Slight..	Slight..	Very marked.	Slight.....	0	Slight..	Complete ..	25

Agglutination Test No. 36.

Only Strain No. 67 was employed and the serum of Monkey No. 79 which had been fed cultures of this organism was tested in different dilutions.

Serum dilution.					
1:10.	1:20.	1:50.	1:100.	1:500.	Hours.
Very marked.....	Marked.....	0	0	0	2
Complete.....	Complete.....	0	0	0	17

Agglutination Test No. 37.

Serum dilution 1:10.	Strain No. 67.	Strain No. 92.	Strain No. 88.	Strain No. 51.	Strain No. 52.	Hours.
Mac Neal, normal, Urbana.	0	0	0	Very marked.	Very marked.	1
	0	0	0	Complete	Complete	5
	0	0	0	Complete	Complete	20
York, nomral, Urbana.	Very marked.	0	0	Very marked.	Very marked.	1
	Complete	Slight.....	0	Complete	Complete	5
	Complete	Slight.....	0	Complete	Complete	20
C. N., pellagrin, Peoria.	Very marked.	Slight.....	0	Very marked.	Very marked.	1
	Complete	Slight.....	0	Complete	Complete	5
	Complete	Very marked.	Slight.....	Complete	Complete	20
S. N., pellagrin, Peoria.	Slight.....	Slight.....	Very marked.	Very marked.	Very marked.	1
	Complete	Slight.....	Complete	Complete	Complete	5
	Complete	Very marked.	Complete	Complete	Complete	20

Agglutination Test No. 38.

Serum dilution 1:10.	Strain No. 107.	Strain No. 108.	Strain No. 111.	Strain No. 86.	Strain No. 67.	Hours.
Mac Neal, normal, Urbana.	0	0	0	0	0	2
	0	0	0	0	0	5
York, normal, Urbana.	0	0	0	0	Very marked.	2
	0	0	0	0	Complete	5
C. N., pellagrin, Peoria.	0	0	0	Slight.....	Very marked,	2
	0	0	0	Very marked.	Complete	5
S. N., pellagrin, Peoria.	0	0	0	0	Very marked,	2
	0	0	0	0	Complete	5

Agglutination Test No. 39.

Serum dilution 1:10.	Strain No. 12.	Strain No. 78.	Strain No. 89.	Strain No. 104.	Strain No. 105.	Hours.
Mac Neal, normal, Urbana.	0	Slight.....	0	0	0	1
	Very marked.	Complete ..	Slight.....	Slight.....	0	14
York, normal, Urbana.	0	Slight.....	0	0	0	1
	Very marked.	Complete ..	Slight.....	Slight.....	0	14
C. N., pellagrin, Peoria.	0	Slight.....	0	0	0	1
	Complete	Complete ..	Slight.....	Slight.....	0	14
S. N., pellagrin, Peoria.	0	Slight.....	0	0	0	1
	Complete	Complete ..	Slight.....	Slight.....	0	14

Agglutination Test No. 40.

Only Strain No. 67 was employed and the sera were all tested in dilution 1:10. The sera were sent to the laboratory as "unknowns" and the clinical diagnoses were furnished after the tests had been carried out.

Mac Neal, normal, Urbana.	York, normal, Urbana.	H. E., normal, Urbana.	D. Y., pellagrin, Chicago.	A. A., luetic, Chicago.	R. Y., luetic, Chicago.	Hours.
0	Marked.....	Marked.....	Marked.....	0	0	1
0	Complete	Complete.....	Complete.....	0	0	3

G. M., pellagrin, Chicago.	O. Y., typhoid Chicago.	G. I., pneumonia, Chicago.	T. R., pellagrin, Chicago.	H. D., normal, Chicago.	M. Y., normal, Chicago.	Hours.
0	0	0	Marked.....	0	0	1
Slight.....	Marked.....	Complete.....	Complete.....	0	Slight.....	3

Agglutination Test No. 41.

Only Strain No. 67 was employed and the sera were all tested in dilution 1:10. The sera were sent to the laboratory as "unknowns" and the clinical diagnoses were furnished after the tests had been carried out.

Mac Neal, normal, Urbana.	York, normal, Urbana.	H. E., normal, Urbana.	B. R., normal, Kankakee.	M. R., normal, Kankakee.	M. N., pellagrin. Kankakee.	W. L., normal, Kankakee.	P. N., normal, Kankakee.	Hours.
0	Marked...	0	0	0	0	Marked.....	Marked.....	1
0	Complete	Marked...	0	0	Complete ..	Very marked.	Very marked.	2

Agglutination Test No. 42.

Only Strain No. 67 was employed and the sera were all tested in dilution 1:10. The sera were sent to the laboratory as "unknowns" and the clinical diagnoses were furnished before these tests were carried out. Compare with Test No. 40.

Mac Neal, normal, Urbana.	D. Y., pellagrin, Chicago.	G. M., pellagrin, Chicago.	G. I., pneumonia Chicago.	T. R., pellagrin, Chicago.	M. Y., normal, Chicago.	York, normal, Urbana.	Hours.
0	Complete	Slight.....	Complete ..	Complete ..	Slight.....	Complete ..	2

Agglutination Test No. 43.

Serum dilution 1:10.	Strain No. 92.	Strain No. 110.	Strain No. 72.	Strain No. 73.	Strain No. 20.	Hours.
Mac Neal, normal, Urbana.	0	0	0	0	0	1
	Very marked.	Very marked.	Slight.....	Slight.....	Slight.....	14
York, normal, Urbana.	0	0	0	0	0	1
	Very marked.	Very marked.	Slight.....	Slight.....	Slight.....	14
C. N., pellagrin, Peoria	0	0	0	0	0	1
	Very marked.	Very marked.	Slight.....	Slight.....	Slight.....	14
S. N., pellagrin, Peoria.	0	0	0	0	0	1
	Very marked.	Very marked.	Slight.....	Slight.....	Slight.....	14

Agglutination Test No. 44.

Serum dilution 1:10.	Strain No. 11.	Strain No. 14.	Strain No. 17.	Strain No. 30.	Strain No. 35.	Strain No. 44.	Strain No. 62.	Strain No. 67.	Hours.
Mac Neal, normal, Urbana.	0	0	0	0	Complete.....	Slight.....	Slight.....	0	2
	Slight.....	0	0	0	Complete.....	Marked.....	Marked.....	0	6
York, normal, Urbana.	0	Complete.....	0	0	Complete.....	Slight.....	Slight.....	Complete.....	2
	Slight.....	Complete.....	0	0	Complete.....	Marked.....	Marked.....	Complete.....	6
C. N., pellagrin, Peoria.	0	Complete.....	0	0	Complete.....	Slight.....	Slight.....	Complete.....	2
	Slight.....	Complete.....	Marked.....	0	Complete.....	Very marked ..	Slight.....	Complete.....	6
S. N., pellagrin, Peoria.	0	0	0	0	Complete.....	0	0	Slight.....	2
	Slight.....	0	0	0	Complete.....	0	Slight.....	Complete.....	6

Agglutination Test No. 45.

Serum dilution 1:10.	Strain No. 88.	Strain No. 85.	Strain No. 83.	Strain No. 80.	Strain No. 79.	Strain No. 75.	Strain No. 12.	Strain No. 19.	Strain No. 97.	Strain No. 67.	Hours.
Mac Neal, normal, Urbana.	0	0	0	Slight.....	Slight.....	0	Marked....	0	Marked....	0	1
	0	0	0	Slight.....	Slight.....	Slight.....	Marked....	0	Complete ..	Marked....	3
	0	0	0	Slight.....	Slight.....	Slight.....	Complete ..	0	Complete ..	Marked....	6
York, normal, Urbana.	0	Slight.....	0	Slight.....	Slight.....	Marked....	Marked....	0	Marked	Complete ..	1
	0	Slight.....	0	Slight.....	Slight.....	Marked....	Marked....	0	Complete ..	Complete ..	3
	0	Slight.....	0	Marked....	Marked....	Marked....	Complete ..	Slight.....	Complete ..	Complete ..	6
C. N., pellagrin, Peoria.	Marked....	Marked....	Marked....	Slight.....	Marked....	Marked....	Marked....	0	Marked....	Complete ..	1
	Complete ..	Marked....	Marked....	Slight.....	Marked....	Marked....	Marked....	0	Complete ..	Complete ..	3
	Complete ..	Marked....	Marked....	Marked....	Marked....	Marked....	Complete ..	Slight.....	Complete ..	Complete ..	6
S. N., pellagrin, Peoria.	0	Slight.....	0	Slight.....	Slight.....	Marked....	Marked....	0	Marked....	Marked....	1
	0	Slight.....	0	Slight.....	Slight.....	Marked....	Marked....	0	Complete ..	Marked....	3
	0	Slight.....	0	Slight.....	Slight.....	Marked....	Complete ..	Slight.....	Complete ..	Complete ..	6

Agglutination Test No. 46.

Only Strain No. 67 was employed and the sera of three monkeys were tested. One monkey, No. 79, had been fed cultures of Strain No. 67. The other two animals were controls. Serum dilutions were 1:10.

Monkey 79.	Monkey 248.	Monkey 290.	Hours.
Complete	Marked	Marked	1
Complete	Marked	Marked	3
Complete	Marked	Marked	6

Agglutination Test No. 47.

Serum dilution 1:20.	Strain No. 10.	Strain No. 82.	Strain No. 101.	Hours.
Mac Neal, normal, Urbana.	0	0	0	1
	0	0	0	4
York, normal, Urbana.	0	0	0	1
	0	0	0	4
D. Y., pellagrin, Chicago.	0	0	0	1
	0	0	0	4
M. N., pellagrin, Kankakee.	0	0	0	1
	0	0	0	4

Agglutination Test No. 48.

Only Strain No. 67 was employed and the sera were tested in different dilutions. The sera were sent to the laboratory as "unknowns" and the clinical diagnoses furnished after the tests had been carried out.

Serum.	Dilution 1:10.	Dilution 1:20.	Dilution 1:50.	Hours.
W. D., normal, Kankakee.	0	0	0	½
	0	0	0	1
	Slight.....	0	0	4
M. Y., normal, Kankakee.	Marked.....	Marked.....	0	½
	Very marked...	Very marked ..	Marked...	1
	Complete.....	Complete.....	Marked...	4
B. R., pellagrin, Kankakee.	0	0	0	½
	0	0	0	1
	Slight.....	0	0	4
P. L., normal, Kankakee.	Marked.....	0	0	½
	Marked.....	0	0	1
	Complete.....	0	0	4
J. S., normal, Kankakee.	Marked.....	0	0	½
	Marked.....	0	0	1
	Complete.....	0	0	4
B. I., syphilis, Chicago.	Marked.....	Slight.....	0	½
	Very marked ..	Marked.....	0	1
	Complete.....	Complete.....	0	4
L. S., syphilis, Chicago.	0	0	0	½
	0	0	0	1
	Slight.....	0	0	4
C. K., syphilis, (?) Chicago.	0	0	0	½
	0	0	0	1
	Slight.....	0	0	4
D. Y.,* pellagrin, Chicago.	Very marked ..	Slight.....	0	½
	Complete.....	Very marked ..	0	1
	Complete.....	Complete.....	0	4
G. S.,** pellagrin, Chicago.	Marked.....	0	0	½
	Very marked ..	0	0	1
	Complete.....	Complete.....	0	4
H. D., normal, Chicago.	0	0	0	½
	0	0	0	1
	Slight.....	0	0	4
D. Y.,* pellagrin, Chicago.	Marked.....	0	0	½
	Very marked ..	Marked.....	0	1
	Complete.....	Complete.....	0	4
G. S.,** pellagrin, Chicago.	Marked.....	0	0	½
	Very marked ..	Marked.....	0	1
	Complete.....	Complete.....	0	4

* Duplicate samples from the same case.
** Duplicate samples from the same case.

Agglutination Test No. 49.

Serum dilution 1:10.	Strain No. 10.	Strain No. 71.	Strain No. 54.	Hours.
H. E., normal, Urbana.	0	0	0	½
	0	0	0	1
Rabbit, normal.	0	0	0	½
	0	0	0	1
C. N., pellagrin, Peoria.	0	0	0	½
	0	0	0	1
S. N., pellagrin, Peoria.	0	0	0	½
	0	0	0	1

Agglutination Test No. 50.

Serum dilution 1:10.	Strain No. 36.	Strain No. 54.	Strain No. 113.	Strain No. 58.	Strain No. 101.	Hours.
H. E., normal, Urbana.	Marked.....	0	0	Marked....	0	½
	Very marked.	Slight.....	0	Marked....	0	1
	Complete	Very marked.	Slight.....	Marked....	Slight.....	3
Rabbit, normal.	Marked.....	0	0	0	0	½
	Very marked.	0	0	0	0	1
	Very marked.	Marked.....	Slight.....	Marked....	Slight.....	3
C. N., pellagrin, Peoria.	Marked.....	0	0	0	0	½
	Very marked.	0	0	0	0	1
	Complete	Very marked.	Slight.....	Marked....	Slight.....	3
B. N., pellagrin, Peoria.	Marked.....	0	0	Marked....	0	½
	Very marked	Slight.....	0	Marked....	0	1
	Very marked.	Very marked.	Slight.....	Marked....	0	3

Agglutination Test No. 51.

Serum dilution 1:10.	Strain No. 82.	Strain No. 9.	Strain No. 63.	Strain No. 10.	Strain No. 102.	Hours.
H. E., normal, Urbana.	0	0	Marked....	Marked.....	Marked.....	1
	0	Slight.....	Marked....	Marked.....	Very marked.	3
	0	0	Marked....	Very marked.	Complete	6
Rabbit, nomral.	Slight.....	0	Marked....	Marked.....	Slight.....	1
	Marked.....	Slight.....	Marked....	Very marked.	Slight.....	3
	Very marked.	Marked....	Marked....	Complete	Very marked.	6
C. N., pellagrin, Peoria.	0	0	0	Marked.....	0	1
	0	0	Slight.....	Very marked.	0	3
	0	0	Slight.....	Complete	0	6
B. N., pellagrin, Peoria.	0	0	Slight.....	Slight.....	0	1
	0	0	Marked....	Marked.....	0	3
	0	0	Marked....	Very marked.	0	6

Agglutination Test No. 52.

Serum dilution 1:20.	Strain No. 54.	Strain No. 36.	Strain No. 113.	Strain No. 63.	Strain No. 9.	Strain No. 102.	Strain No. 58.	Hours.
Mac Neal, normal, Urbana	0	Very marked.	0	0	0	0	0	1
	0	Complete	0	0	0	0	0	6½
York, normal, Urbana.	0	Marked.....	0	0	0	0	0	1
	Marked...	Complete	0	0	0	0	0	6½
D. Y., pellagrin, Chicago.	0	Very marked.	0	0	0	0	0	1
	Marked...	Complete	0	0	0	0	0	6½
M. N., pellagrin, Kankakee.	0	Marked.....	0	0	0	0	0	1
	Marked...	Complete	0	0	Slight..	0	0	6½

Agglutination Test No. 53.

Serum dilution 1:20.	Strain No. 14.	Strain No. 17.	Strain No. 30.	Strain No. 35.	Strain No. 44.	Strain No. 62.	Hours.
Mac Neal, normal, Urbana.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
York, normal, Urbana.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
H. D., normal, Chicago.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
G. S.,[1] pellagrin, Chicago.	Slight.....	0	0	0	0	0	½
	Marked....	0	0	0	0	0	2
	Complete ..	0	0	0	0	0	5
D. Y.,[2] pellagrin, Chicago.	Slight.....	0	0	0	Slight....	Slight.....	½
	Marked....	0	0	0	Slight....	Marked.....	2
	Complete ..	0	0	0	Slight....	Complete	5
G. S.,[1] pellagrin, Chicago.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
D. Y.,[2] pellagrin, Chicago.	Slight.....	0	0	0	Slight....	Slight.....	½
	Slight.....	0	0	0	Slight....	Marked.....	2
	Complete ..	0	0	0	Slight....	Complete	5
B. R., pellagrin, Kankakee.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	Very marked.	5
T. R., pellagrin, Chicago.	0	0	0	0	Slight....	0	½
	0	0	0	0	Slight....	0	2
	0	0	0	0	Slight....	0	5
G. M., pellagrin, Chicago.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
D. Y.,[2] pellagrin, Chicago.	Slight.....	0	0	0	Slight....	0	½
	Marked....	0	0	0	Slight....	0	2
	Complete ..	0	0	0	Slight....	Complete	5
M. N., pellagrin, Kankakee.	Slight.....	0	0	0	Slight....	0	½
	Complete ..	0	0	0	Slight....	0	2
	Complete ..	0	0	0	Slight....	0	5

[1] Two samples of serum sent at different times.
[2] Three samples of serum from the same case.

Agglutination Test No. 53—Concluded.

Serum dilution 1:20.	Strain No. 75.	Strain No. 79.	Strain No. 83.	Strain No. 85.	Strain No. 88.	Strain No. 67.	Hours.
Mac Neal, normal, Urbana.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
York, normal, Urbana.	0	0	0	0	0	Slight.....	½
	0	0	0	0	0	Marked.....	2
	0	0	0	0	0	Very marked.	5
H. D., normal, Chicago.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
G. S.,[1] pellagrin, Chicago.	0	0	0	0	0	Slight.....	½
	0	0	Slight..	0	Slight....	Marked.....	2
	0	0	Comp..	0	Complete	Complete	5
D. Y.,[2] pellagrin, Chicago.	0	0	0	0	0	Slight.....	½
	0	0	0	0	0	Marked.....	2
	0	0	0	0	0	Complete	5
G. S.,[1] pellagrin, Chicago.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
D. Y.,[2] pellagrin, Chicago.	0	0	0	0	0	Slight.....	½
	0	0	0	0	0	Marked.....	2
	0	0	0	0	0	Complete	5
B. R., pellagrin, Kankakee.	0	0	0	0	0	0	½
	0	0	0	0	0	Slight.....	2
	0	0	0	0	0	Slight.....	5
T. R., pellagrin, Chicago.	0	0	0	0	0	Slight.....	½
	0	0	0	0	0	Marked.....	2
	0	0	0	0	Slight....	Complete	5
G. M., pellagrin, Chicago.	0	0	0	0	0	0	½
	0	0	0	0	0	0	2
	0	0	0	0	0	0	5
D. Y.,[2] pellagrin, Chicago.	0	0	0	0	0	Slight.....	½
	0	0	0	0	0	Marked.....	2
	0	0	0	0	0	Complete	5
M. N., pellagrin, Kankakee.	0	0	0	0	0	Slight.....	½
	0	0	0	0	0	Marked.....	2
	0	0	0	0	0	Complete	5

[1] Two samples of serum sent at different times.
[2] Three samples of serum from the same case.

Of the 114 bacterial strains isolated from the different stools, 14 were lost before being tested. These were the strains designatd by the following numbers—7, 15, 24, 31, 39, 40, 41, 42, 43, 45, 50, 61, 74, 77. Each of the remaining 100 bacterial strains was subjected to one or more agglutination tests in which the serum of normal persons as well as serum from pellagrins was employed, as shown in the above tables. Among these one hundred strains, only a few manifested any distinctly different behavior toward the sera of pellagrins as compared with the sera of normal individuals. These were Strains No. 14, No. 35, No. 44, No. 62 and No. 67, and possibly No. 85 and No. 88.

Results of agglutination tests, previous to July, 1911, upon Strains No. 14, No. 35, No. 44, No. 62 and No. 67.

Control sera.	Positive results—strains—					Negative results—strains—				
	14.	35.	44.	62.	67.	14.	35.	44.	62.	67.
Kerr	0	0	0	0	0	4	1	3	3	3
Mac Neal	0	0	1	1	0	5	1	2	2	5
Guinea-pig	0	1	0	0	0	2	0	2	3	3
Total	0	1	1	1	0	11	2	7	8	11
INSANE—NOT PELLAGRINS.										
M. L	1	.....	.....	.....	2	0	.....	.....	.....	0
B. N	1	.....	.....	.....	2	0	.....	.....	.....	0
Total	2	.....	.....	.....	4	0	.....	.....	.....	0
PELLAGRINS.										
P. E	2	1	2	1	2	1	0	0	1	0
M. Y	1	1	1	.....	.....	1	0	0	.....	.....
M. G	4	1	2	2	4	0	0	0	0	0
G. I	1	1	.....	.....	.....	1	0	.....	.....	.....
T. E	1	1	0	0	4	3	0	2	2	0
D. E	1	.....	1	2	1	0	.....	1	0	1
W. N	1	.....	1	2	2	0	.....	0	0	0
J. S	1	.....	0	0	0	0	.....	1	1	1
E. P	1	.....	0	1	0	0	.....	1	0	1
D. D	1	.....	0	0	1	0	.....	1	1	0
A. D	2	.....	0	0	2	0	.....	1	1	1
S. E	1	.....	.....	.....	2	0	.....	.....	.....	0
J. N	1	.....	.....	.....	2	0	.....	.....	.....	0
Total	18	5	7	8	20	6	0	7	6	4

The results of these tests made previous to July, 1911, are briefly summarized in the above table and the total number of tests on the different classes of sera are seen to be as follows:

	14.		35.		44.		62.		67.	
	+.	0.	+.	0.	+.	0.	+.	0.	+.	0.
Normal controls	0	11	1	2	1	7	1	8	0	11
Insane controls	2	0	.....	.....	.....	.....	.....	.....	4	0
Pellagrins	18	6	5	0	7	7	8	6	20	1

These tests directed attention particularly to Strains No. 14, No. 35 and No. 67 and especially to the last one, No. 67.

The results of the agglutination tests made during July and August, 1911 (Tests 22-53, inclusive), tend to break down the evidence suggesting that these bacterial strains bear a special relation to the disease pellagra, by showing that positive agglutination of them is frequently brought about by the sera of normal individuals and that the sera of pellagrins sometimes fail to produce this result. Some of these results, however, did support, in a way, the earlier evidence, especially the positive agglutinations of Strain No. 67 produced by the serum of every one of the acute typical cases of pellagra in sane individuals in the Cook County Hospital. The conflicting character of the evidence would seem to call for more work along this line.

In the following table the results of the later tests with Strain No. 67 are briefly summarized:

SUMMARY OF RESULTS OF AGGLUTINATION TESTS UPON STRAIN NO. 67 DURING JULY AND AUGUST, 1911.

Individual.	Residence.	Remark.	Positive results.	Negative results.
Sera of healthy individuals.				
Mac Neal	Urbana		0	[1]16
York	..do		15	0
H. E	..do		3	0
H. D	Chicago		0	3
M. Y. (C)	..do		0	[2]2
M. Y. (K)	Kankakee		1	0
Monkey 248	..do		0	[2]1
Monkey 230	..do		0	[2]1
Total			19	23
Serum of monkey fed on cultures of Strain No. 67.				
Monkey 79	Kankakee		2	0
Sera of patients not pellagrins.				
B. R	Kankakee	Insane	0	1
M. R	..do	..do	0	1
W. L	..do	..do	1	0
P. N	..do	..do	1	0
W. D	..do	..do	0	[2]1
P. L	..do	..do	1	0
J. S	..do	..do	1	0
A. A	Chicago	Sane, syphilis	0	1
R. Y	..do	..do	0	1
B. I	..do	..do	1	0
L. S	..do	..do	0	1
C. K	..do	..do	0	1
O. Y	..do	Sane, typhoid	1	0
G. I	..do	Sane, pneumonia	2	0
Total			8	7
Sera of pellagrins.				
A. D	Chicago	Sane	4	0
C. C. H	..do	..do	3	0
D. Y	..do	..do	9	0
G. M	..do	..do	2	[3]3
T. R	..do	..do	3	0
G. S	..do	..do	3	1
M. G	Peoria	Insane	1	0
D. E	..do	..do	0	2
S. N	..do	..do	5	0
P. Y	..do	..do	1	0
B. N	..do	..do	3	0
C. N	..do	..do	6	0
B. R	Kankakee	..do	0	[2]2
S. E	..do	Insane[4]	0	2
M. N	..do	Insane	6	0
Total			46	10

[1] Four of these were slight agglutinations.
[2] All of these were slight agglutinations.
[3] Two of these were slight agglutinations.
[4] Diagnosis of pellagra doubtful.

E. Brief Description of Some of the Bacterial Strains.

Strain No. 14—This was derived from a thin colony, spreading beneath the surface, on an aerobic blood-agar plate inoculated with unheated suspension of Specimen No. 11. This specimen was a watery stool passed by the patient W. N. early in an exacerbation of definite pellagra. The culture was found to be impure and was separated into two strains by plating during January, 1911. The strain then designated as 14B gave the more definite agglutination reactions and was accepted as the authentic Strain No. 14, the other component being disregarded. The organism was an actively motile bacillus, varying in thickness from 1.0 micron to 1.8 microns and in length from 2.1 microns to 8.1 microns. The ends were rounded. In gelatin stab culture it produced a funnel-shaped liquefaction. In litmus milk the reaction remained alkaline; the milk was slightly curdled after four days, and the curd dissolved to some extent afterward. No gas was produced in broth containing dextrose, levulose, lactose, maltose or saccharose. There was no production of indol in Dunham's pepton-salt solution. On agar slants the growth was white at first, but later became orange in color.

The contaminating organism, separated from the above strain by plating the original Strain 14, was designated as Strain 14a. In its various characters it agreed closely with *B. coli*.

Strain No. 35 was derived from a colony on the aerobic blood-agar plates inoculated with unheated suspension of Specimen No. 15. This stool was passed by a pellagrin showing active erythema on the hands, but the usual precautions against contamination of the stool were not carried out. The organism was an actively motile bacillus of about the same size as *B. coli*. In gelatin stab culture it produced a funnel-shaped liquefaction. In litmus milk the reaction remained alkaline but there was slight coagulation after four days. No gas was produced in broth containing dextrose, levulose, lactose, maltose or saccharose, and indol was not produced in Dunham's pepton-salt solution. Pigment was not observed in the culture of this strain, so that it differed from Strain 14 in this respect.

Strain No. 44 was derived from a colony on the aerobic plates of litmus lactose gelatin inoculated with unheated suspension of Specimen No. 17. This stool was passed by a pellagrin showing a subacute active erythema on the hands. The organism was an actively motile bacillus resembling *B. coli.* in size and shape. In gelatin stab culture there was no liquefaction, but gas bubbles were seen in the gelatin after 3 days. Litmus milk was rendered acid in 24 hours and coagulated in 48 hours. No subsequent digestion of the clot was observed. Gas was produced in fermentation-tube cultures in broth containing various sugars as follows; dextrose, 95 per cent gas in the closed arm; levulose, 45 percent; lactose, 40 percent; maltose, 62 per cent; saccharose, none. Cultures in Dunham's pepton-salt solution gave a pronounced positive reaction to the test for indol. Pigment was not observed in the cultures of this strain.

Strain No. 62 was derived from a colony on the anaerobic plates of glucose agar inoculated with unheated suspension of Specimen No. 19. This stool was passed by a pellagrin with definite active pellagrous erythema on the hands, which had been noted first about three weeks before. The organism was a granular bacillus appearing somewhat larger than *B. coli*, some of the rods being very long. Most of the colonies on the set of glucose-agar plates were composed of similar bacilli. In gelatin stab culture there was no liquefaction, and gas bubbles were observed after 11 days. Litmus milk was acidified in 24 hours and coagulated in 48 hours. There was no subsequent digestion of the casein. In fermentation-tube cultures in broth containing various sugars, gas was produced as follows: dextrose, 45 percent; levulose, 45 percent; lactose, 45 percent; maltose, 50 percent; saccharose, none. Indol was produced in Dunham's pepton-salt solution. A slightly red pigment was observed in some of the cultures of this bacillus.

Strain No. 67 was derived from a colony on the aerobic blood-agar plates inoculated with unheated suspension of the same Specimen No. 19. The

organism was an actively motile bacillus with rounded ends, about 4 microns long by 1.4 microns thick on the average. Variations in length between 2.4 microns and 6.2 microns and in thickness between 1.0 micron and 1.6 microns were observed. The flagella were peritrichous and apparently numbered from 4 to 10 for each cell (this point was not satisfactorily ascertained). In gelatin stab-culture, it produced a funel-shaped liquefaction resembling closely that produced by Strain No. 14 and Strain No. 35. In litmus milk the reaction remained alkaline, but there was slight coagulation after 4 days and some digestion of the casein apparent at this time but more definite subsequently. No gas was produced in fermentation-tube cultures or broth containing dextrose, levulose, lactose, maltose or saccharose. No indol could be detected in cultures grown in Dunham's peptone-salt solution. Fresh agar cultures were colorless, but later became orange in color. This strain corresponded in its various characters very closely to Strain No. 14 and, except for the pigment, it also agreed well with Strain No. 35.

F. Summary and Conclusions.

It must be evident that there was considerable variety in the character of the fecal material examined in respect to its relation to pellagra. Of the first ten specimens, three, No. 5, No. 8 and No. 7 were furnished by inmates of the Kankakee State Hospital who showed a suspicious pigmentation of the skin, but in all probability did not have pellagra; five, No. 2, No. 3, No. 4, No. 6, and No. 9, were from pellagrins well on the road to recovery from an attack of the disease, which has not recurred in them up to the present time, August, 1911; two specimens, No. 1 and No. 10, were from pellagrins who had recently suffered a very severe acute attack and in whom the skin lesions had practically disappeared, although the patients still remained very weak and apparently about to die. The other fourteen specimens seem to be, as a whole, more nearly represntative of the condition of the stools in pellagra. Six of them, No. 11, No. 12, No. 14, No. 16, No. 18, and No. 20 were obtained at intervals from the same patient, W. N., and during this time the skin lesions evolved in such a way as to indicate an acute exacerbation of the disease, and the erythema appeared on a new area, the forehead, gradually extending downward over it; and finally before the last specimen was obtained the patient had recovered. Two specimens, No. 15, and No. 21, were obtained from another patient, the first one during a recurrence of the skin eruption, and the second after all skin manifestations had disappeared. One specimen, No. 13, was obtained from a case in which the skin lesions had persisted for months, indicating a chronic type of the disease. Two others, No. 17 and No. 19, were obtained from patients soon after the recognition of a recurrence of the skin eruption. Finally, the last three specimens were obtained from a fatal case in which the eruption had been present for three months, and was very severe at the time. One specimen, No. 22, was a fluid stool obtained 41 hours before the death of the patient, the second, No. 23, was obtained from the cecum, and the third, No. 24, from the ileum, at the autopsy 21 hours after the death of the patient.

In the preceding pages, an attempt has been made to record our observations in detail, without attempting a discussion of the data. It must be evident that further experimental work is necessary before it will be possible to draw any important conclusions concerning questions in this field. The following conclusions are at any rate suggested by the observations and are set down here in a tentative way.

1. In pellagra, especially in the acute attack, there are marked changes in the fecal flora as compared with the normal. Relative diminution in the number of bacterial cells per milligram of feces is frequently very great. The numerical relations of the different types of bacteria normally seen in

the feces are disturbed, and in addition several new forms appear, more or less heterogeneous in nature. Protozoa, especially amebae and flagellates, are frequently present.

2. In cultures from the feces of pellagrins, various departures from normal relationships of the fecal bacteria are frequent, and many forms of bacteria occur which are not found in cultures of fecal bacteria of healthy men.

3. Three bacterial strains derived from three different cases reacted to agglutination tests with sera of pellagrins in a manner somewhat suggestive. These strains, No. 14, No. 35 and No. 67, were all derived from pellagrins at Peoria but they were agglutinated by sera of pellagrins at Kankakee and at Chicago as well as by sera of patients at Peoria. This somewhat suggestive evidence of a relationship to pellagra is refuted or very much weakened by the fact that these bacteria were also agglutinated by the sera of insane persons free from pellagra at Peoria and at Kankakee, and by the sera of apparently normal persons at Kankakee, at Chicago and at Urbana. Preliminary cultural investigation has suggested that two of these strains (No. 14 and No. 67) are probably identical in nature, and that perhaps the other strain (No. 35) is a closely related variety of the same species. They do not belong in the *B. coli* group.

4. Other bacterial strains which showed suggestive agglutination relations were all non-liquefying, gas-forming bacteria, probably closely related to *B. coli*.

VII.

COMPLEMENT FIXATION REACTION IN PELLAGRA.

(Dr. J. F. Waugh, from the Laboratory of Drs. James N. Hyde and Oliver S. Ormsby.)

The technique of the test was that described by Noguchi. The material used included the following:

One cc. washed human corpuscles in proportion of one drop to four cc. normal salt solution; two units amboceptor of .003cc. titre; two units complement or .035cc. to .040cc.; .02cc. active patient's serum or .08cc. inactive serum, both being used; as antigens, an alcoholic extract of the liver from a pellagrin and a similar extract of the liver from a monkey, which was killed forty-one days after an erythema appeared, were used. The first period of incubation was for one hour after which the amboceptor was added and the tubes again incubated; when hemolysis was complete in the control tubes, the results in the other tubes were recorded. In standardizing the antigens, sera from very active cases of pellagra were used. Negative cases were used as controls.

TABLE NO. 1.

HUMAN SERA.

Case No.	Serum tested.	Antigen used.	Result.
1	Pellagra, Peoria State Hospital	Extract, human pellagra liver	—
2	..do	..do	—
3	..do	..do	+
4	..do	..do	+
5	..do	..do	—
6	..do	..do	+
7	..do	..do	+
9	..do	..do	+
10	..do	..do	+
11	..do	..do	+
12	..do	..do	+
13	..do	..do	—
14	..do	..do	+
15	..do	..ho	+
16	..do	..do	—
19	..do	..do	+
20	..do	..do	—
21	..do	..do	+
22	Normal, Peoria State Hospital	..do	+
23	Pellagra, Peoria State Hospital	..do	+
24	..do	..do	+
25	..do	..do	—
26	..do	..do	+
27	..do	..do	—
28	..do	..do	—
29	..do	..do	—
30	..do	..do	+
31	..do	..do	—
32	..do	..do	+
33	..do	..do	—
34	..do	..do	+
35	Normal, Peoria State Hospital	..do	+
36	..do	..do	+
37	..do	..do	—
38	..do	..do	+
39	Pellagra, Peoria State Hospital	..do	+
40	..do	..do	+
41	..do	..do	+
42	..do	..do	—
43	..do	..do	+
44	..do	..do	+
45	..do	..do	+
46	..do	..do	+
47	..do	..do	+
48	Pellagra, Kankakee State Hospital	..do	+
60	Pellagra, Peoria State Hospital	..do	—
61	..do	..do	+
62	..do	..do	—
63	..do	..do	—
64	..do	..do	—
65	..do	..do	—
66	..do	..do	—
67	..do	..do	+
68	..do	..do	—
69	..do	..do	+
70	..do	..do	+

+, Middy positive.
—, Negative.

Number of cases of pellagra, 51. Positive, 32 or 61 7/13 %; negative, 19 or 38 6/13 %.

Normal sera—Positive, 4; negative, 1.

TABLE No. 2.

HUMAN SERA.

No.	Serum from—	Antigen.	Result of test.
1	Pellagrin, Peoria Hospital	Extract, monkey liver	+
3	..do	..do	+
6	..do	..do	—
7	..do	..do	+
12	..do	..do	+
20	..do	..do	—
34	..do	..do	—
37	Normal, Peoria Hospital	..do	—
38	..do	..do	—
48	Pellagrin, Kankakee Hospital	..do	+
60	Pellagrin, Peoria Hospital	..do	—
61	..do	..do	+
62	..do	..do	—
63	..do	..do	—
64	..do	..do	—

Number of cases of pellagra, 13. Positive, 6; negative, 7.

TABLE No. 3.

MONKEY SERA.

No.	Condition of animal.	Antigen.	Results of test.	Antigen.	Results of test.
1	Inoculated, eruption	Extract human pellagra liver.	—	Extract monkey liver	—
3	Normal monkey	..do	—	..do	—
5	..do	..do	+	..do	+
6	Inoculated, eruption	..do	+	..do	+
7	..do	..do	+	..do	+
11	..do	..do	+	..do	+
14	Inoculated, no eruption	..do	—	..do	—
16	Normal monkey	..do	—	..do	—
19	Inoculated, no eruption,	..do	—	..do	—
26	Inoculated, eruption	..do	—	..do	—
9	..do	..do	+	..do	+
29	Not inoculated, eruption	..do	—	..do	+
30	..do	..do	—	..do	+
31	Normal monkey	..do	—	..do	—
32	..do	..do	—	..do	—
33	Not inoculated, eruption	..do	—	..do	—
34	Normal monkey	..do	—	..do	—
35	..do	..do	—	..do	—

Number of monkeys inoculated, 8.
Human and monkey antigen—Number positive, 4; number negative, 4.
Monkeys having eruption and not inoculated, 3.
Human antigen—Positive, 0; negative, 3.
Monkey antigen—Positive, 2; negative, 1.
Normal monkeys, 7.
Human antigen—Positive, 1.
Monkey antigen—Negative, 6.

Table No. 1 represents 51 sera from pellagrins which were tested with an alcoholic extract of human pellagra liver as antigen. Of these 51 sera, 32 or 61 7/13 percent gave a mildly positive reaction; 19 or 38 6/13 percent were negative. In this table are also five normal sera from persons who came in daily contact with the pellagra patients at Peoria. Four of these were positive and one negative. Thirteen specimens of blood from cases

other than pellagra, or at least giving no evidence of the disease, were used as controls. Among these were four sera from luetic patients, one of which gave a mildly positive reaction.

In Table No. 2, the results of thirteen positive sera, tested with monkey antigen, are shown: the patients from which the specimens of blood were taken, being in various stages of the disease. Six of the cases gave a positive reaction, seven being negative.

Table No. 3 shows the reaction on eighteen sera from monkeys, both antigens being used. Eight of the eighteen monkeys had been inoculated with blood from well marked cases of pellagra, and had an erythematous eruption (now known to be physiological) present when the specimen of blood was taken. Four of the sera gave a positive reaction with both antigens, while four were negative. Three of the sera were from animals having an eruption but which had not been inoculated: However, they were either caged with or in close proximity to the inoculated monkeys. With human antigen, none were positive; with the monkey antigen, two were positive and one negative. Seven of the specimens were from monkeys considered normal although they too were either with or near the animals having an eruption. One gave a positive reaction with both antigens while six proved to be negative.

The serum from a monkey at Washington, D. C., having a marked erythema of the face was tested with monkey antigen, a negative result being secured.

Inhibition to hemolysis was only partial in all the positive cases; in no instance was there a strong reaction such as we get in lues when a luetic liver extract is used as antigen.

Other antigens are being prepared which, with those in this report, will be used in the future work. While the above tests are strongly suggestive, further work will be necessary to demonstrate whether or not a specific reaction is present.

VIII.

CUTANEOUS TESTS WITH CORN EXTRACTS IN PELLAGRINS.

(By Arthur D. Hirschfelder, M. D., Baltimore.)

The zeistic theory of pellagra as enunciated by Lombroso and V. Babes that "pellagra is to be considered as a chronic and periodically occurrent intoxication which is due to a specific substance formed in more or less spoiled corn," is founded more upon statistical evidence that upon clear cut experiments. Lombroso and subsequent workers, it is true, have isolated from corn toxic products which have some action upon the nervous system of dogs, and v. Babes and Manicatide claim to have prevented this action in rabbits by injection of blood serum from a cured pellagrin. On the other hand, comparatively little has been done to test the sensitiveness of pellagra patients themselves to substances derived from corn.

If the zeistic theorists of pellagra were correct, it seemed possible that the chronic corn intoxication presupposed by Lombroso and V. Babes might be accompanied by a condition of anaphylactic hypersensitiveness to products derived from corn, or perhaps only from spoiled corn. The present series of observations was undertaken accordingly with a view of determining the presence or absence of such sensibility.

Since, v. Pirquet has demonstrated that the cutaneous reaction affords the most delicate means of testing anaphylactic sensitization in man to tuberculin and other substances. Quite recently Rufus Cole and W. S. Thayer were able to demonstrate hypersensitization to buckwheat infusion in a case of fagopyrismus reported by H. L. Smith. They found that if a drop of buckwheat extract were rubbed into a portion of the skin from which the epidermis had been removed by scratching, an urticarial wheal and general constitutional symptoms appeared within half an hour.

Since certain analogies between pellagra in man and fagopyrismus in animals had been recognized for decades, it seemed possible that a similar anaphylaxis to corn products might be met within pellagrins. It seemed possible also that such a reaction if positive, might be of importance for the diagnosis of pellagra.

In these observations cutaneous tests were made with substantially the same technique employed by v. Pirquet, except that corn extracts were substituted for tuberculin in making the test.

The procedure was as follows: 20 g. of corn was extracted with 50cc. of ether, alcohol, 10 percent NaCl, or 0.2 percent NaOH. The extract was filtered and 1/10 vol. 5 percent carbolic acid added to the clear filtrate so as to give it a content of 0.5 percent carbolic acid. The ethereal extracts were allowed to evaporate at 46°, until the odor of ether had disappeared.

The site chosen for the test was an area upon the patient's wrist which was subject to pellagrous pigmentation, thickening or desquamation and, in the most cases, was bare so as to be exposed to the action of light. A drop of the extract to be tested was placed upon the skin and a pin-head area of

epidermis beneath the drop was excoriated by the torsion of a v. Pirquet stylet. Into this excoriated area the extract was rubbed with a glass rod. A series of epidermal punctures were made in this way in a line across the wrist, with another line of duplicate punctures above them. In each series there were a pair of controls in which only the pure NaCl or NaOH solution or alcohol was placed upon the skin.

Within half an hour after the puncture a small red or sometimes blanched areola and occasionally a small papule formed about the site of inoculation, but in only one case did these exceed 5mm. in size and no differences could be noted between the areas about the punctures with corn extracts and the controls. The reactions in sites which were nearest the middle of the forearm were often slightly more marked (areolae about 1mm. larger than the rest), but these reactions were always quite as marked with the control fluids as with the extracts and hence were of little significance.

The reactions, which were regarded as negative in all cases, consisted of simple traumatic reactions, were watched for about half an hour and the sites of inoculation were again inspected three hours, twenty-four hours and forty-eight hours later, as well as at frequent intervals between.

Extracts were made from samples of good corn, spoiled corn taken from the Arkansas Insane Asylum at the time of a pellagra outbreak, and a sample of spoiled corn containing Aspergillus fumigatus. The extracts of the latter were filtered through a Berkefield filter in order to avoid the danger of inoculating the aspergillus. Other extracts were made from the apparently excellent corn meal used at the Peoria State Hospital for the Insane at the time that the pellagra was breaking out throughout the asylum, and when a number of cases of acute pellagra were developing. Tests were made upon thirteen cases of well defined pellagra diagnosed by Dr. Geo. A. Zeller and confirmed by Drs. Singer and MacNeal of the Illinois Pellagra Commission.

These reactions were all negative. Just before leaving Peoria a sample of spoiled corn was obtained which had been rejected by the asylum and sent out to the hog farm over a year previously. Extracts of this corn were inoculated into six patients with subacute pellagra. The effects were observed for three hours after inoculation but were uniformly negative.

In order to determine whether the presence of antibodies formed in a previous attack of pellagra might cause the reaction to be given by persons who had been afflicted with the disease in the previous year but who were free from symptoms at the time of inoculation, observations were made upon seven such patients. In all cases the results were negative.

The results of these tests, therefore, render it improbable that pellagra is due to or accompanied by a condition of hypersensitiveness of the individual to products derived from good or from spoiled corn.

I take pleasure in expressing my thanks to Dr. George A. Zeller and the Illinois Pellagra Commission for placing at my disposal the patients and laboratory of the Peoria State Hospital, as well as to Dr. Carl Alsberg of the Bureau of Plant Industry for furnishing samples of good and spoiled corn.

Bibliography.

Lombroso, C.: Die Lehre von der Pellagra. Aetologische, klinische, und prophylaktische Untersuchungen. Transl. by H. Kurella. Berl., 1898.

Babes, V. and Sion, V.: Die Pellagra.—Nothnagel's Handb. d. spez. Path. u. Therap. Wien, 1901.

v. Pirquet, C.: Tuberkulindiagnose durch cutane Impfung.—Berl. klin. Wochnschr., 1907.

Smith, H. L.: Buckwheat poisoning, with report of a case in man.—Arch. Int. Med. Chicago, 1909, III, 350.

IX.

ATTEMPTS AT THE EXPERIMENTAL TRANSMISSION OF PELLAGRA.

(By H. Douglas Singer, W. J. MacNeal, and J. T. Rooks.)

The first requisite for adequately dealing with pellagra, as with other diseases, is the determination of its cause and mode of transmission. At the present time so little is really known concerning the aetiology of pellagra that the field for speculation is extremely wide as is well evidenced by the widely varying hypotheses which obtain. If it were possible to successfully induce the disease in lower animals the research would at once become narrowed and concentrated while material for accurate observation would be readily obtainable. With this in mind the commission has devoted much time to the attempt to transmit pellagra to lower animals, plans for this work being formulated very shortly after the appointment of the commission. Monkeys have been selected for this purpose on account of their close relationship to man in the scale of evolution. The work was begun in February, 1910, and the experiments may be classed under three main headings: (1) Feeding and inoculation with both healthy and damaged corn products, (2) Feeding with material excreted by pellagrins, (3) Inoculation with tissue emulsions and body fluids of pellagrins.

The monkeys used have all been specimens of Rhesus Macacus imported from India and obtained through a dealer in New York. At first they were kept in the basement of one of the cottages at the Kankakee State Hospital but in the spring of 1910 they were moved into a frame building which was originally constructed for use as a tuberculosis camp so that the animals were practically out of doors and had plenty of room for exercise. The food has consisted mainly of wheaten bread, bananas and peanuts up to the spring of 1911, since when all monkeys have been given in addition corn bread and corn meal mush of which they seem to be very fond. Much trouble and a very high death rate has ensued from an infection with a parasite resembling the oesophagostomum worm which is not an inhabitant of the lumen of the bowel but forms a cyst in the wall of the gut, generally in the subserous layer, and sets up a very severe inflammatory condition of the mucosa with ulceration. This infection was most probably present when the animals were imported as it is unknown in this country. As will be seen from the detailed report below the mortality has been very high from this cause, 13 out of 40 monkeys having died. Besides these, seven of the first dozen died with the same condition within two or three weeks of their arrival at Kankakee. Tuberculosis has been responsible for death in only three cases.

Monkey No. 1—This monkey was fed daily on cornbread and corn meal mush, peanuts and bananas being given occasionally, from February 4 1910, to July 12, 1910, when corn diet was discontinued.

July 12, 1910. The animal was fed about two grams of fecal material, chiefly mucus from the patient J. N. at the Kankakee State Hospital, about three weeks after the onset of a severe acute attack of pellagra, the patient being very weak and ill, although the skin manifestations were subsiding.

On July 18th the monkey was fed with feces from another pellagrous patient, C. G., who had been transferred from Peoria to the Kankakee State Hospital, in whom the skin symptoms were disappearing although there was still diarrhoea with a large number of amoebae in the stools. A similar feeding was given on July 21st with feces from the same patient.

On December 17, 1910, the corn diet was again started.

On February 10, 1911, the monkey was fed 50cc. of badly spoiled corn meal which had been fermented with a pure culture of Penicillium since June 6, 1910. The acidity of this fermented meal was 761.7 expressed as cubic centimeters N/10 NaOH per 100 grams of dry meal.

On February 17th, the animal received 30cc. of the same fermented meal and a similar dose was repeated at intervals of about two weeks until the end of March, the regular diet of corn meal and corn bread being continued in the intervals. It was found impossible to feed this mouldy meal more frequently, as the animal had to be starved before it would eat the very sour mixture. When administered the fermented mush was mixed with milk and some fresh corn mush.

The condition of the animal remained normal, except that a slight looseness of the stools was noted on July 22nd immediately after the second dose of the feces of the pellagrin C. G.

On November 17, 1910, there was a slight diarrhoea with blood in the stools. This diarrhoea had disappeared on November 29th, and the monkey remained well until April 9, 1911. On this day it was evidently sick, refused food and showed a profuse bloody diarrhoea. The animal died on April 12, 1911. At autopsy the only lesions found were those of oesophagostomiasis.

Monkey No. 2—July 13, 1910, received a hypodermic injection of 9.5cc. of defibrinated blood from the patient J. N. at the Kankakee State Hospital, who presented a picture of extreme illness with pellagra and diarrhœa, although the skin manifestations of the acute attack were disappearing. The inoculated material was all absorbed on July 17th.

August 3rd 5cc. of blood were withdrawn from the heart under ether anæsthesia for inoculation into another monkey.

August 27, 1910. 12cc. of blood were withdrawn from the heart for inoculation.

September 8, 1910. Bled to death from the carotid artery under ether anaesthesia.

The animal presented no evidences of disease at any time, the only point concerning it being the appearance of an erythematous area in the perineal region which is more fully discussed later. At the autopsy no signs of disease were discovered and sections prepared from all tissues showed no abnormalities.

Monkey No. 3—July 29, 1910. Fed with 2cc. of a suspension of protozoa obtained by Dr. MacNeal from the stools of the patient C. G.

September 8, 1910. Subcutaneous inoculation with the filtrate obtained by passing defibrinated blood of Monkey No. 2 through a Pasteur porcelain filter which allows one litre of distilled water to pass through in thirty minutes at a pressure of two atmospheres. The blood was diluted with two parts of 0.8 percent salt solution before filtration. Total amount injected 44cc., part of this being given on September 9th.

October 30, 1910. 23cc. of blood withdrawn from the heart under light anaesthesia for inoculation into another animal. This animal has presented a very marked erythematous condition of the perineum but otherwise no change, being apparently well and healthy at the end of August, 1911.

Monkey No. 4—July 18, 1910. 5cc. of an emulsion of feces from the pellagrous patient C. G. were injected into the rectum and a similar dose was given on the evening of the same day.

July 31, 1910. 5cc. of an emulsion of feces from the patient C. G. injected into the rectum.

August 27, 1910. Injected subcutaneously with 12cc. of defibrinated blood recently drawn from the heart of Monkey No. 2.

This monkey also developed a marked erythema of the perineal region but showed no evidence of diesase and had at no time any diarrhoea.

It was accidentally killed on September 21. 1910, while being anaesthetised for the purpose of being photographed. At the autopsy a few small tubercles were found in the lungs but no other signs of disease either macroscopic ally or microscopically.

Monkey No. 5—July 30, 1910. Subcutaneous injection of 7.5cc. of defibrinated blood taken from the patient A. P. at the Kankakee State Hospital. This patient showed considerable pigmentation of the hands and forearms which was at the time regarded as being slightly suspicious of pellagra, but from the subsequent course of the case was almost certainly not so. This monkey has showed no signs of disease and is in good condition at the end of August, 1911.

Monkey No. 6—August 3, 1910. Injected subcutaneously with 5cc. of defibrinated blood drawn from the heart of Monkey No. 2.

This monkey developed diarrhoea on October 14, 1910, which continued with gradually increasing emaciation until December 1, 1910, when the animal was found dead in its cage. The autopsy showed no disease with the exception of an inflamed condition of the intestinal mucosa and enlargement of the mesenteric lymp glands. In the light of other autopsy findings, it seems probable that the cause of this condition was oesophagostomiasis, although the characteristic cysts and worms were not found.

Monkey No 7—August 13, 1910. Injected subcutaneously with a suspension in 0.8 percent salt solution of a culture on blood agar of a bacillus cultivated from the blood of the patient J. N.

September 26, 1910. Injected subcutaneously in the back with 9cc. of defibrinated blood drawn from the heart of Monkey No. 9.

January 23, 1911. Received subcutaneously 8.5cc. of cerebro-spinal fluid drawn from the patient A. D. at the Cook County Hospital, 26 hours after death from a severe attack of pellagra.

The monkey seemed a little sick the day after the injection with the bacillus, showing a slight rise of temperature (103.9F) but had entirely recovered on the following day. No other evidence of any abnormality had been noted and the monkey is alive and well at the end of August, 1911.

Monkey No. 8—August 18, 1910. 4cc. of cerebro-spinal fluid obtained from a pellagrous patient, E. P., during an acute exacerbation were injected subcutaneously.

The animal remained well until October 21, 1910, when it was noted to have severe diarrhoea which continued with progressive emaciation until November 23, 1910, when it was found dead. At the autopsy the characteristic nodules of oesophagostomiasis were found in the large intestine without evidence of any other disease elsewhere.

Monkey No. 9—August 19, 1910. Received a subcutaneous injection by Captain J. F. Siler of 6.5cc. of defibrinated blood from a patient, E. M., at the Peoria State Hospital suffering from an acute attack of pellagra.

September 26, 1910. 14cc. of blood were withdrawn from the heart under ether anaesthesia.

This animal had more or less diarrhoea, even before the first inoculation and this condition has continued with a slowly increasing emaciation up to the end of August, 1911, at which time it is in very bad condition. It also developed a very marked erythema.

Monkey No. 10—August 18, 1910. 4cc. of cerebro-spinal fluid from the patient E. M., with symptoms of active pellagra, were injected into the peritoneal cavity.

February 17, 1911. Fed with 30cc. of extremely mouldy corn meal mush inoculated with penicillium June 6, 1910, having an acidity of 761.7cc. of deci-normal caustic soda per 100g. of dry meal. This feeding was repeated at intervals of about two weeks until the end of April 1911.

The animal remained healthy all through this period and is in fair condition at the end of August, 1911, when it shows a well marked erythema.

Monkey No. 11—August 23, 1910. Injected subcutaneously in the abdominal wall with 9cc. of defibrinated blood from a patient C. H., showing acute symptoms of pellagra, at the Peoria State Hospital by Captain J. F. Siler.

This animal presented no evidence of disease, except that the hair was noted to be very thin over the entire body on January 10, 1911, this loss of hair gradually increasing until March, 1911, when the skin was almost bare. On April 24, 1911, the monkey was obviously ill and died on April 26, 1911. At autopsy the organs were all normal with the exception of the intestines which showed the characteristic nodules of oesophagostomiasis.

Monkey No. 12—August 23, 1910. Subcutaneous injection by Captain J. F. Siler with 10.5cc. of defibrinated blood obtained from D. D., a patient at the Peoria State Hospital suffering from a severe attack of pellagra.

Nothing abnormal was observed until November 11, 1910, when it was noted as being very thin and sick. Marked diarrhoea occurred on November 17, 1910, with much mucus in the stools and the animal died November 25, 1910. At the autopsy the only abnormalities were severe inflammation with ulceration of the large bowel, nodules of oesophagostomiasis in the caecum, and enlargement of mesenteric lymph glands.

Monkey No. 13—September 8, 1910. Received subcutaneously 5cc. of defibrinated blood drawn from the carotid of Monkey No. 2, diluted with 10cc. of 0.8 percent normal salt.

With the exception of some erythema and desquamation on the tail, this animal has shown nothing worthy of note and is alive though with considerable diarrhoea at the end of August, 1911.

Monkey No. 14—September 8, 1910. Subcutaneous injection of 10cc. of undiluted defibrinated blood drawn from the carotid of Monkey No. 2.

September 17, 1910. The hair was shaved from the buttocks, perineum, upper portion of thighs and the left forearm, and the animal was placed in a cage exposed to the sun. The exposure was continued until October 24, 1910.

January 14, 1911. The animal received a burn of second degree on the abdominal wall from the steam pipes which soon healed.

This monkey presented a slight erythema around the anus and tail and upon either side of the ischial callosities but none upon the other shaved areas. No signs of disease have been observed at any time and the animal is apparently well at the end of August, 1911.

Monkey No. 15—September 8, 1910. Received subcutaneously 4cc. of a thick emulsion of the spleen of Monkey No. 2 in 0.8 percent salt solution, prepared about one hour after death by bleeding.

On September 18, 1910, there was marked diarrhoea which became steadily more severe. Examination of the stools on September 24, 1910, showed numerous red blood cells and leucocytes with much mucus. Stains for tubercle bacilli were negative. The monkey died September 28, 1910. The autopsy revealed extreme emaciation but no lesion with the exception of very numerous nodules in the large intestine containing the oesophagostomum.

Monkey No. 16—September 8, 1910. Under ether anaesthesia 0.25cc. of a thin emulsion of the lower part of the lumbar enlargement of the spinal cord of Monkey No. 2 was injected into the cerebrum. The emulsion was made in 0.8 percent salt solution and injected about two hours after the death of Monkey No. 2.

This monkey showed a little redness around the anus and some desquamation on the perineum and tail. Alive and well at the end of August, 1911.

Monkey No. 17—This animal was sickly and thin when received.

September 8, 1910. Injected subcutaneously with 10cc. of clear blood serum obtained by centrifuging the defibrinated blood of Monkey No. 2 for one hour forty minutes at a speed of 1,000 r. p. m. The inoculation was made three and one-half hours after withdrawal.

The animal rapidly became more emaciated and ill, dying on September 17, 1910. At autopsy acute miliary tuberculosis of all organs was found.

Monkey No. 18—September 9, 1910. Received subcutaneously 20cc. of the unwashed sediment obtained by centrifuge from the defibrinated blood of Monkey No. 2 after removal of the serum injected into Monkey No. 17. This injection was made 19 hours after the blood was drawn, the deposit having been kept in a refrigerator.

The animal was noted to be somewhat thin and weakly on October 14, 1910, at which time it also showed some erythema about the perineum. This condition continued until November 13, 1910, since when the erythema has not been noted. The general health also improved but some diarrhoea and emaciation were again noted on December 15, 1910, which continued until December 30, 1910. Since that time the monkey has appeared in excellent health up to August 31, 1911.

Monkey No. 19—This animal was kept in the animal house from February, 1910, until September 8, 1910. No particular attention was paid to it before this date when it was found to have a well marked erythematous condition of the perineum. It was therefore not used for experimental purposes but was kept under observation. The erythema remained unchanged until October 17, 1910, when diarrhœe with progressive emaciation and loss of appetite were noted. The stools finally became bloody and death ocurred on October 22d. Autopsy revealed a few subpleural tubercles and the intestines showed the lesions of oesophagostomiasis.

Monkey No. 20—September 21, 1910. Inoculated subcutaneously with 12.5cc. of defibrinated blood obtained three and one-half hours after death from Monkey No. 4. The animal was exposed to direct sunlight daily until October 24, 1910.

The animal has remained well until the end of August, 1911, except for slight diarrhoea on February 2, 1911.

Monkey No. 21—September 17, 1910. The buttocks, perineum, inner surface of thighs and the left forearm were shaved and the animal exposed to direct sunlight for control. Owing to lack of monkeys for experiment it was necessary to make use of the animal.

September 21, 1910. Injected subcutaneously with 8cc. of an emulsion in 0.8 percent salt solution of the spleen of Monkey No. 4 four hours after the death of the latter. Exposure to sunlight was continued as before until October 24, 1910.

On December 6, 1910, the hair was found to be very thin on the tail and on December 15, there were observed a few small papules and ulcers upon the tail which however soon healed. No other abnormalities have been noted and the monkey is in good condition at the end of August, 1911.

Monkey No. 22—September 7, 1910. 10.5cc. of defibrinated blood of the patient D. D., at the Peoria State Hospital were inoculated subcutaneously immediately after withdrawal by Captains Siler and Nichols. The patient showed a well marked recent attack of pellagra.

Beyond a slight erythema of the perineum the condition remained negative until October 19th, when the animal was noted as thin and obviously ill. Death occurred on October 23d, and at autopsy caseating tubercles were found in the lungs, liver, spleen and lymph glands.

Monkey No. 23—September 7, 1910. 10.5cc. of defibrinated blood obtained from a patient H. R., at the Peoria State Hospital, were injected by Captains Siler and Nichols immediately after withdrawal into the peritoneal cavity. The patient presented the characteristic eruption of a recent attack of pellagra in an acute stage.

The animal developed an erythema of the perineum but showed no symptoms of disease up to October 26, 1910, when it was sent to Captain H. J. Nichols at the Army Medical School, Washington, D. C. Captain Nichols reports that the animal died when being bled on October 30, 1910. The blood so obtained was injected into two other monkeys but without result up to September 6, 1911.

Monkey No. 24—September 7, 1910. Received about 1.5cc. of blood serum freed from corpuscles by means of a centrifuge after defibrination obtained from a patient R. B., at the Peoria State Hospital, presenting active skin lesions of pellagra. The injection was made by Captains Siler and Nichols into the brain upon the right side.

The animal has presented no evidences of disease except occasional diarrhœe. It is alive though not very well at the end of August, 1911.

Monkey No. 25—September 8, 1910. Inoculated subcutaneously by Captains Siler and Nichols with 9.5cc. of blood serum separated by centrifuge

after defibrination, the serum first obtained being centrifuged a second time. The blood was obtained from a patient C. H., at the Peoria State Hospital, showing active skin lesions of pellagra and the inoculation was made four hours after the blood was drawn.

January 23, 1911. Received an emulsion in 12cc. of 0.8 percent normal salt of 0.4 grams of the spleen of a patient A. D., 26 hours after death from a severe attack of pellagra at the Cook County Hospital.

There have been no evidences of disease at any time with the exception of slight diarrhoea on October 19, 1910 and the animal is in good health at the end of August, 1911.

Monkey No. 26—September 9, 1910. Injected subcutaneously by Captains Siler and Nichols with filtered and diluted blood serum obtained from the patient C. H., during an acute attack of pellagra. The method of preparation consisted in mixing equal parts of defibrinated blood and 0.8 percent salt solution and then centrifugalising. The separated serum was then passed through a Berkefeld filter and 21cc. of the filtrate were injected. Some of the filtrate was also added to bouillon tubes and incubated remaining sterile for six days.

This animal presented slight erythema of the perineum. It has also lost most of the hair from its body, this having taken place between December, 1910, and January, 1911, but has otherwise remained well until the end of August, 1911.

Monkey No. 27—September 9, 1910. Received 7cc. of undiluted, filtered blood serum (prepared like that given to Monkey No. 26 with the exception that there was no dilution) obtained from the patient C. H. Cultures made from the filtrate remained sterile.

No evidences of disease were detected and this animal was sent to Captain H. J. Nichols at Washington for observation on October 26, 1910, and is reported to be still alive and without any definite developments on September 6, 1911.

Monkey No. 28—This monkey had been used in Chicago for experimental work with sporothryx infections, from which it had entirely recovered. It had not been in contact at all with the animals at Kankakee.

September 12, 1910. Received subcutaneously 12cc. defibrinated blood from a patient A. S., at the Elgin State Hospital with severe, though subsiding, symptoms of pellagra of about six weeks' duration. The animal was then returned to Chicago under the care of Dr. O. S. Ormsby at the Rush Medical College until November 17, 1910, when it was sent to the Kankakee State Hospital.

This animal has shown the usual erythematous condition of the perineum in very marked degree but has developed no evidences of disease, being alive and well at the end of August, 1911.

Monkey No. 29—This animal was received from New York on October 7, 1910, with a vivid erythematous condition of the perineum. It was not used for experiment beyond the withdrawal of blood for complement fixation tests. On October 17, 1910, the animal appeared to be ill and had some diarrhoea with blood in the stools. The condition became rapidly worse and the animal died on October 26, 1910. At autopsy a few minute subpleural tubercles were found together with the intestinal nodules and ulceration due to oesophagostomiasis.

Monkey No. 30—When received on October 7, 1910, showed some slight erythema of the perineum and was consequently not used for experiment. 10cc. of blood were withdrawn from the heart on October 10, 1910, for complement fixation tests. This animal developed bloody diarrhoea on October 17, 1910, but later improved and is alive and well at the end of August, 1911.

Monkey No. 31—October 10, 1910. 10cc. of blood withdrawn from the heart for complement fixation test.

October 12, 1910. Received subcutaneously 15cc. defibrinated blood from the patient W. N. at the Peoria State Hospital, showing recent active symptoms of pellagra.

February 3, 1911. Fed with an emulsion of a bacillus isolated from the stools by Dr. W. J. MacNeal. These feedings have been repeated at intervals of from 7 to 10 days up to the end of August, 1911.

March 13, 1911. Fed with mouldy corn meal mush, inoculated with Penicillium on June 6, 1910. Similar feedings were also given March 15, 1911, March 27, 1911 and April 11, 1911.

This animal has developed no evidences of disease and is alive and well at the end of August, 1911.

Monkey No. 32—October 10, 1910. 10cc. blood drawn from the heart for complement fixation tests.

October 12, 1910. Injected subcutaneously with 12cc. defibrinated blood from a patient, S. M., at the Peoria State Hospital showing recent active symptoms of pellagra.

This animal presented no evidences of disease until July, 1911, when it developed severe diarrhoea and died. At the autopsy the only lesions found were those of oesophagostomiasis.

Monkey No. 33—When received October 7, 1910, this animal showed a slightly reddened perineum and was not used for experimental purpose.

October 10, 1910. 10cc. of blood drawn from the heart for complement fixation tests.

The animal was sickly, coughing considerably and died November 11, 1910. At autopsy widespread tubercular disease of the lungs, lymph glands, liver and spleen was found.

Monkey No. 34—October 10, 1910. 10cc. blood drawn from the heart for complement fixation tests.

October 12, 1910. Injected subcutaneously with 12cc. defibrinated blood from the patient M. M. at the Peoria State Hospital, suffering from a recent acute attack of pellagra.

This monkey shows a marked erythema of the perineum but no sign of disease at the end of August, 1911.

Monkey No. 35—October 10, 1910. 10cc. of blood drawn from the heart for complement fixation tests.

October 12, 1910. Received subcutaneously 18cc. defibrinated blood from the patient L. T. at the Peoria State Hospital showing recent active pellagra.

February 3, 1911. Injected subcutaneously with one-fifth part of a 48-hour culture of bacillus isolated from the stools of a pellagrin by Dr. W. J. MacNeal.

The monkey has shown no signs of disease at any time. There were no symptoms of any kind following the injection with the bacillus and the animal is alive and well at the end of August, 1911.

Monkey No. 36—October 30, 1910. Injected subcutaneously with 21cc. of the filtrate obtained by passing a mixture of equal parts of the defibrinated blood of Monkey No. 1 and 0.9 percent salt solution.

The monkey showed no definite symptoms, although a papular eruption with whitish desquamation was observed upon the nose and lips on December 27, 1910, and continued to spread over the face until January 24, 1911, after which they slowly disappeared.

In July, 1911, there appeared a severe diarrhoea with rapid failure and death. The lesions of oesophagostomiasis were found post mortem.

Monkey No. 37—October 30, 1910. Injected subcutaneously with 6cc. of defibrinated blood of Monkey No. 1.

This animal remained well until December 2, 1910, when diarrhoea appeared. This rapidly became worse and on examination of the stools on December 8, 1910, showed numerous red blood cells, pus and epithelial cells. No protozoa and no acid fast bacilli were found. Death occurred on December 12, 1910. Post mortem examination revealed a few minute tubercles in the lungs and an acute inflammation with ulceration in the descending colon and rectum. In all probability this was due to the oesophagostomum although the characteristic worms and nodules were not found.

Monkey No. 38—Beginning on December 17, 1910, the animal was fed strictly upon corn in the form of bread and mush similar to that given to the patients and employees at the Kankakee State Hospital.

March 13, 1911, and at intervals of 7 to 10 days thereafter, a suspension of the bacillus from the stools of pellagrins isolated by Dr. W. J. MacNeal were fed, the corn diet being maintained.

This monkey had slight diarrhoea on March 15, 1911, and since that time has been sickly with loose stools. It is alive and has shown no definite symptoms at the end of March, 1911.

Monkey No. 39—Beginning December 17, 1910, when the animal seemed in excellent health this monkey was placed upon a strict corn diet, which was maintained to the time of death. On January 6, 1911, it was obviously ill with diarrhoea, although noted as well on January 3, 1911, and died January 7, 1911. At the autopsy the only lesions found were those of oesophagostomiasis, the worms being found.

Monkey No. 40—Corn diet maintained continuously from December 17, 1910, until January 14, 1911. This animal developed diarrhoea on January 3, 1911, and died January 15, 1911, the worms and lesions of oesophagostomiasis being found in the intestinal wall.

Guinea Pig No. 1—August 13, 1910. Injected into the peritoneal cavity with a suspension of a bacillus cultivated from the blood of a patient J. N., at the Kankakee State Hospital during the stage of subsidence of the symptoms of a very severe attack of Pellagra.

The animal showed no ill effects, continuing to eat heartily without rise of temperature or loss of weight.

Guinea Pig No. 2—February 3, 1911. One-tenth part of a 48-hour culture on agar of Dr. W. J. MacNeal's bacillus (See report on fecal bacteria) injected subcutaneously.

The animal showed no symptoms as the result of the injection.

Kitten No. 1—July 31, 1910. Under light ether anaesthesia 5cc. of an emulsion from the stools of the pellagrous patient C. G., at the Kankakee State Hospital, containing very numerous active amoebae were injected into the rectum.

The animal showed no diarrhoea or other symptoms at any time.

Summary of Experiments.

(1) Twelve monkeys have been inoculated either subcutaneously or intraperitoneally with defibrinated blood obtained from patients suffering from pellagra in the recent or subsiding stage. (In one of these the case was probably not pellagra.)

(2) Seven monkeys have been injected subcutaneously with defibrinated blood obtained from other monkeys showing an erythematous condition of the perineum, now recognized as being physiological.

(3) Three monkeys have been injected subcutaneously with the filtrate obtained by passing the blood of pellagrins through Pasteur or Berkefeld filters.

(4) One monkey received the sediment obtained after centrifugalisation of blood from another monkey.

(5) Three monkeys were given hypodermic injections of the blood serum obtained in two instances from human pellagrins and in the third from a monkey. Of the former one was first filtered through a Berkefeld filter.

(6) Three monkeys received injections of cerebrospinal fluid obtained from human pellagrins. Of these one was procured postmortem and given subcutaneously, in the other two the fluid was drawn during life, one being injected into the subcutaneous tissues and the other into the peritoneal cavity.

(7) One monkey was injected in the cerebral hemisphere with an emulsion of the spinal cord of another monkey.

(8) Three monkeys have received subcutaneous injections of an emulsion of spleen, one of these being obtained from a human pellagrin, the other two from monkeys.

(9) Four monkeys have been fed for long periods upon a strict corn diet and of these one has also received extremely mouldy corn meal, and

one has been fed with a bacillus obtained from the stools of pellagrins showing certain agglutinating relations with blood serum as more fully detailed in the report upon the fecal bacteria by Dr. W. J. MacNeal.

(10) One monkey has been fed with extremely mouldy corn meal and the bacillus of Dr. W. J. MacNeal.

(11) One monkey and one guinea pig were inoculated subcutaneously with the bacillus of Dr. W. J. MacNeal.

(12) Twenty-three guinea pigs were inoculated or fed with extracts from mouldy corn meal. (See report by Dr. H. S. Grindley and Mr. A. F. Wussow.)

(13) One monkey and one guinea pig were inoculated with a bacillus isolated from the blood of a human pellagrin.

(14) One kitten received per rectum an emulsion of a stool from a pellagrin containing numerous living amoebae.

(15) Three monkeys have been fed with the fecal matter of pellagrins containing living amoebae.

Summary of Results.

(1) *Feeding and inoculation with corn and corn products.* Most of this work is included with the report by Prof. H. S. Grindley and Mr. A. F. Wussow upon their studies of maize. With regard to the feeding of monkeys both with healthy corn products as used in the Kankakee State Hospital and with badly moulded and soured corn meal mush, the results have been entirely negative.

(2) *Feeding with material excreted by pellagrins.* For this purpose stools from virulent cases have been used which were found to contain active amoebae. A coccidium-like body isolated from the stools of one case and a bacillus isolated from the stools of two cases (see report on Fecal Bacteria by Dr. W. J. MacNeal) were also used. The results have been uniformly negative.

(3) *Inoculation with tissue emulsions and body fluids of pellagrins.* In these experiments we have used blood prepared in different ways, cerebrospinal fluid and emulsions of spleen. The results again must be regarded as entirely negative.

At this point it would be well to call attention to a physiological condition occurring in these monkeys which does not appear to be generally known. During early life the skin of the perineum is white or bluish-white but upon reaching puberty these animals develop a vivid red color in this region similar to that which is well known in the closely related species of baboons. This redness is accompanied by a marked oedema and involves not only the perineum but also the genital folds sometimes extending upwards on the lower part of the abdomen, downward on the inner surfaces of the thighs and around the anus to the root of the tail. By a curious coincidence a number of our monkeys developed this erythema, as indicated in our preliminary report, at a more or less definite interval after they had been inoculated and we were inclined to attach some significance to this occurrence. The appearance is very much more marked in the female than in the male animal but we have seen some examples in the latter which were very distinct. The phenomenon has been studied and discussed by R. I. Pocock, F. Z. S., Superintendent of the Zoölogical gardens at London, England, to whose courtesy in a personal interview the members of the commission are greatly indebted. Mr. Pocock suggests that the condition is a signal to the male of capability of impregnation and has noted a relationship between its intensity and the periods of menstruation which we cannot entirely confirm as the erythema has in some instances been most marked at the time of discharge of blood. Its occurrence in the male, also suggests the need for further study. Apparently one of the main reasons for this condition being not more generally known is that the animals frequently die in captivity before reaching maturity.

X.

BLACK-FLIES AND BUFFALO-GNATS (SIMULIUM) IN ILLINOIS.

(By Stephen A. Forbes, State Entomologist.)

Purpose and Scope of the Work.

In the summer of 1910, I was advised by Dr. W. J. MacNeal, of the University of Illinois, and also by Dr. Oliver S. Ormsby, Secretary of the Pellagra Commission of this State, that this commission was especially interested in the distribution of our various species of black-flies (Simulium), because of the supposed relation of these insects to the introduction and spread of pellagra, and that it would like to have my aid in securing information upon this subject. In view of the fact that it is made by law one of the duties of the Entomologist of Illinois "to investigate all insects of this State injurious or dangerous to the public health," I was bound to answer to this call as a matter of official duty, and not as a favor merely.

I was fortunately so situated as to make it possible to begin upon this subject at once, the one of my assistants, Mr. Charles A. Hart, who is best acquainted with aquatic insects, being stationed at the time on the Illinois River at Havana for a study of the mosquitoes at that point, made in the hope of finding means to suppress a troublesome mosquito infestation on the grounds of the Chautauqua Association of the Illinois State Epworth League. The necessary instructions were sent to him August 8, 1910, and he devoted a considerable part of the remainder of the season to a search for black-fly larvae and adults in and near the waters of the Illinois River, and of its smaller tributaries, from Matanzas Lake below Havana to Peoria.

As only a mere beginning could be made upon the subject within so short a time, and as the funds available were mainly already assigned to other problems, an item for the expenses of an investigation of this subject was included in my estimates for the years 1911-1912, as submitted to the Legislature at its 47th session, in 1911. This appropriation was not allowed, however, and no adequate work could be done this year. I have nevertheless brought together all published information upon the subject of the distribution and life histories of black-flies in Illinois, all the data from the collections of the State Laboratory of Natural History and the Entomologist's Office, and all the information contained in the field notes of my office, running back over many years, with a view to presenting at this time as full a report upon this topic as is practicable; and this paper is submitted as a preliminary statement. I still hope to be able to follow it with a fuller account, based on a general survey of the State, and an accurate study of the life histories of our species.

General Description.

The buffalo-gnats, or black-flies, all species of the genus Simulium, are small two-winged insects with thick, hump-backed bodies and sharp piercing

and sucking beaks (Fig. 2). They vary in length, according to species, from 1/25 to 1/6 of an inch—1 to 4½mm. They are notorious for the immense numbers in which they swarm in early spring, especially along the larger streams, and for the painfulness of the punctures made by the females (the males being inoffensive) and the ferocity and persistence of their attack. They are, generally speaking, more annoying than seriously injurious to mankind, although several deaths have been more or less plausibly attributed to their attack; but to domestic animals—especially to cattle, horses, and mules, and even to poultry—they are a terrible and terrifying scourge.

As is very commonly the case with blood-sucking Diptera, the young or larvae of these flies are aquatic. The eggs are laid in patches upon objects under water, the larvae transform there to pupae, and the pupae to winged adults, which escape to the surface each in a bubble of air absorbed from the water through the gills of the pupa, and stored up under its cuticle. The larvae are so abundant locally, under the most favorable conditions, that the water is said sometimes fairly to boil as the winged insects burst from its surface, each in its air bubble.

Number and General Distribution of Species.

There are about sixty-five species of this genus in the world. Twenty-five of them have been found in North America and fifteen in the United States. Nine species are known by us to occur in Illinois, and a possible tenth species is represented by an unidentified larva found in Vermilion county, Illinois, and also abundant in Yellowstone Park (Fig. 24). One American species, *S. hirtipes*, found in northern Illinois, occurs in Europe, and another, *S. reptans*, abundant throughqut Europe, is reported from Greenland also, but not elsewhere in North America. It is to this latter species, indeed, that the spread of pellagra has been especially ascribed in Italy.

With a single exception, our American black-flies have, so far as known, quite similar habits. *S. pictipes*, found from New York to Illinois, Kentucky, Texas, and California differs from the other more abundant species in the fact that it does not bite either man or beast.

Injuries to Man.

Our more abundant Illinois species make a ferocious attack upon domestic animals and men, inflicting a bite much more severe than that of a mosquito, with more serious after-consequences. The stylets with which the wound is inflicted are stouter, having more the form of a lancet than the needle-like organs of the mosquito's beak, and the venom injected into the cut from the salivary glands is a more efficient poison than the saliva of the mosquito. Men are less subject to injury than other animals, partly no doubt because their clothing protects them, partly because they can put themselves beyond the reach of the pests, but apparently also because they are more resistant to the poison.

The nature of this plague to human kind is shown by a statement in Agassiz's "Lake Superior" (p. 61), written in July, 1850, by J. Elliot Cabot, who prepared the narrative of the Agassiz tour. "Neither the love of the picturesque, however, nor the interests of science, could tempt us into the woods, so terrible were the black-flies. This pest of flies, which all the way hither had confined our ramblings on shore pretty closely to the rocks and the beach, and had been growing constantly worse and worse, here reached its climax. Although detained nearly two days, * * * we could only sit with folded hands, or employ ourselves in arranging specimens, and such other occupations as could be pursued in camp, and under the protection of a 'smudge.' One, whom scientific ardor tempted a little way up the river in a canoe, after water-plants, came back a frightful spectacle, with blood-red rings round his eyes, his face bloody, and covered with punctures. The next morning his head and neck were swollen as if from an attack of ery-

sipelas. Mr. S. said he had never seen the flies so thick. * * * He consoled us, however, by the information, that it was nothing to what they have further north."

The species of that region are *S. venustum* (Figs. 6—12) and *S. vittatum* (Figs. 13—15), both common in central and northern Illinois.

These northern species are also referred to by Dr. A. S. Packard in his book on "Our Common Insects," published in 1873. "The Labrador fisherman," he says, "spends his summer on the sea shore, scarcely daring to penetrate the interior on account of the swarms of these flies. During a summer residence on this coast, we sailed up the Esquimaux River for six or eight miles, spending a few hours at a house situated on the bank. The day was warm and but little wind blowing, and the swarms of black-flies were absolutely terrific. In vain we frantically waved our net among them, allured by some rare moth; after making a few desperate charges in the face of the thronging pests, we had to retire to the house, where the windows actually swarmed with them; but here they would fly in our faces, crawl under one's clothes, where they even remain and bite in the night. The children in the house were sickly and worn by their unceasing torments; and the shaggy Newfoundland dogs whose thick coats would seem to be proof against their bites ran from their shelter beneath the bench and dashed into the river, their only retreat. In cloudy weather, unlike the mosquito, the black-fly disappears, only flying when the sun shines. The bite of the black-fly is often severe, the creature leaving a large clot of blood to mark the scene of its surgical triumphs."

The pernicious activities of the South American black-flies were thus described in 1880 by Prof. W. S. Barnard (American Entomologist, Vol. 3, p. 191): "In tropical America they are a dreadful scourge, where for several nights I was kept awake by them when trying to sleep in the forests near the rivers, sometimes finding myself and my shirt thickly specked with blood, from their punctures. These minute sand-flies of the Amazon have hard bodies, and the swarm seeks entrance beneath one's garments, from which they can not be kept out. There they were especially active at night, together with the mosquitoes."

Cases of reported fatal attacks upon man are given by Dr. C. V. Riley in a general article upon the subject published in 1886,* and by F. M. Webster in a paper published in 1904.† "Sufficient facts are on record," Dr. Riley says, "to show that if the gnats attack a person suddenly in large swarms and find him unprepared or far away from shelter, they may cause death. * * * In 1884 several persons were killed by buffalo-gnats. Mr. H. A. Winter, from near Helena, Ark., while on a hunting trip, was attacked by them one and a half miles from home, while passing some low ground. Running towards a house, he was seen to fall dead. All exposed parts of his body had turned black. Another man was killed near Wynne Station, Ark., on the Iron Mountain Railroad."

A more specific account of a fatal attack is given by Mr. A. E. Buck,‡ who writes that a nephew of his was left upon an island of the Hatchie River, in western Tennessee, by a fishing party which took away the only boat. As he could not swim and had no matches with which to make a smudge, he remained all day at the mercy of the gnats. Although rescued towards evening, he died that night, with his hands, arms, face, and neck very much swollen. "There is no doubt," says Mr. Buck, "that the buffalo-gnats killed him." Webster says that during the period from 1881 to 1884 "several people were killed in Louisiana and Arkansas by being bitten by these gnats, as I was able to prove by the statements of physicians who attended the sufferers. * * * "I shall never forget," he adds, "the sensation [of the bite] as that of having the skin rudely punctured as if by a blunt, hot, pin or awl, leaving behind a dull aching pain." §

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* Report U. S. Commissioner of Agriculture for the year 1886, p. 501.
† Proceedings 25th Ann. Meeting Soc. Promotion Agr. Sci., pp. 53-72.
‡ Insect Life, Vol. I (1888), pp. 60 and 61.
§ Proceedings 25th Ann. Meeting Soc. Promotion Agr. Sci., pp. 59 and 61.

The local effect on man is the raising of an itching, burning lump or welt, which lasts for hours, or sometimes even for days. The possibilities of injury by a single puncture are illustrated by Prof. N. Leon, of Jassy, Roumania, in an article published in 1909.* A soldier was bitten once upon the upper eyelid on the afternoon of April 19, with the effect to close the eye before the next day. Although the swelling was reduced within four days by antiphlogistic applications, the pressure on the blood-vessels of the eyeball had caused a dry gangrene which permanently blinded the eye.

Injuries to Domestic Animals.

I find, however, no record of human suffering to parallel that of the domestic animals, especially cattle, when heavily attacked by the black-fly. In these, hard tumors are produced which suppurate within a few hours, lasting eight or ten days. These are most numerous on the less hairy parts of the body—the mouth, the nose, the eyes, the ears, the mammae, and the abdomen. The flies often penetrate the nasal cavities, causing inflammation and consequent difficulty of respiration which may even produce death by asphyxiation. When first attacked, horses and mules become perfectly frantic, rush hither and thither, rolling on the ground, dashing off wildly again, and repeating these actions until they become worn out. Cattle act very similarly, rush through dense thickets to rid themselves of their tormentors, but all in vain, as the speed of the black-fly on the wing is greater than that of its victims. Even hogs run madly about, burying themselves in mud holes if these are accessible; and sheep run about blindly, with piteous bleats. In Louisiana, in 1882, the deer were driven from the woods by them, frequently taking refuge from their tormentors in the smudges built by planters for the protection of their cattle. When in their agonies, they would allow people to rub the gnats from their bodies, and would even lie down in the glowing embers or hot ashes in their frantic efforts to gain relief.†

When domestic animals are lightly attacked the condition of the victim is not particularly threatening, and health may be restored within a few days. Indeed, herds subject to this infestation become partially immune to it, suffering much less than cattle brought in from outside districts. If, however, the number of punctures is great, threatening symptoms appear, invariably ending in death. The appearance of fatigue, the complete failure of the appetite, the staring coat, the drooping head, the hanging ears, the eyes at first injected and afterwards dull and expressionless—all indicate an overwhelming malady. The animal trembles in all its members and staggers when it walks; its mucous membranes are at first congested, but later become pale except where points of inflammation mark the punctures of the pest. There is a high fever at first, with full and rapid pulse; but later this becomes feeble and threadlike, and sometimes intermittent, and death appears after a few hours, unless efficient treatment has been promptly applied.

Prevention and Protection.

Measures of prevention and protection against these insects are of two kinds—the use of repellents intended to drive away the winged flies, and measures for the local destruction of the aquatic larvae. The repellents used are either smudges, or surface applications made to keep the flies from biting. The black-fly will not endure dense smoke, and the well-known mosquito smudge seems to be ordinarily sufficient for the protection of man. It is easy to drive the flies from houses or tents by burning pyrethrum powder inside; this either kills the flies or stupefies them so that they do not bite for some time thereafter. Lugger says that this method is in gen-

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* Centralblatt fur Bakteriologie, Parasitenkunde, und Infectionskrankheiten, Bd. 51, p. 659.
†Bull. U. S. Div. Ent., No. 12, p. 32.

eral use by the hunters and trappers of the Hudson Bay Company, and that he had also used it successfully in his numerous trips in Minnesota.* Oil of tar is commonly applied to the exposed parts of the body for the purpose of repelling the insects, and this preparation is supplied by the Hudson Bay Company to its employees. Minnesota fishermen and hunters frequently grease their faces and hands with a mixture of kerosene and mutton tallow for the same purpose. Description of measures for the destruction of the larvae and pupae in streams may best be left until the life history of the black-flies has been discussed.

General Features of Life History of Illinois Species.

Neither the life histories nor the habits of any of our American species have been sufficiently studied, and the one best known (*S. pictipes*, Figs. 4, 5) happens to be of the least interest from our present point of view, since it has never been known to bite. Our Illinois species differ considerably in distribution, life history, and places of most frequent occurrence. Two of them, the so-called turkey-gnat (*S. meridionale*, Fig. 1) and the buffalo-gnat (*S. pecuarum*, Figs. 2, 3) are the species to which southern accounts of these insects usually apply. Although they occur occasionally far to the north, they are southern in their general range and predominant numbers, and have not been found by us in northern Illinois. *S. venustum*, the black-fly or sand-fly of the northern woods, is, on the other hand, perhaps the most abundant species in the north, although *S. vittatum* is frequently found in its company. The first of these is said by Prof. F. L. Washburn to be an annoyance to stock in Minnesota, and the second a torment to mankind. These two species are the commonest ones in northern and central Illinois. We have likewise a fifth species, hitherto undescribed, the larva of which is abundant in the Illinois River, and four or five others which occur more sparingly in various parts of the State.

Our species differ also in the number of generations, the two especially southern forms (*pecuarum* and *meridionale*) having, so far as known, but one generation in a year, which reaches the winged stage in early spring, while the two most abundant northern forms (*venustum* and *vittatum*) appear in the winged stage at intervals throughout the summer, and evidently have two or more generations—just how many is not yet known. *S. pictipes* also develops at least two generations.

Some of these species breed mainly in small streams, while others find favorable situations for reproduction in the largest rivers. *S. meridionale* and *vittatum* are examples of the first habit, and *pecuarum* and *venustum* of the second. Larvae and pupae of all are limited to flowing streams, the larvae quickly dying, indeed, if transferred to quiet water. They are evidently very sensitive to a deficiency of oxygen, and can live, as a rule, only where the current is swift or where its movement is so interrupted by shallows or by objects lying or growing or suspended in the stream as to produce at least a surface whirl or ripple.

The larvae are rather peculiar creatures, with slender, cylindrical, maggot-like bodies, thickened and club-shaped at the hinder end, by which they adhere to some submerged object, and with a pair of fanlike clusters of filaments near the mouth. They are commonly grouped in colonies, often thickly covering the object to which they are attached. They spin from their mouths silken threads, with which they form a loose network covering the surfaces they occupy, and by means of which they can recover their position if swept away by the current. They move mainly like a measuring-worm, with the aid of a sucker near each end of the body. They pupate in a case or nest composed of web spun from the mouth (Fig. 11), and the pupa breathes by a pair of tufted gills extending forward from the open mouth of the case.

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* Second Ann. Rep. Ent. State Exper. Sta., Univ. Minn., p. 182.

In the two species whose life histories have been fairly well followed, namely *pictipes* and *venustum*, about two months elapse in summer between the laying of the egg and the appearance of the winged fly, the egg stage lasting about one week, the larval, four weeks, and the pupal, three. In colder weather the development proceeds more slowly. As these species hatch from the egg in New York in the first part of May, there is time, at this rate, for three successive generations, the last of which hibernates in the larval stage, pupating in April of the following year. We have sufficient data concerning the times of occurrence of the winged black-flies in Illinois to bring all but three of our species under this category. The single-brooded species appear in the winged stage in central Illinois in April and May, the date of maximum abundance here in two successive years having been about April 25. The farther south one goes, and the earlier the spring, the earlier is the swarming time of the gnats. Indeed, there is one report from Louisiana of the appearance of winged buffalo-gnats during every month of an unusually mild winter, and a consequent failure of the usual spring rush in February and March.* Although six of our Illinois species send out summer generations, these are so scanty and scattering that it is difficult to find winged specimens in the field, even by careful, expert search, at any time except in spring.

Breeding Situations of the Black-flies.

The number of our Illinois species and the fact of their distribution in all parts of the State make it practically certain that black-flies may be found, sooner or later, wherever and whenever the somewhat peculiar local conditions required for their breeding are present. These conditions are, in the first place, running water continuous through the breeding season, and, in the second place, either a rippling surface or a fairly rapid flow of the stream. It is also necessary that there should be solid objects in the water, not more than a few inches under the surface, upon which the eggs may be laid and to which the larvae may cling. The water must also, of course, contain a sufficient supply of the smaller plankton and other organic particles upon which the larvae feed. As they remain attached like plants, and can not search for food, they are dependent on whatever chance brings within the reach of the prehensile apparatus about the mouth. The species which breed in rivers find these conditions most general during high water, especially in spring. Then the current of the stream is comparatively swift and strong near the shores, and the marginal overflow reaches to trees and shrubs, stranded driftwood, and the like, which create the necessary surface disturbance and at the same time provide places of attachment for the eggs and larvae. In the smaller streams, on the other hand, times of flood are less favorable except where there is a rocky bed; but as the summer grasses grow, dipping into the stream, and marginal shrubs droop their twigs, loaded with leaves, into the water, and as the heavier objects on the bottom of the creeks and rivulets are brought near the surface by the shrinking of the stream, many suitable places may be found here and there for the black-fly to deposit its eggs and for the young to reach the pupation stage.

Myriads of these insects are sacrificed, as our field notes show, when the waters fall, leaving the pupae exposed, and liable to dry out. Small fish, and certain carnivorous insects, especially case-worms, devour the larvae, and their numbers in summer and fall are rarely very great in our latitude. The bottom-lands of our principal rivers—the Illinois, the Mississippi, the Ohio, and the Wabash—from the middle of April to the middle of May, are almost the only situations in which the black-flies may be called a plague. As the swarms of these insects are readily blown about by the wind, they are often carried to considerable distances from their place of origin; and cases are on record in which they must have been borne several miles in this way. The adults are not long-lived, and an outbreak does not ordinarily continue annoying longer than ten days. A storm of wind and rain

* Insect Life Vol. IV, p. 143.

may, in fact, put an end to it in even less time. The black-fly plague is virtually uncontrollable, except in a local way where it is due to a comparatively small stream. Such a stream may be cleaned and cleared of breeding places, and may, if further measures are necessary, be treated with phinotas oil in a way to destroy all the black-fly larvae, with no injury to the fish which it may contain. It is scarcely necessary for my present purposes to describe this method in detail, especially as those interested may get particulars by writing to the U. S. Department of Agriculture for Bulletin 46 of its Division of Entomology.

The Illinois Species of Simulium.

S. bracteatum Coq. This American species, first described in 1898, is in our collections only from Algonquin, McHenry county, Ill., where adults were taken by Dr. Wm. A. Nason on house windows and on plants beside a creek May 1 and 4 and August 16 and 22. It is thus evidently at least two-brooded. Outside Illinois it is known to occur in Massachusetts, New York, Michigan, Kansas, and California. We have nothing on record concerning its breeding places or habits.

S. hirtipes Fries. A very rare species in our collections, two adults only having been taken at Algonquin, McHenry county, on April 29. It is locally abundant, however, in New York. MacGillivray and Houghton found it common in the Adirondack Mountains during May and the early part of June, 1903; and it has also been received by Johannsen from Ithaca, N. Y., and from Idaho.

It is a European species, widely distributed in central and northern Europe, where, as in this country, it apparently occurs but once a year—in northern Scandinavia, for example, from the middle of June to the beginning of August.* There is probably but one generation in a season.

It is a persistent biting species, and probably breeds in small streams, since larvae and pupae of *hirtipes* have been collected by Kellogg from the campus of Stanford University, in California, and in Austria it is reported only from the high mountain ranges. Its occurrence in the Adirondacks, at Ithaca, and also at Algonquin, Ill., in the neighborhood of a small stream, and Zetterstedt's statement that it is found in Scandinavia among grasses and upon the leaves and flowers of shrubs, especially of willows,—all support this supposition. Larvae are found in New York in the latter part of April and the first two weeks of May, most of them pupating before the middle of the latter month, and adults appearing eight or nine days later—some, indeed, as early as May 1.

S. meridionale Riley. (Fig. 1.) This species, which is known as the turkey-gnat, is one of the most troublesome and widespread black-flies in the United States. It appears to be the predominant element in the great spring outbreaks along our larger Illinois rivers—the Illinois, the Mississippi, and the Wabash. We have it from several points in the river bottoms and on the margins of the bluffs about Havana. Osborn says in his "Insects Affecting Domestic Animals"† that "in this species the breeding grounds are limited to the smaller streams and branches, and the larvae are found attached to submerged dead leaves." Adults are in our collections from Mt. Carmel, White county, on the Wabash; from Greene county, on the lower Illinois; and from Normal, McLean county. Still others were collected near a small creek at Aledo, in Mercer county, well up towards northern Illinois. All were taken between April 9 and May 13. The time of maximum abundance in central Illinois in two successive years was about April 25.

The range of the species outside Illinois is very broad, including New Hampshire, Massachusetts, Virginia, Kentucky, Nebraska, Louisiana, Texas, and New Mexico. Notwithstanding its occasional occurrence far to the north, it is essentially a southern species, and it is most abundant to the southward in this state.

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* Diptera Scandinaviae disposita et descripta, Johanne Wilhelmo Zetterstedt, T. IX, p. 3420.

† Bull. No. 5, N. Ser., Bureau of Ent., U. S. Dept. Agr.

The fact that it commonly appears on the wing but once during the year, its usual period in the South being about six weeks in spring, points to the conclusion reached by Riley that it has but one annual generation. In Louisiana this is abroad in February and March, but in New Mexico it is said by Townsend to have been abundant in 1891 from the middle to the last of May, apparently continuing through the month of June. In the year 1891 it was common on the lower Red River in Louisiana in December, January, February, and March—a fact attributed by local observers to the unusually warm and open character of the winter. In northern Ohio (Wayne county) adults were abundant May 11, and larvae, some of which were very small, and pupae, as well as adults, were found on the 16th of May.* In New Mexico, C. H. Tyler Townsend found this species (re-described by him as *S. occidentale*) swarming May 7, and generally abundant by the middle to the last of May.

Its life history has really not been traced, and nothing is known of the stages or places in which it passes the summer and fall. It hibernates as a larva, and pupates in spring. It is one of the three or four most notorious and destructive of our American black-flies, and joins with the buffalo-gnat (*S. pecuarum*) in doing enormous damage to live stock and poultry in the southern states.

A correspondent, James T. Gilliam, of the U. S. Entomologist, writing from Charlotte county, Virginia, in 1888, makes a statement especially interesting because of its possible bearing upon the function of this gnat as a carrier of the germs of contagious disease. He reports that in his region it is known as the "cholera-gnat," because supposed to produce chicken cholera. Thousands of chickens and turkeys are killed by it every year in that section. "I moved to this place in January last," he says, "and was told that it would be impossible to raise chickens or turkeys as the cholera would kill them all; notwithstanding which I bought both chickens and turkeys, determined to fight the cholera should it appear. Saw nothing of it until about the first of April, when my attention was attracted first by the turkeys shaking and rubbing their heads, and upon examination found the gnats upon the wattles sucking vigorously. The gobblers and roosters are the first to succumb, as their wattles and combs are larger, exposing a larger surface for the gnats to work upon. The fowl grows weak and feverish; the discharge from the bowels becomes frequent and watery, resembling sulphur and water, and in a few days the fowl dies of 'chicken cholera.'" †

Riley gives a very different account of the effect of these gnats on poultry in Louisiana, showing that the local conditions in Virginia were peculiar. "Setting turkeys and hens," he says, "are frequently forced by the gnats to leave their nests. Young fowl are killed outright. The gnats, in attacking fowls of all kinds, force their way under the wings of their victims, where they can not be dislodged."

A similar suspicion of the conveyance of disease may be based upon Riley's statement with respect to swine, which, he says, show the effects of the bite but very little at first, large numbers dying, however, soon after the attack, while others die about six weeks after the disappearance of the buffalo-gnats, perishing usually from large ulcerated sores which cause blood poisoning.

Comparing the smaller turkey-gnats with the southern buffalo-gnat, *pecuarum*, he says that they are not so bloodthirsty, nor do they form such large swarms. "The snorting, biting, switching of tails, and the general restlessness of the stock in the fields soon reveal the presence of their foes. The gnats will, upon arrival, rapidly circle around the animal, select a point of attack, fasten themselves upon the chosen spot, and immediately commence to bite. The genital and anal regions, the ears and portions of body between the forelegs—in short, those parts where the skin is most easily punctured—are selected by these insects. The attack is so rapid, that in course of one minute the body of the tormentor is seen to expand with blood, which shows

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* Bull. No. 31, N. Ser., Div. Ent., U. S. Dept. Agr., p. 86.
† Insect Life, Vol. I, p. 14.

plainly through the epidermis of the abdomen. The bitten part of the animal shows a nipple-like projection, and if the insect is removed by force a drop of blood as large as a good-sized pin's head will ooze out. Other gnats will almost at once pounce upon the same spot and continue the biting. All those veins which project under the skin of the animal are also favorable points of attack, and their course is made visible by the hordes of gnats fastened upon them.

"The great danger of an attack by these insects lies in the unexpectedness of their appearance. As already mentioned there may be no indication of their presence in any neighborhood and the roads are free of them. But with the change of the prevailing wind they may appear, and when one is passing certain localities, such as low, wet, and shady ground, or dense thickets of underbrush, they will start forth like a cloud, and cover the animals at once. Open fields may be entirely free from gnats, but if animals pass certain places in them, out dart the tormentors, and the animals attacked can only save themselves by running to high places exposed to the full rays of the sun. The gnats, following the animals for some distance, leave as suddenly as they appeared, and hide themselves again in the thickets. In the cities they appear suddenly with certain winds, chiefly with those blowing from the south, southeast, and west, and usually disappear again with winds blowing from the opposite direction."*

S. pecuarum Riley. (Figs. 2 and 3.) This species, commonly called the buffalo-gnat, is a companion to *meridionale*—reported, however, to breed mainly in the large rivers, while *meridionale* is commonly a small-stream species. The two become mingled in swarms when abundant, and have similar habits, *pecuarum* being the larger and the more bloodthirsty of the two. It is credited to this State by Aldrich in his "Catalogue of North American Diptera," but has not been taken by us in Illinois, our collections of Simulium not having been made, in fact, in those parts of the State where it is most likely to occur. Its general range is similar to that of the turkey-gnat, although, like that species, it is essentially a southern form. Its known area of distribution extends from Alaska, Hudson Bay, and New Hampshire, to Mississippi and Louisiana, and from Massachusetts and Connecticut to Kansas and Missouri. It is a single-brooded species, so far as known.

S. pictipes Hagen. (Figs. 4, 5.) *Pictipes* is represented in our collection only by a single specimen of the adult fly obtained by Dr. Nason at Algonquin, Ill. Outside this State it occurs from New York to Idaho, Kentucky, Texas, and California. In New York it is locally very abundant in swift and rocky streams; and it has been studied with unusual care at Cornell University. There are several generations—probably three—in a single season, the egg stage lasting eight days, the larval stage, three weeks, and the pupal stage, four. These are given as the periods for warm summer weather. They are doubtless longer when the water is cooler. As it is not known to bite it has little interest for our present purpose.

S. venustum Say. (Figs. 6—12.) This species and *S. vittatum* are together called "the black-fly" in northern latitudes, where they are the northern representatives of *meridionale* and *pecuarum* in the South. *Venustum* is the species found so disturbing by Agassiz in 1850, as described in his "Lake Superior." "Flies exceedingly troublesome," says the narrator, under date of August 12, "rising in swarms from the blueberry bushes when we touched them. * * * Having for the first time open ground enough to observe their manœuverings, we tried to outrun them, and easily left them behind, but in a short time the swarm, like a pack of wolves, and guided to all appearance in like manner by scent, came ranging up in a body and fell on afresh."† That conditions in that region are still the same is shown by an article in the 12th Report of the Michigan Academy of Science (1910),‡ which says that members of the engineering staff of the Uni-

* Report of the Entomologist, U. S. Dept. Agr., for the year 1886, pp. 496-497.
† Page 115.
‡ A Remedy for the Black-fly pest in certain Streams in the Southern Peninsula of Michigan. By Cora D. Reeves.

versity of Michigan were driven from their camp on Douglas Lake, in Cheboygan county, by the black-flies in June, 1909; and that the opening of the engineering camp and biological station were postponed for a week the following year on account of these pests. The species here seems to have been *S. venustum* only.

Its life history has been unusually well worked out in New York by Sara J. McBride,* by studies made at Mumford on specimens obtained from a small creek. The flies, she says, made their first appearance in the winged stage about the first of April. Larvae were present at the same time in the water, and these were pupating by June 1. "The natural position of the larvae in the stream is a few inches below the surface of the water and in the current of the stream. * * * When frightened they drop into the water, suspended to the substance to which they had been attached by means of a fine delicate thread, in a similar manner to many land larvae. They can ascend this thread, but it is very easily broken by the action of the water * * *. The pupae, as well as larvae, perish in water of a temperature warmer than that of the stream. * * * I was enabled to obtain the perfect insect by keeping pupae in a covered box in the current of the stream. A day or two previous to emerging from the water, the pupa loosens itself from the case or "pouch" by a gentle wriggling motion from side to side. When it becomes free it rises to the surface of the water, and the fly gradually draws itself out of a slit the entire length of the pupa. The legs are the last to appear. The fly rests on the surface of the water until its wings expand and dry. This process usually takes a minute of time—sometimes more or less. They leave the water just before sunset, and will then be found flying among low herbage near the bank of the stream. * * * There have been a succession of broods this summer. During the warm season, a period of two months elapses between the egg and perfect forms. They were a week or ten days as eggs, four weeks as larvae, and about three weeks as pupae. * * * At the present time (Oct. 18th) there are large quantities of minute larvae on the leaves of the water-cress."

In northern Minnesota, according to Lugger, the earliest generation is on the wing from May 15 to June 1, and a second in June and July; and Sanderson says that in New Hampshire the flies are most numerous during early summer and again late in the same season.

The general distribution is similar to that of *meridionale* and *pecuarum*, the outlying boundaries of its area traversing New Hampshire, Canada, Minnesota, Wyoming, Idaho, and British Columbia, on the north, and Texas, Louisiana, Mississippi, and Florida, on the south.

In this State we have taken it from a small, swift stream near Fountain Bluff in southern Illinois, from Algonquin in the northern part of the State, from the Salt Fork in Champaign county, from Spoon River in Fulton county, and from White Oak Run near Havana. The latter, a clear, rapid tributary of Matanzas Lake, contained larvae and pupae in abundance from May to October. Adults were collected by Dr. Nason at Algonquin on twenty-two dates including every month from April to October, from trees and other vegetation along a creek, from pastures, vacant lots, and gardens, and from the windows of his house. Garman found the winged fly emerging from the pupa in Kentucky in August or September. This is clearly one of the several-brooded species, and probably matures three generations in Illinois.

S. vittatum Zetterstedt. (Figs. 13—15.) Commonly associated in the north with the preceding, this species shares with that the general name of "the black-fly." It is our most abundant creek species in central Illinois, and the one most likely, in my judgment, to be connected with pellagra in this part of the country. It is a several-brooded species, adults having been obtained by us April 9 and July 20, and larvae and pupae on sixteen different dates from April 4 to September 2, and larvae also on March 12.

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* The So-called Web-worm of Young Trout. Ent. and Bot., Vol. II, pp. 365-367.

In Kansas adults were used by Prof. Hunter in an inoculation experiment with guinea-pigs and monkeys, from the 21st of August to the 4th of November.

It is generally distributed wherever streams of the right character are to be found, the ordinary gravelly creek seeming to be its favorite breeding place. It was not obtained by Dr. Nason in his numerous collections, running through several years, at Algonquin, in McHenry county, but has been found by us in Cook and Carroll counties in extreme northern Illinois, and also in tributaries of the Saline River in Saline county, in the extreme southern part of the State. In central Illinois we have it from small streams near Bartonville and Farm Creek near Peoria, from Spoon River in Fulton county, from Quiver Creek and White Oak Run in Mason county, from the Illinois River at Havana (shore of Cook's Island), from the Fox River at Ottawa, from various streams in Champaign and Vermilion counties, and from creeks along the lower Illinois in Greene county. At Muncie in Vermilion county, where larvae alone were common April 20, nearly all had pupated by May 3.

Its recorded general distribution ranges from Greenland, New York, Minnesota, and South Dakota, to Nebraska, Kansas, and California. It has not been taken, as will be noticed, from the South. It is said by Washburn, in Minnesota, to pay especial attention to mankind, *venustum*, commonly associated with it, being peculiarly annoying there to domestic animals. Hunter's experiments for the transfer of pellagra from human beings to monkeys by means of this species of Simulium are reported in full in the Journal of the American Medical Association for February 24, 1912, and an abstract of this article appears in the Journal of Economic Entomology for the same month.

Simulium johannseni Hart, n. sp. (Figs. 16—20.) A species of buffalo-gnat most nearly allied perhaps to the turkey-gnat, *meridionale*, has been found in considerable numbers in central Illinois, especially on the Illinois River at Havana. Submitted to Prof. O. A. Johannsen, of Orono, Me., the leading authority on the species of this genus in America, it was pronounced new and undescribed. It first came to our notice through dredgings made from the Illinois River at Havana March 25, 1895, appearing in large numbers in a collection made with a naturalist's dredge from the bottom of the river near the west shore, in the neighborhood of an old railroad bridge. Larvae were found at the same station March 31 and April 8; and both larvae and pupae were taken here, and also at Stony Creek, Vermilion county, April 8 and 20. Adults were collected at Havana from April 19 to 25, 1910 (being especially abundant on the 22d), and again June 14; and finally a single specimen was caught at the same place October 1. April 22 was a windy day, and the flies were assembled on driftwood in a swarm; and others were floating on the surface in a dense layer covering a small area protected by surrounding logs. The dates for the adult show that this is a several-brooded species.

Simulium venustoides Hart, n. sp. (Figs. 21—23.) A second new species, allied to *S. venustum*, is in the Nason collection from Algonquin, Ill. It is represented by specimens taken May 4 and 7, July 8, September 7, and October 17, 20, and 24, from plants along a creek, in pastures and gardens, and on vacant lots. This is clearly a several-brooded species, breeding in small streams.

Descriptions of the above new species are given in the Twenty-seventh Report of the State Entomologist of Illinois, pages 32 and 34 and 42-44.

Possible Relations to Pellagra.

To ascertain definitely whether the distribution of black-flies in Illinois, and the times of their principal appearance, local and general, have any relation to the occurrence and frequency of cases of pellagra, would require a very much broader and closer survey of the State with this point especially in mind than it has been possible for me to make. With the excep-

tion of a part of the data obtained at Havana and Peoria in 1910, those here reported are the product of general miscellaneous collections made during many years, with no thought of any pathological application. They are sufficient, however, to show the common occurrence of black-flies throughout the State. Our specimens have come from sixteen counties—five in northern Illinois, eight in central, and three in southern, as follows: Northern Illinois—McHenry, Carroll, Cook, La Salle and Mercer; central Illinois—Peoria, Tazewell, McLean, Vermilion, Champaign, Mason, Fulton, and Greene; and southern Illinois—Wabash, Saline, and Jackson.

The places and situations of occurrence are such as to warrant the opinion that black-flies might be found in larger or smaller number in every county of the State. They would be most abundant, of course, along the larger rivers (and it is only there that they become noticeable as pests), and the species would differ with the size and character of the streams, and to some extent with the latitude.

The only attempt I have been able to make towards a comparison of local facts concerning Simulium with the local data of pellagra, is based on observations made at Bartonville, near Peoria, in the latter part of August, 1910. The location there of the General Hospital for the Insane, in which pellagra is almost continuously present, gave us reason to examine the surroundings of this institution as carefully as possible; and visits were made to this place by Mr. C. A. Hart on the 29th, 30th, and 31st of August. In a small stream just north of the hospital grounds at Bartonville, which leaves the bluff on which the buildings stand, passes under the highway, and flows eastward through low ground towards the river, Simulium larvae were obtained just below the wagon bridge, on the leaves of trailing branches and on other objects in the stream, although none could be found in this stream above the highway. The point at which the black-flies were breeding was about a third of a mile in a direct line from the hospital buildings. No pupae were seen in the water, and no winged flies could be caught by diligent sweeping of the vegetation in that vicinity. Two small streams emerging from shady valleys in the bluffs to the south of the hospital grounds were destitute of Simulium larvae.

In Kickapoo Creek, between Bartonville and Peoria, a very few larvae and pupae were found, and a considerable number were taken in favorable places all along Farm Creek near the East Peoria station across the river from the hospital. These were not in the deeper or wider parts of the creek, but in its very smallest lateral divisions and the shallowest margins of the riffles. All the specimens taken at this time in these streams proved to be *Simulium vittatum*. A thorough search of the river margin at Peoria, made August 31st, was without result, no trace of Simulium being found in the main stream. Not a single winged black-fly could be found here, although the presence of small numbers of the pupae showed that a very few might be abroad. The probability of any activity of black-flies in conveying pellagra at this place and time seems, consequently, very small.

I have next to scan my miscellaneous data with reference to the possibility of distinguishing successive generations, and periods of greatest abundance, of the insects on the wing. Throwing all these data together I find that we have made collections of adults upon thirty-six of the two hundred and four days from April 3d to October 24th, and that there are two rather conspicuous blanks in the series, one extending from May 22d to June 14th—twenty-two days—and the other from July 21st to August 11th—twenty days. Accepting these as indications of the dividing lines between successive generations, we may conclude provisionally that we have three generations in the season, the first covering April and the greater part of May, the second the latter part of June and most of July, and the third extending from the middle of August to the last of October. These intervals might perhaps be filled in, at least in part, if we had larger collections; but they correspond fairly well to such definite facts as we have concerning the length of a generation period in Simulium. Precise work on this subject has been done only in New York, and there only for two species, *pictipes* and *venustum*, the first of

which possibly does not occur in Illinois. For both these New York species it has been shown that in the warmer part of the summer the development of a generation requires about eight weeks, one of which is passed in the egg, four in the larva, and three in the pupa stage. Making reasonable allowance for a prolongation of the period of development of the earliest and latest generations grown in the cooler weather of the season, we may fairly suppose that we have three generations of six of our Illinois species, the first extending through April and May, the second coming in June and July, and the third in August, September, and October. Entomologists will readily understand that with any such succession of generations as this in a single season, the periods of the later ones are always the longer. The other three Illinois species seem to give us but one generation each, which we know to appear in April and May.

It has been a matter of special interest to me to compare this hypothetical scheme of generations with pellagra data communicated to me by Dr. H. Douglas Singer, in a letter written December 29, 1911. The statements of this letter are illustrated by a curve showing the number of fresh cases of pellagra occurring at the Bartonville general hospital for each month from July, 1909, to September, 1911. There are five high points in this curve for these twenty-six months—one at the beginning of the record, which, starting with 21 cases for July, 1909, rises to 71 for August, and then drops rapidly away to three in December. This is much the highest wave of the curve. The next wave of increase begins with a single case in April, 1910, rises to 16 cases in May and to 34 in June, and drops to four in July. We have next a lower wave of 16 cases in August, 1910, 15 in September, and one in October. Two cases in the following March (1911) become four in April and six in May, fall to one in June, rise again to three in July and seven in August, and fall to none in September.

On the supposition of a connection between black-fly outbreaks and pellagra waves, we should naturally expect the former to precede the latter somewhat—just how far, of course no one can tell, since that would involve a knowledge of the incubation period of the disease. A comparison of my hypothetical periods of our black-fly generations with these waves of frequency of new cases of pellagra, gives an indication of a correspondence between the two series for the first two generations of the year, but negatives the idea of any stimulating influence of the implied third generation. Thus, omitting the 1909 record as begun too late to serve our purpose, the March and April generation of black-flies for 1910 connects with an April and May increase of pellagra; the supposed June and July generation of that year, with high numbers of new cases for August and September; the March and April generation of 1911 connects with an April and May increase of pellagra for that year; and the June and July generation with a July and August increase. The August to October generation, on the other hand, is followed by a decline in the number of new cases in both 1909 and 1910, the record for 1911 breaking off within this period.

These interpretations, it is true, are decidedly hypothetical, but they may be taken as at least suggestive of a causal relationship, and as indicative of a method of analysis which, used in proper cases, may give definite results. We need to know accurately the life histories of the various species of Simulium for the entire year in some locality where pellagra is more or less prevalent, and to know also the exact facts as to the local abundance of the winged flies during the successive generation periods. If there are recognizable and considerable variations in abundance, or definite breaks in the insect series, correlated in a uniform way with waves of pellagra increase presently following; and if exceptions to this correlation are to be clearly explained by exceptional circumstances, we shall have strong reason to believe that one or more of the species of Simulium then and there present are causally related to the conveyance of pellagra from one person to another. Other and more direct lines of operation on this problem belong to the pathologist rather than to the entomologist.

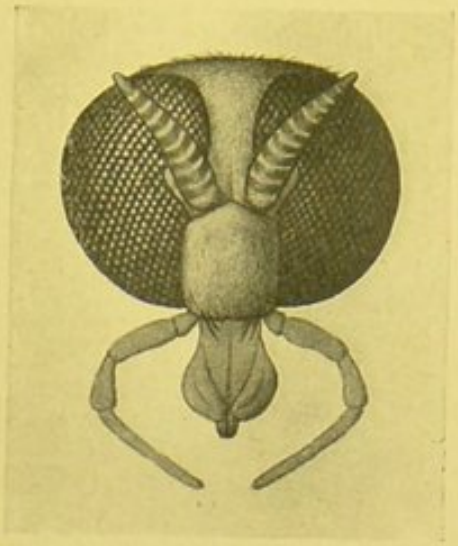

FIG. 1. The Turkey-gnat, *Simulium meridionale*, front of head. × 35. (Drawn from dried specimens; structure of palpi not to be depended on.)

FIG. 2. The Buffalo-gnat, *Simulium pecuarum*, adult fly. × 10. (From H. Garman.)

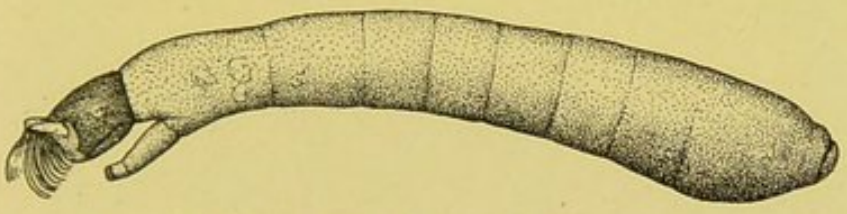

FIG. 3. The Buffalo-gnat, *Simulium pecuarum*, larva, lateral view. × 10. (From H. Garman.)

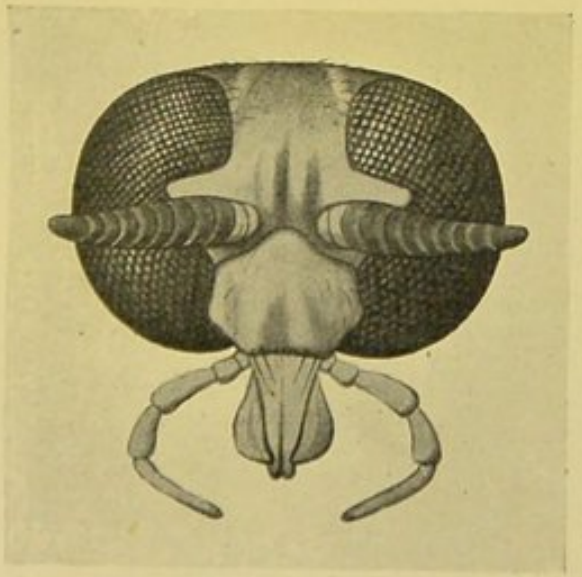

FIG. 4. *Simulium pictipes*, front of head of female. × 35. (Not reliable as to structure of palpi.)

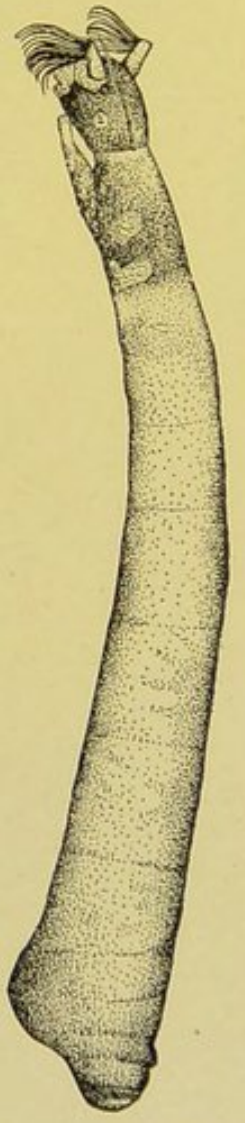

FIG. 5. *Simulium pictipes*, larva. × 10. (From H. Garman.)

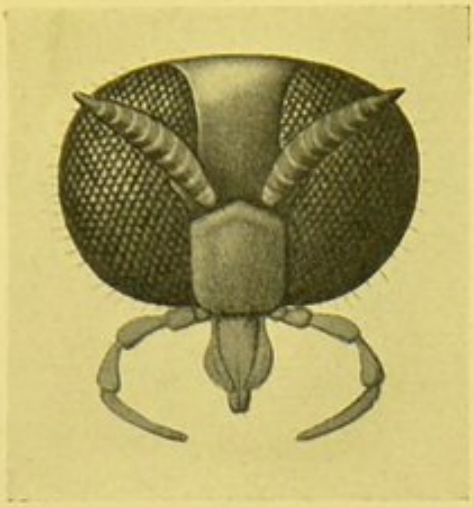

FIG. 6.

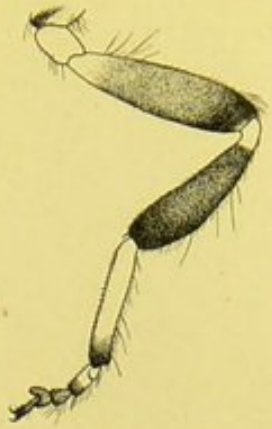

FIG. 7.

FIG. 8.

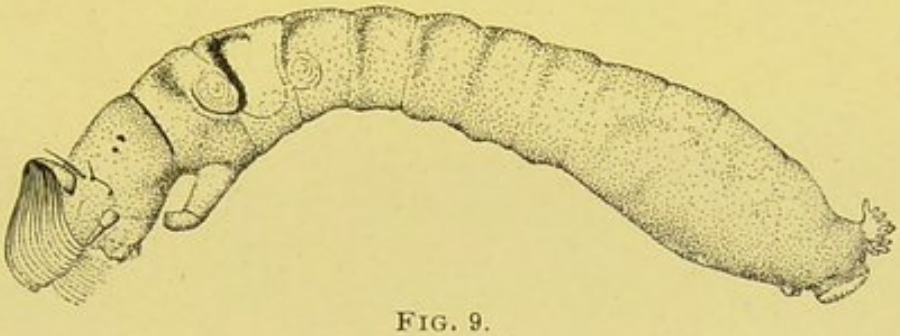

FIG. 9.

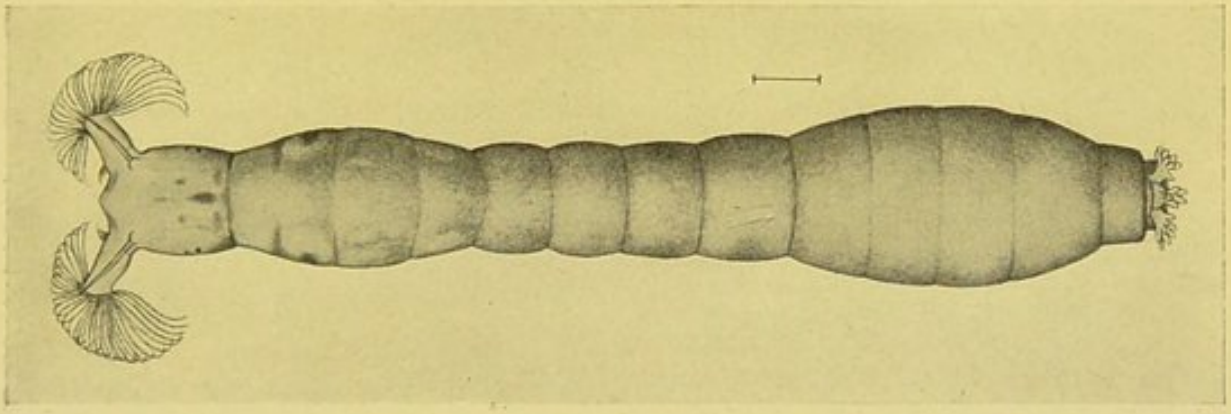

FIG. 10.

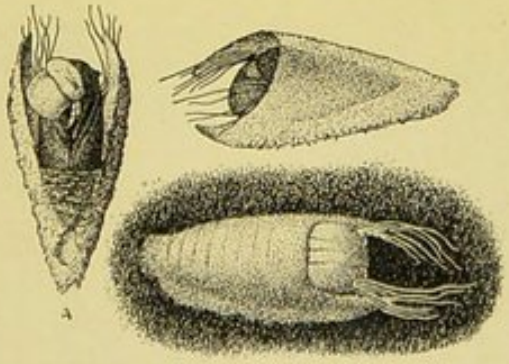

FIG. 11.

FIGS. 6-11. The Black-fly, *Simulium venustum:* FIG. 6, female, front of head (× 35. Drawn from dried specimens; structure of palpi not to be depended on); FIG. 7, right hind leg of male (× 23); FIG. 8, thorax and head of male (× 22); FIG. 9, larva, lateral view; FIG. 10, larva, dorsal view; FIG. 11, pupa and cocoon, lateral and dorsal aspects, A, adult emerging. (Figs. 9 and 11 from H. Garman.)

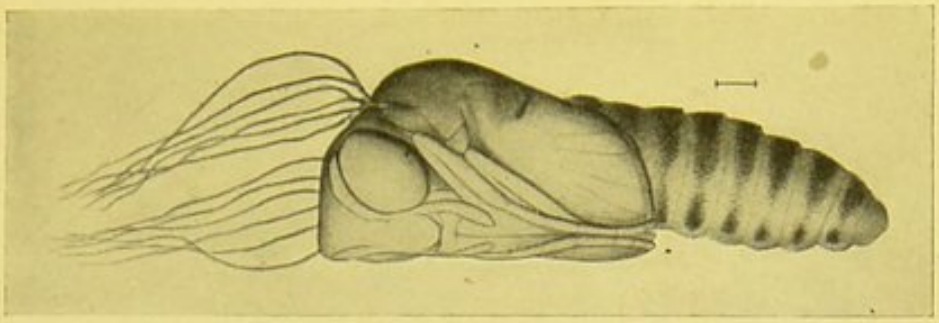

FIG. 12. The Black-fly, *Simulium venustum*, pupa, three-quarters view. × 15.

FIG. 13.

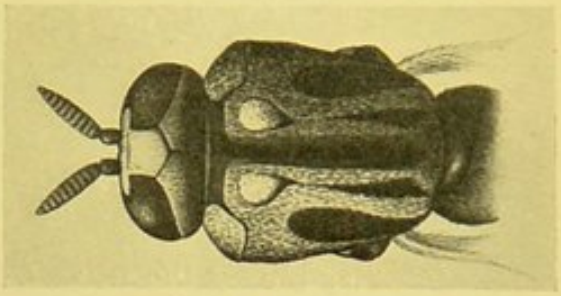

FIG. 14.

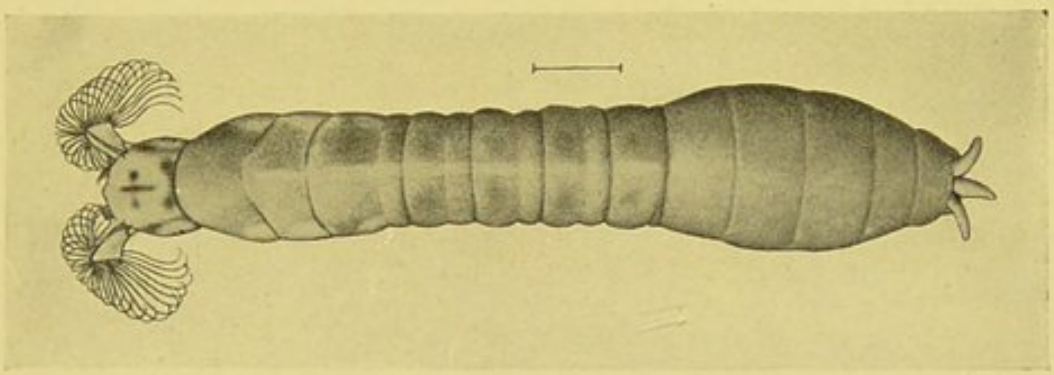

FIG. 15.

FIGS. 13-15. *Simulium vittatum:* FIG. 13, front of head of female (× 35. Not reliable as to structure of palpi); FIG. 14, thorax and head of female (× 22); FIG. 15, larva, dorsal view (× 10).

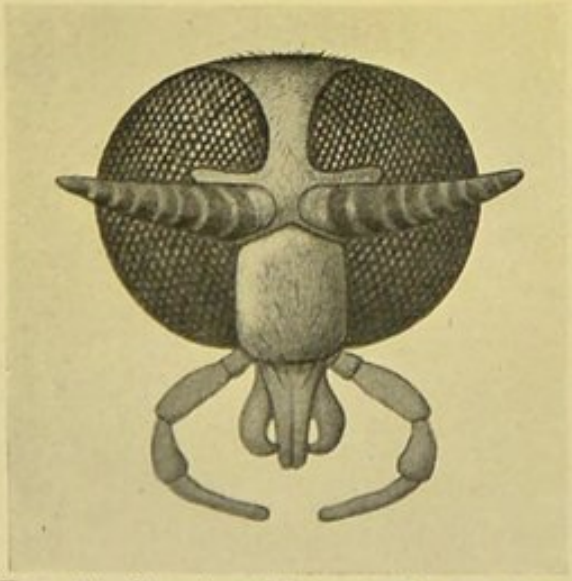

FIG. 16. *Simulium johannseni*, front of head of female. × 35. (Not reliable as to structure of palpi.)

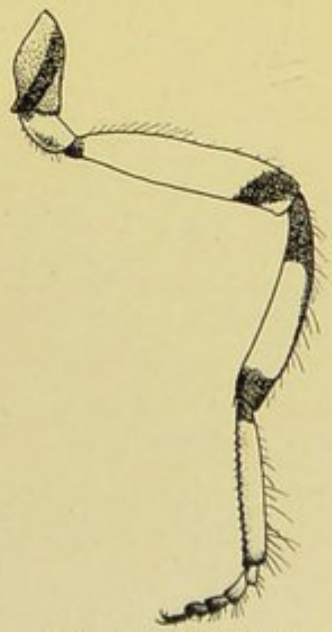

FIG. 17. *Simulium johannseni*, right hind leg of female. × 11.

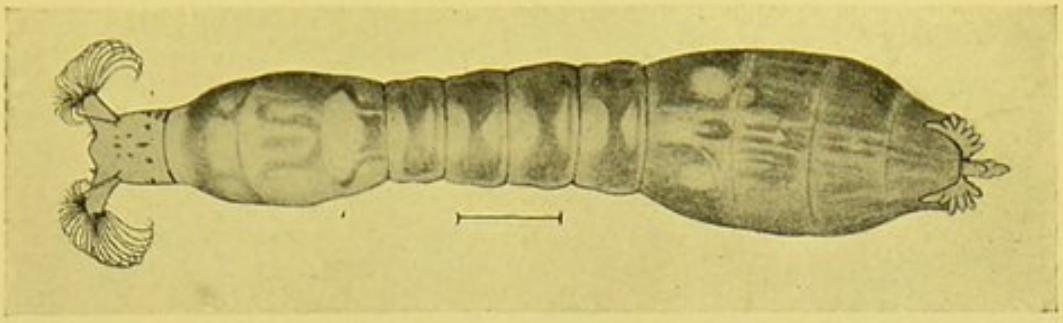

FIG. 18. *Simulium johannseni*, larva, dorsal view. × 8¾.

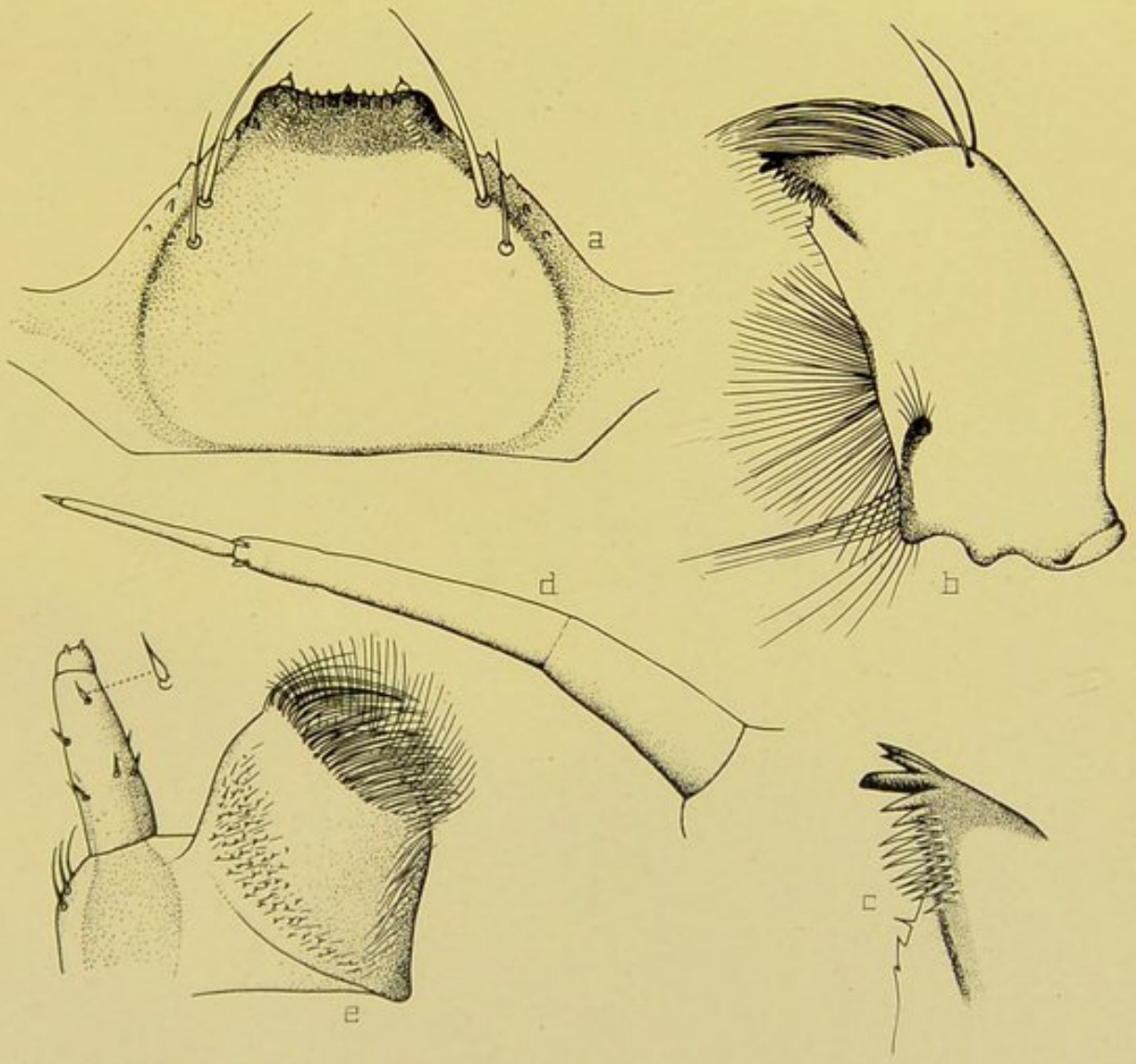

FIG. 19. *Simulium johannseni*, antenna and mouth-parts of larva: *a*, labium from beneath, ventral view; *b*, mandible, ventral view; *c*, toothed tip of mandible; *d*, antenna; *e*, maxilla, ventral view.

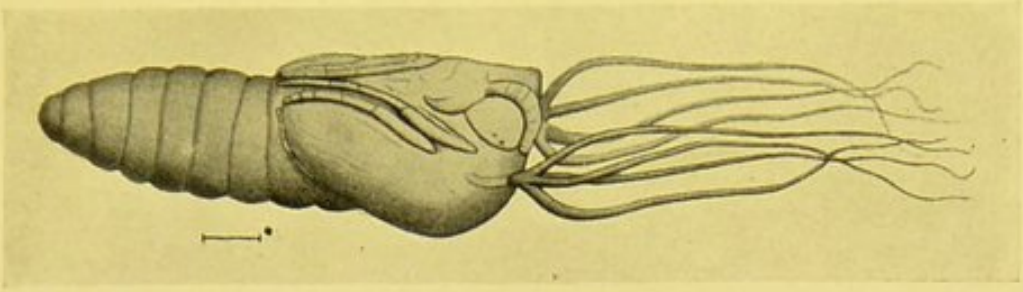

FIG. 20. *Simulium johannseni*, pupa, three-quarters view. × 8¾.

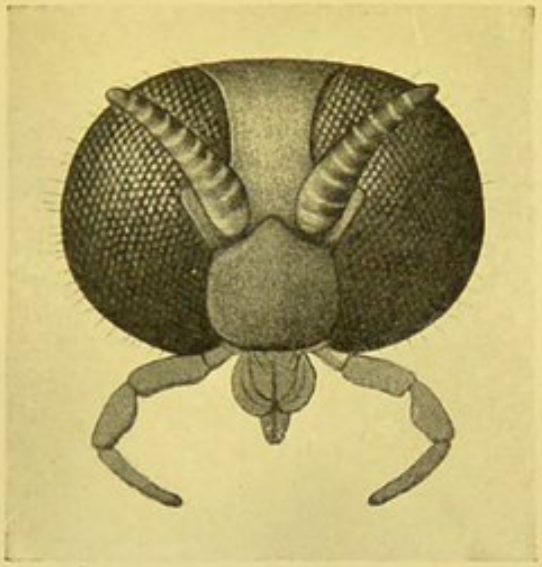

FIG. 21.

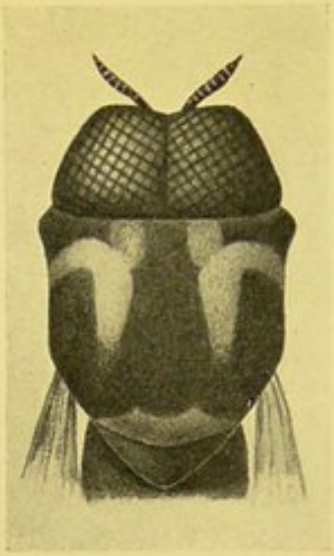

FIG. 22.

FIG. 23.

FIGS. 21–23. *Simulium venustoides:* FIG. 21, front of head (× 35); FIG. 22, head and thorax of male (× 22); FIG. 23, right hind leg of male (× 23).

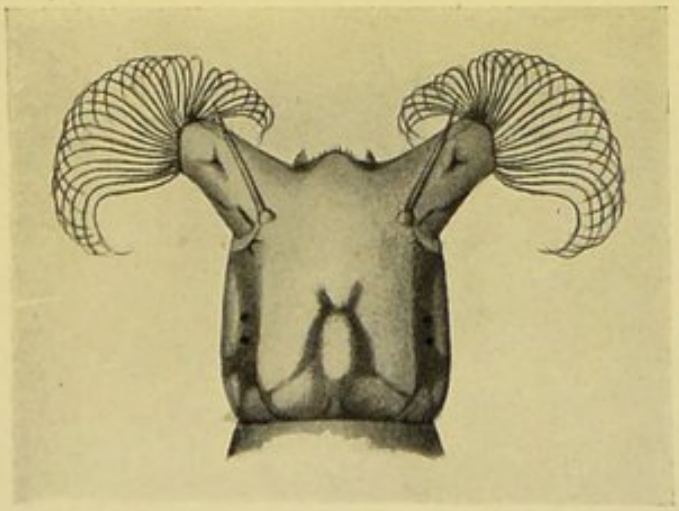

FIG. 24. *Simulium* sp., head of larva from above. × 29.
(Vermilion county and Yellowstone Park.)

ARTICLES CONSULTED—AMERICAN AND ENGLISH.

1818. Cornelius, Elias.—A Destructive Insect. Am. Journ. Sci., Vol. I, p. 328. (Apparent reference to buffalo-gnat. See Insect Life, Vol. I, p. 224.)

1850. Agassiz, Louis, and Cabot, J. Elliot.—Lake Superior: its Physical Character, Vegetation, and Animals, compared with those of other and Similar Regions, pp. 34, 55, 57, 61, 79, 115.

1870. The Death Web of Young Trout. Am. Ent. and Bot., Vol. II, pp. 174, 227.

Osten Sacken, R.—On the Transformations of Simulium. Am. Ent. and Bot., Vol. II, pp. 229-231.

McBride, Sara J.—The So-called Web-worm of Young Trout. Am. Ent. and Bot., Vol. II, pp. 365-366.

1873. Packard, A. S.—Our Common Insects, pp. 72-73.

1879. Hagen, H. A.—A New Species of Simulium with a Remarkable Nympha Case. Proc. Boston Soc. Nat. Hist., Vol. XX, pp. 305-307.

1880. Barnard, W. S.—Notes on the Development of a Black-fly (Simulium) Common in the Rapids around Ithaca, N. Y. Am. Ent., Vol. III, pp. 191-193.

1881. Hagen, H. A.—On Simulium. Can. Ent., Vol. XIII, pp. 150-151.

Simulium from Lake Superior. Am. Nat., Vol. XV, pp. 330, 916.

1883. Hagen, H. A.—Simulium Feeding on Chrysalids. Ent. Monthly Mag., Vol. XIX, pp. 254-255.

1885. Riley, C. V.—The Southern Buffalo Gnat (Simulium sp.). Rep. Ent. U. S. Dept. Agr. for 1884, pp. 340-345.

1886. Doran, E. W.—The Buffalo-gnat. Rep. on the Econom. Ent. of Tenn. to the Bureau of Agriculture, Statistics, Mines, and Immigration, pp. 239-242.

1887. Webster, F. M.—Report on Buffalo-gnats. Bull. 14, Div. Ent., U. S. Dept. Agr., pp. 29-39.

Riley, C. V.—Buffalo-gnats. Rep. Ent., U. S. Dept. Agr., for 1886, pp. 492-517.

1888. Riley, C. V.—A Virginia Simulium called "Cholera Gnat." Insect Life, Vol. I, p. 14.

An Application for Buffalo-gnat Bites. Insect Life, Vol. I, p. 15.

Buffalo-gnats attacking Man. Insect Life, Vol. I, pp. 60-61.

Howard, L. O.—Notes on a Simulium Common at Ithaca, N. Y. Insect Life, Vol. I, pp. 99-101.

Formula for a Buffalo-gnat Application. Insect Life, Vol. I, p. 143.

Osborn, Herbert.—An Old American Account of the Buffalo-gnat. Insect Life, Vol. I, pp. 224-225.

Buffalo-gnats on the Red River. Insect Life, Vol. I, pp. 313-314.

1889. Marlatt, C. L.—Report of a Trip to investigate Buffalo-gnats. Insect Life, Vol. II, pp. 7-11.

1891. Townsend, C. H. Tyler.—A New Simulium from Southern New Mexico. Psyche, Vol. VI, pp. 106-107.

1892. Notes on Buffalo-gnats. Insect Life, Vol. IV, pp. 143-144.

1893. Proc. Ent. Soc. Wash., Vol. III, p. 317.
Townsend, C. H. Tyler.—On a Species of Simulium from the Grand Canon of the Colorado. Trans. Am. Ent. Soc., Vol. XX, pp. 45-48.
Garman, H.—Silk Spinning Fly Larvae. Science, Vol. XXII, pp. 215-217.

1895. Death Web of Young Trout. Insect Life, Vol. VII, p. 50.
Cockerell, T. D. A.—Notes from New Mexico. Insect Life, Vol. VII, p. 211.
The Buffalo Gnat. Insect Life, Vol. VII, p. 426.
Townsend, C. H. Tyler.—On the Correlation of Habit in Nemocerous and Brachycerous Diptera between Aquatic Larvae and Blood-sucking Adult Females. Journ. N. Y. Ent. Soc., Vol. III, pp. 134-136.
Miall, L. C.—The Natural History of Aquatic Insects. Simulium, pp. 175-188.
Comstock, J. H., and Comstock, Anna B.—A Manual for the Study of Insects. The Black-flies, pp. 451-453.

1896. Lugger, O.—Buffalo-gnats, Black-flies. Second Ann. Rep. Ent. of State Exper. Sta., Univ. Minn., pp. 172-182.
Osborn, H.—Insects Affecting Domestic Animals. Bull. No. 5, Div. Ent., U. S. Dept. Agr. Black Flies, Buffalo Gnats, pp. 31-58.
Coquillett, D. W.—The Buffalo-gnats, or Black-flies, of the United States. Bull. No. 10, Div. Ent., U. S. Dept. Agr., pp. 66-69.

1899. Carpenter, Geo. H.—Insects: their Structure and Life, p. 124.
Herrick, Glenn W.—The Southern Buffalo Gnat (*S. pecuarum* Riley). Bull. 53, Miss. Agr. Exper. Sta., pp. 2-4.

1901. Kellogg, Vernon L.—Food of Larvae of Simulium and Blepharocera. Psyche, Vol. IX, pp. 166-167.
Needham, J. G., and Betten, C.—Aquatic Insects in the Adirondacks. Bull. 47, N. Y. State Mus., pp. 407-408, pl. 15, figs. 9-11, 18-20; also pp. 393, 574.

1902. Taylor, T. H.—On the Tracheal System of Simulium. Trans. Ent. Soc., London, 1902, pp. 701-716.
Webster, F. M., and Newell, Wilmon.—Insects of the Year in Ohio. Bull. 31, N. S., Div. Ent., U. S. Dept. Agr., pp. 84-90.

1903. Johannsen, O. A.—Notes on Some Adirondack Diptera Collected by Messrs. MacGillivray and Houghton. Ent. News, Vol. XIV, pp. 14-17.
Johannsen, O. A.—Aquatic Nematocerous Diptera. Aquatic Insects in New York State, Pt. 6. Bull. 68, N. Y. State Mus., pp. 336-388.

1904. Webster, F. M.—The Suppression and Control of the Plague of Buffalo-gnats in the Valley of the Lower Mississippi River, and the Relations thereto of the Present Levee System, Irrigation in the Arid West and Tile Drainage in the Middle West. Proc. 25th Ann. Meeting, Soc. Promotion Agr. Sci., pp. 53-72.
Weed, Clarence M.—Experiments in Destroying Black-flies. Bull. 112, N. H. Agr. Exper. Sta. 4 pp.
Weed, Clarence M.—An Experiment with Black Flies. Bull. 46, Div. Ent., U. S. Dept. Agr., pp. 108-109.

1905. Washburn, F. L.—Simuliidae, Black-flies, Buffalo Gnats. 10th Ann. Rep. State Ent. Minn., pp. 70-76.
Aldrich, J. M.—A Catalogue of North American Diptera. Smithsonian Miscellaneous Collections, Vol. XLVI, pp. 168-171.

1906. Headlee, T. J.—Blood Gills of *Simulium pictipes*. Am. Nat., Vol. XL, pp. 875-885.

1910. Reeves, Cora D.—A Remedy for the Black Fly Pest in Certain Streams of the Southern Peninsula of Michigan. 12th Rep. Mich. Acad. Sci., pp. 77-78.

Sanderson, E. Dwight.—Controlling the Black Fly in the White Mountains. Journ. Econ. Ent., Vol. III, pp. 27-29.

Lavinder, C. H.—The Theory of the Parasitic Origin of Pellagra. Public Health Reports, Vol. XXV, pp. 735-736. Washington, D. C.

Recent Investigations on Pellagra. Nature, Vol. LXXXIV, pp. 538-539.

Sambon, Louis W.—Progress Report on the Investigation of Pellagra. Journ. Tropical Medicine and Hygiene, Vol. XIII, pp. 271-282, 287-300, 305-315, 319-321.

1911. Knab, Frederick.—Dr. A. Lutz's Studies of Brazilian Simuliidae. Proc. Ent. Soc. Wash., Vol. XIII, pp. 172-179.

Shelford, R.—Simulium and Pellagra. Nature, Vol. LXXXV, p. 41.

Hewitt, C. Gordon.—Simulium Flies and Pellagra. Nature, Vol. LXXXV, pp. 169-170.

Roberts, Stewart R.—Sambon's New Theory of Pellagra and its Application to Conditions in Georgia. Journ. Amer. Med. Ass'n, Vol. LVI, pp. 1713-1715.

1912. Hunter, S. J.—The Sand-fly and Pellagra. Journ. Econ. Ent., Vol. V, pp. 61-63.

Garman, H.—A Preliminary Study of Kentucky Localities in which Pellagra is Prevalent. Bull. 159, Ky. Agr. Exper. Sta. 79 pp.

XI.

PROTOZOAL INFECTION OF PATIENTS AT THE KANKAKEE STATE HOSPITAL.

(By J. T. Rooks, M.D.)

In the summer of 1910 Captain Joseph F. Siler, U. S. A., coöperating with the State of Illinois Pellagra Commission, while investigating the causes of the prevalence of pellagra in Illinois, discovered that the stools of about sixty percent of non-pellagrous patients examined at the Peoria and Kankakee State Hospitals contained amoebae and even a greater percentage flagellates. At the Cook County Institutions at Dunning examination revealed a somewhat smaller but still considerable percentage of infection with amoebae. In view of these findings it was suggested by Dr. Singer that the stools of a number of cases at the Kankakee State Hospital be subjected to a careful microscopic examination at the time of admission and again at later times for the purpose of determining whether the infection took place after admission and if possible as to whether any pathogenicity could be attributed to these micro-organisms.

In carrying out this investigation the technique used by Captain Siler has been followed. Each Saturday was set apart for the purpose of examining the stools of all patients admitted during the current week. Each patient was given a large dose of magnesium sulphate before eating breakfast with instructions to drink plenty of water, and a sample of the first liquid stool passed was collected in a small glass jar fitted with a cork and at once hurried to the Laboratory where it was kept warm until examined. Care was taken to select a sample containing any shreds of mucus which might be present. It was then gently agitated with a platinum loop and a small drop placed upon a warm glass slide and examined while fresh. In many cases it was necessary to examine a number of different preparations before arriving at satisfactory conclusions. In view of the present uncertainty regarding the different types of amoebae no attempt has been made to classify the varieties found. The majority show a well-defined nucleus with marked activity which together with their size seems to distinguish them from the Entamoeba Histolytica and Amoeba Coli. They correspond in appearance with those described by Captain Siler as Entamoeba Tetragena.

In regard to the nine cases in which the diagnosis of encysted amoebae was made it must be admitted that the question has been raised as to whether these so-called encysted forms are really amoebae or epithelial cells. Without entering upon a lengthy discussion as to the points of differentiation, it suffices to say that the presence of daughter cysts, the clear hyaline ring of ectoplasm and the absence of nucleus were regarded as sufficient evidence of their protozoal character.

The first examination was made, as stated, within one week of the admission of the patient in most instances, although in a few cases it was necessary to repeat the dose of epsom salts on a later day in order to secure a satisfactory specimen. At the end of 5 or 6 months the second examina-

tion of all cases was made within a period of 2 or 3 weeks so that the interval which had elapsed between the two examinations varied considerably in different cases. During this interval some of the cases examined had died, left the hospital, or for some other reason could not be studied, so that of the original 181 only 104 were still available for the second examination.

TABLE I.

	Number of cases	Amoebae present				Flagellates		Amoebae and flagellates
		Active	Encysted	Total	Percent	Total	Percent	
First examination..	181	19	9	28	15.5	27	14.9	7
Second examination	104	21	.....	21	20.2	23	22.1	7

Of the 28 showing amoebae at the first examination, only 11 were available for the later investigation and in these the amoebae were found in only 3 cases. At the second examination amoebae were found in 18 cases which had previously given negative results. It should also be noted that where amoebae and flagellates were found together these cases have been included also in the totals for the two types of organism given separately.

Attention was also paid to the relationship between the presence of amoebae at the first examination and the action of the bowels, the results being given below in percentages.

TABLE II.

Number of cases	Normal stools	Diarrhoea	Constipation	Alternating diarrhoea and constipation
28.....	75.0	10.7	7.1	7.1

It is obvious that no very definite statistical conclusions can be drawn from the above figures since the failure to find amoebae at one examination by no means precludes the possibility of their presence within the intestine. In every negative case repeated examinations should be made. Nevertheless there is a wide discrepancy between the number of infected individuals here found and the figures given by Captain Siler. This can in part be explained by the fact that in selecting cases for examination Capt. Siler asked to have included especially any patients showing chronic diarrhoea, so that his material can not be regarded as being a fair average of the inmates. Nevertheless this selection of cases can hardly explain the whole difference unless this amoeba is to be regarded as the cause of the chronic diarrhoea, which from the facts in this series seems hardly justifiable. Furthermore, even on such a hypothesis, being acquainted with the group of cases examined by Captain Siler at the Kankakee State Hospital, I know that the proportion of individuals suffering from chronic diarrhoea included in his series was much too small to permit of this explanation. It must therefore appear that, while an amoebic infection of the intestinal canal is common in this State, the proportion becomes larger when living in the two State Hospitals investigated and the Cook County Institutions. The increase in numbers shown in the above tables at two separate examinations might be thought to bear this out, but it must also be noted that of eleven cases showing amoebae on the first test, only three showed them at a later date.

With regard to pathogenicity there is little evidence to show that any harm results from infection with this amoeba in the majority of instances. Twenty-five percent of the infected cases which were studied showed some disturbance of the bowels, but there was nothing in the general nutrition or health which seemed to be related to amoebiasis. Nevertheless it must be remembered that amoebic ulceration of the intestine and even solitary liver abscess have been reported at autopsy in cases at the Peoria State Hospital.

Summary.

1. Of 181 recently admitted cases, 15.5 percent showed amoebae in the stools which apparently belonged neither to the Amoeba Coli nor Entamoeba histolytica groups.

2. One hundred four of these cases re-examined later showed 20.2 percent of amoebae.

3. The percentage of infected individuals apparently increases with the term of residence in the Peoria and Kankakee State Hospitals.

4. It seems at least probable that the majority of these organisms are non-pathogenic.

REPORT OF THE BIO-CHEMICAL WORK DONE UNDER THE AUSPICES OF THE ILLINOIS PELLAGRA COMMISSION.

XII.

Part I—Dietary Studies at the Peoria State Hospital.

(By A. F. Wussow and H. S. Grindley.)

Introduction.

One of the problems presented to the Pellagra Commission for study when it was appointed was the investigation of the food supplies of the State charitable institutions. In this connection, it was planned, first, to make dietary studies at the Peoria State Hospital on account of the prevalence of pellagra at that institution. These were to be followed by similar studies in one of the other institutions where either no pellagra or but few cases had occurred. After these had been completed, the work was to be continued by dietary studies in the other institutions and by metabolism experiments, the scope and extent of which would be determined by the results obtained. Unfortunately, the lack of time and funds has made it impossible to do more than start the work as outlined. The food supply of the Peoria State Hospital alone was investigated; but the results obtained demonstrate that such work is called for.

It is the object of this report to present the results of the studies at the Peoria State Hospital. Primarily, the investigations sought two things: first, to determine as accurately as means would permit, the nutritive value of the food supply at the hospital; and, second, to determine the nutritive values of the two special diets, the Corn and Corn-free Diets, which had been in use at the institution for about one year. To obtain the desired information, two dietary studies were conducted.

In order to determine with absolute accuracy the food consumption of the entire population of the hospital, it would have been necessary to conduct a large number of dietary studies. It was not possible to do this. As an alternative, it was decided to select a group of patients of convenient size which would be as representative as possible of the entire patient body, in respect to the amount of food eaten, the amount of work done, and their physical and mental condition.

At the time of the studies, there were six diets in use at the institution. They were as follows:

1. General Diet—furnished to the greater part of the population.
2. Special Diet—for the hospital and infirmary patients.
3. Tent Colony Diet—for consumptive patients inhabitating the tent colony wards.

4 and 5. Corn and Corn-free Diets—These will be explained later.

6. Employés' Diet.

To illustrate the differences in these, specimen diets taken from the hospital diet sheet for September 9, 1910 are given.

TABLE 1—SPECIMEN DIETS—PEORIA STATE HOSPITAL, SEPTEMBER 9, 1910.

	Breakfast.	Dinner.	Supper.
General diet.	Boiled rice. Steamed potatoes. Bread. Butterine. Syrup. Coffee.	Steamed potatoes. Creamed onions. Bread. Butterine. Vegetable soup. Crackers.	Peach tapioca. Bread. Butterine. Tea.
Special diet.*	Boiled rice. Bread. Butterine. Syrup. Toast. Coffee. Milk.	Creamed potatoes. Prune pudding. Bread. Butterine. Vegetable soup. Crackers. Milk.	Spice pudding. Bread. Butterine. Peach tapioca. Tea. Milk.
Tent Colonies.*	Boiled rice. Bread. Butterine. Syrup. Coffee. Toast. Milk.	Creamed potatoes. Prune pudding. Bread. Butterine. Vegetable soup. Crackers. Milk.	Bread. Spice pudding. Butterine. Peach tapioca. Tea.
Employés diet.	Fried potatoes. French toast. Corn flakes. Rhubarb sauce. Bread. Butterine. Coffee.	Salmon. Creamed potatoes. Scalloped corn. Cabbage salad. Sliced tomatoes. Bread. Butterine. Pumpkin pie. Cheese. Coffee.	Salmon. Creamed potatoes. Scalloped corn. Cabbage salad. Sliced tomatoes. Bread. Butterine. Pumpkin pie. Cheese. Coffee.

* Bed patients and convalescents get milk or egg-nog at 10 a. m. and 3 p. m.

In a way, the General Diet is the basis of the others. With the exception of the Employés Diet, the others are special diets given to comparatively few patients. By far the greater number of inmates received the General Diet and, for this reason, it was selected for the first study.

DIETARY STUDY NO. 1, GENERAL DIET.

There were several groups which appeared to fill the required conditions. Two of them, consisting of 200 to 250 patients each, were too large to work with. The third was a colony of about 53 men. Fifty of these were epileptics, two were dements, and one was an idiot. Mentally, their conditions varied from fair intelligence to extreme stupidity. Physically, they ranged from a young and fairly strong boy of about 19 years to feeble old men. A number of them did some work taking care of their cottage and dining room. Most of them took more or less exercise walking around the grounds. None probably did any very hard work. From appearances, this group seemed to be fairly representative of the entire patient population of the institution, and the amount of food they consumed was probably very close to the average for all the patients, especially for those on the General Diet.

The Diet for the Week.

The menus for the week are given on the following pages. They are arranged parallel to those for the Corn and Corn-free Diets which were investigated later. As explained in the foot note, no butterine was served on the first day because the supply had run out. At one meal, however, cheese was substituted for the butterine. Just previous to the beginning of the study, the baker of the institution met with an accident which incapacitated him. Another baker was secured to take his place but he was unable to turn out the necessary work and confined his efforts chiefly to keep up the supply of bread. On this account there were missing from the General Diet the usual cake and pastry goods as follows:

Wednesday, September 7—Coffee cake.
Thursday, September 8—Biscuits.
Friday, September 9—Cookies.
Saturday, September 10—Ginger bread.
Monday, September 12—Biscuits.
Tuesday, September 13—Cookies.

Since these would have added to the appearance of the diet and, possibly, influenced the amount of food consumed, these facts are noted.

On the other hand, milk appears twice during the week in the diet studied, though it is not a regular constituent of the General Diet. When any was left over from its other uses, it was sent to the group experimented upon.

Table 2—Menus.

GENERAL DIET.

Breakfast.	Dinner.	Supper.
	THURSDAY, SEPT. 8.	
Oat meal. White bread. Coffee. Steamed potatoes.	Boiled cabbage. Beef stew. White bread. Butterine. Coffee.	Green beans and potatoes. White bread. Butterine. Tea.
	FRIDAY, SEPT. 9.	
Boiled rice. Steamed potatoes. White bread. Butterine. Coffee.	Vegetable soup. Crackers. Steamed potatoes. Creamed onions. White bread. Butterine.	Peach tapioca. White bread. Butterine. Tea.
	SATURDAY, SEPT. 10.	
Corn meal mush. Milk. Steamed potatoes. White bread. Butterine. Coffee.	Sausage. Navy beans. Beet pickles. White bread. Butterine. Coffee.	Rhubarb sauce. Macaroni and cheese. White bread. Butterine. Tea.
	SUNDAY, SEPT. 11.	
Boiled rice. Milk. White bread. Butterine. Coffee.	Boiled cabbage. Green beans. Peach pie. White bread. Butterine. Coffee.	Stewed prunes. White bread. Butterine. Tea.

Table 2—Continued.

CORN DIET.

Breakfast.	Dinner.	Supper.
	THURSDAY, SEPT. 29.	
Hominy.	Beef stew.	Stewed tomatoes.
Milk.	Cabbage.	Cheese.
White bread.	Canned corn.	Tapioca pudding.
Butterine.	Tomatoes.	Corn bread.
Coffee.	White bread.	Butterine.
	Butterine.	Tea.
	Coffee.	Milk.
	FRIDAY, SEPT. 30.	
Corn flakes.	Beef soup.	Stewed prunes.
Milk.	Crackers.	Corn starch pudding.
Beef stew.	Creamed potatoes.	Milk.
White bread.	String beans.	White bread.
Butterine.	Corn bread.	Butterine.
Coffee.	Butterine.	Ive cookies.
		Tea.
	SATURDAY, OCT. 1.	
Oat meal.	Sausage.	Stewed tomatoes.
Milk.	Navy beans.	Corn starch pudding.
Corn bread.	Bread pudding.	White bread.
Butterine.	Corn bread.	Butterine.
Coffee.	Butterine.	Ginger bread.
	Coffee.	Tea.
	SUNDAY, OCT. 2.	
Corn meal mush.	Boiled cabbage.	Lima beans.
Frankfurters.	Mashed potatoes.	Corn bread.
White bread.	Whole tomatoes.	Butterine.
Butterine.	Corn bread.	Rice pudding.
Coffee.	Butterine.	Milk.
	Squash pie.	Tea.
	Coffee.	

Table 2—Continued.

CORN-FREE DIET.

Breakfast.	Dinner.	Supper.
	THURSDAY, SEPT. 29.	
Boiled rice. Hot milk. Toast. White bread. Butterine. Coffee.	Beef stew. Cabbage. Macaroni and cheese. Tomatoes. White bread. Butterine. Coffee.	Stewed tomatoes. Cheese. Tapioca pudding. White bread. Raised rolls. Butterine. Tea. Milk.
	FRIDAY, SEPT. 30.	
Farina. Milk. Beef stew. White bread. Butterine. Coffee.	Beef soup. Crackers. Creamed potatoes. String beans. White bread. Butterine.	Stewed prunes. Spiced pudding. Milk. White bread. Butterine. Ive cookies. Tea.
	SATURDAY, OCT. 1.	
Oat meal. Milk. White bread. Butterine. Coffee.	Sausage. Navy beans. Bread pudding. White bread. Butterine. Coffee.	Stewed tomatoes. Chocolate pudding. White bread. Butterine. Ginger bread. Tea.
	SUNDAY, OCT. 2.	
Farina. Frankfurters. White bread. Butterine. Toast. Coffee.	Boiled cabbage. Boiled beef. Whole tomatoes. White bread. Butterine. Squash pie. Coffee.	Lima beans. White bread. Butterine. Rice pudding. Milk. Tea.

Table 2—Continued.

GENERAL DIET.

Breakfast.	Dinner.	Supper.
	MONDAY, SEPT. 12.	
Corn meal mush. Steamed potatoes. White bread. Butterine. Coffee.	Beef stew. Lentils. Onions. White bread. Butterine. Coffee.	String beans and potatoes. White bread. Butterine. Tea.
	TUESDAY, SEPT. 13.	
Boiled rice. Stewed prunes. White bread. Butterine. Coffee.	Vegetable soup. Crackers. Steamed potatoes. Navy beans. White bread. Butterine.	Cheese. Hominy. White bread. Butterine. Tea.
	[1]WEDNESDAY, SEPT. 7.	
Boiled rice. Steamed potatoes. White bread. Coffee.	Beef stew. Lima beans. Sliced cucumbers. White bread. Coffee.	Hominy. White bread. Cheese. Tea.

On Wednesday, September 7, and Thursday, September 8, (breakfast) no butterine was given because the supply had run out. On Wednesday, September 7, at supper, cheese was substituted for butterine. See also description of the diet regarding pastry goods.

Table 2—Continued.

CORN DIET.

Breakfast.	Dinner.	Supper.
	MONDAY, OCT. 3.	
Corn flakes. Milk. Beef stew. White bread. Butterine. Coffee.	Steamed potatoes. Lentils. Corn bread. Butterine. Toast in custard. Coffee.	Macaroni and tomatoes. Scalloped corn. White bread. Biscuits. Butterine. Tea.
	TUESDAY, OCT. 4.	
Oat meal. Milk. Corn bread. Butterine. Coffee.	Beef soup. Crackers. Baked potatoes. Stewed corn. White bread. Butterine.	Corn fritters. White bread. Butterine. Cocoanut pudding. Ive cookies. Tea.
	WEDNESDAY, OCT. 5.	
Hominy. Toast. Hot milk. Boiled beef. White bread. Butterine. Coffee.	Boiled cabbage. Boiled potatoes. Whole tomatoes. Corn bread. Butterine. Coffee.	Stewed prunes. White bread. Butterine. Corn starch pudding. Coffee cake. Tea.

Table 2—Concluded.

CORN-FREE DIET.

Breakfast.	Dinner.	Supper.
	MONDAY, OCT. 3.	
Oat meal. Milk. Beef stew. White bread. Butterine. Coffee.	Steamed potatoes. Lentils. White bread. Butterine. Toast in custard. Coffee.	Macaroni and tomatoes. Tapioca pudding. White bread. Biscuits. Butterine. Tea.
	TUESDAY, OCT. 4.	
Oat meal. Milk. White bread. Butterine. Coffee.	Beef soup. Crackers. Baked potatoes. Stewed tomatoes. White bread. Butterine.	Boiled rice. White bread. Butterine. Cocoanut pudding. Ive cookies. Tea.
	WEDNESDAY, OCT. 5.	
Farina. Toast. Hot milk. Boiled beef. White bread. Butterine. Coffee.	Boiled cabbage. Boiled potatoes. Whole tomatoes. White bread. Butterine. Coffee.	Stewed prunes. Baked tomatoes. White bread. Butterine. Coffee cake. Tea.

In addition, each of the three groups received six pounds of sugar per week. Syrup was supplied *ad libitum*, practically, a large can of it being kept in the dining room.

Plan of the Experiment.

The method used in this experiment was to determine accurately the quantities of food actually eaten by the group under observation, to take representative samples of the materials eaten, and analyze them chemically, and from the data thus obtained, to calculate the quantities of nutrients, energy, etc., actually consumed.

The system employed at the hospital for distributing the food made the work of weighing and of selecting the samples comparatively simple. The food for the entire institution is cooked in one kitchen and taken to the dining rooms in the cottages in metal boxes and containers. A complete set of such boxes and containers was secured, numbered, and reserved for the experiment. Each box or container was weighed before being used. At the same time that the food for the experimental cottage was placed in the weighed receptacle, a second portion ("duplicate") consisting of about half the amount of the first was placed in a second receptacle. Care was taken to have both portions alike. The food for the patients was weighed, taken to the cottage, and served in the usual manner. After the meal was finished, all untouched food was put back in the boxes or containers in which it came, all "leavings" were carefully collected and placed in an empty weighed can, and then both were returned to the kitchen and weighed. The amount of food used in each case was determined and from the "duplicate" portions, an aliquot part was weighed out for the sample.[1] The entire amount of waste food was taken for a sample.

[1] Salt, pepper, vinegar, and syrup were regularly kept in the dining room. It was necessary to weigh these only at the beginning and close of the experiment, or when the supply became exhausted (as in the case of the syrup), and take samples proportionate to the amounts used during the periods between the weighings.

In all cases composite samples were made of similar food materials as shown in Table 4.

The composite samples were placed in sterilized ten-gallon milk cans, or smaller receptacles for butterine and syrup, and kept in a cold storage room at low temperature (about 38° F.). Small quantities of formaldehyde and thymol were used for preservatives.

Data regarding the composite samples, the quantities of foods used, and the proportions taken for the samples, are tabulated on the following pages.

TABLE 4—DESCRIPTIONS OF COMPOSITE SAMPLES AND QUANTITIES OF FOOD USED IN DIETARY STUDY NO. 1—GENERAL DIET.

Laboratory No.	Food sample.	Date.	Meal.	Kind of food.	Weight of food used—Kilos.	Amount taken for composite equal to—
20039	Animal foods ..	Sept. 7	Dinner	Beef stew	14.07	One-fourth of amount used.
		..do	Supper	Cheese	3.29	
		Sept. 8	Dinner	Beef stew	15.43	
		Sept. 10	..do	Sausage	6.48	
		Sept. 12	..do	Beef stew	15.73	
		Sept. 13	Supper	Cheese	3.53	
	Total				58.53	
20040	Vegetable foods.	Sept. 7	Breakfast	Boiled rice	12.51	One-fourth of amount used.
		..do	..do	Steamed potatoes	6.15	
		..do	Dinner	Lima beans	12.15	
		..do	..do	Sliced cucumbers	5.94	
		..do	Supper	Hominy	14.76	
		Sept. 8	Breakfast	Steamed potatoes	7.23	
		..do	..do	Oatmeal	14.70	
		..do	..do	Sugar	1.05	
		..do	Dinner	Boiled cabbage	14.39	
		..do	Supper	Green beans and potatoes	22.47	
		Sept. 9	Breakfast	Boiled rice	14.56	
		..do	..do	Steamed potatoes	7.78	
		..do	Dinner	..do	11.70	
		..do	Supper	Sugar	1.22	
		Sept. 10	Breakfast	Corn meal mush	15.21	
		..do	..do	Steamed potatoes	6.86	
		..do	Dinner	Navy beans	16.86	
		..do	..do	Beet pickles	7.77	
		..do	Supper	Rhubarb sauce	13.33	
		Sept. 11	Breakfast	Boiled rice	24.07	
		..do	..do	Sugar	0.55	
		..do	Dinner	Boiled cabbage	7.99	
		..do	..do	Green beans.	15.90	
		..do	Supper	Stewed prunes	18.98	
		Sept. 12	Breakfast	Corn meal mush	11.51	
		..do	..do	Steamed potatoes	8.16	
		..do	Dinner	Lentils	5.21	
		..do	..do	Onions	3.08	
		..do	Supper	String beans and potatoes.	14.74	
		Sept. 13	Breakfast	Boiled rice	14.52	
		..do	..do	Stewed prunes	2.24	
		..do	Dinner	Steamed potatoes	7.17	
		..do	..do	Navy beans	14.75	
		..do	Supper	Hominy	18.68	
		Sept. 7–Sept. 13		Vinegar	0.62	
	Total				374.81	

Table No. 4—Continued.

Laboratory No.	Food sample.	Date.	Meal.	Kind of food.	Weight of food used—Kilos.	Amount taken for composite equal to—
20041	Bread	Sept. 7	Breakfast	White bread	6.25	One-eighth of amount used.
		..do	Dinner	..do	7.25	
		..do	Supper	..do	5.71	
		Sept. 8	Breakfast	..do	5.75	
		..do	Dinner	..do	6.37	
		..do	Supper	..do	6.14	
		Sept. 9	Breakfast	..do	5.75	
		..do	Dinner	..do	5.32	
		..do	..do	Crackers	2.04	
		..do	Supper	White bread	6.14	
		Sept. 10	Breakfast	..do	6.65	
		..do	Dinner	..do	5.65	
		..do	Supper	..do	6.20	
		Sept. 11	Breakfast	..do	6.10	
		..do	Dinner	..do	6.32	
		..do	Supper	..do	6.09	
		Sept. 12	Breakfast	..do	5.49	
		..do	Dinner	..do	6.74	
		..do	Supper	..do	7.36	
		Sept. 13	Breakfast	..do	7.06	
		..do	Dinner	..do	5.14	
		..do	..do	Crackers	1.52	
		..do	Supper	White bread	7.13	
	Total				134.17	
20042	Mixed foods	Sept. 9	Dinner	Creamed onions	10.30	One-fourth of amount used.
		..do	..do	Vegetable soup	18.47	
		..do	Supper	Peach tapioca	21.19	
		Sept. 10	..do	Macaroni and cheese	4.03	
		Sept. 11	Dinner	Peach pie	7.88	
		Sept. 13	..do	Vegetable soup	15.44	
	Total				77.31	
20044	Milk	Sept. 10	Breakfast	Milk	11.84	One-fourth of amount used.
		Sept. 11	..do	..do	12.23	
	Total				24.07	
20043	Coffee and tea	Sept. 7	Breakfast	Coffee	16.88	One-eighth of amount used.
		..do	Dinner	..do	16.56	
		..do	Supper	Tea	15.19	
		Sept. 8	Breakfast	Coffee	16.28	
		..do	Dinner	..do	12.86	
		..do	Supper	Tea	13.02	
		Sept. 9	Breakfast	Coffee	18.35	
		..do	Supper	Tea	15.27	
		Sept. 10	Breakfast	Coffee	16.11	
		..do	Dinner	..do	16.80	
		..do	Supper	Tea	13.24	
		Sept. 11	Breakfast	Coffee	15.05	
		..do	Dinner	..do	14.90	
		..do	Supper	Tea	12.94	
		Sept. 12	Breakfast	Coffee	18.18	
		..do	Dinner	..do	14.25	
		..do	Supper	Tea	13.50	
		Sept. 13	Breakfast	Coffee	18.95	
		..do	Supper	Tea	16.03	
	Total				294.36	

Table No. 4—Concluded.

Laboratory No.	Food sample.	Date.	Meal.	Kind of food.	Weight of food used—Kilos.	Amount taken for composite equal to—
20045	Butterine	Sept. 8	Dinner	Butterine	0.64	One-fourth of amount used.
		..do	Supper	..do	0.69	
		Sept. 9	Breakfast	..do	0.83	
		..do	Dinner	..do	0.74	
		..do	Supper	..do	0.71	
		Sept. 10	Breakfast	..do	0.78	
		..do	Dinner	..do	0.73	
		..do	Supper	..do	0.77	
		Sept. 11	Breakfast	..do	0.72	
		..do	Dinner	..do	0.81	
		..do	Supper	..do	0.74	
		Sept. 12	Breakfast	..do	0.81	
		..do	Dinner	..do	0.68	
		..do	Supper	..do	0.67	
		Sept. 13	Breakfast	..do	0.72	
		..do	Dinner	..do	0.67	
		..do	Supper	..do	0.77	
	Total				12.48	
20047	Syrup	Sept. 7-Sept. 10		Syrup	13.78	One-twenty-fifth of amount used.
		Sept. 10-Sept. 13		..do	12.66	
	Total				26.44	
20050	Salt	Sept. 7-Sept. 13.		Table salt	0.65	
20048	Waste food	Sept. 7	Breakfast	"Table waste"	2.47	Total amount taken for sample.
		..do	Dinner	..do	4.30	
		..do	Supper	..do	1.83	
		Sept. 8	Breakfast	..do	3.58	
		..do	Dinner	..do	4.61	
		..do	Supper	..do	4.30	
		Sept. 9	Breakfast	..do	3.04	
		..do	Dinner	..do	1.16	
		..do	Supper	..do	3.06	
		Sept. 10	Breakfast	..do	5.80	
	Total				34.15	
20049	Waste food	Sept. 10	Dinner	"Table waste"	1.07	Total amount taken for sample.
		..do	Supper	..do	1.57	
		Sept. 11	Breakfast	..do	1.80	
		..do	Dinner	..do	3.50	
		..do	Supper	..do	1.15	
		Sept. 12	Breakfast	..do	3.00	
		..do	Dinner	..do	1.52	
		..do	Supper	..do	0.83	
		Sept. 13	Breakfast	..do	0.76	
		..do	Dinner	..do	1.95	
		..do	Supper	..do	2.56	
	Total				19.71	

The experiment began with breakfast on Wednesday, September 7, and continued through supper on Tuesday, September 13, lasting one whole week.

After the samples were all collected, coffee and tea, milk, and butterine were immediately prepared for analysis by thoroughly mixing and taking a two quart portion of each. The remaining samples, contained in nine ten-gallon milk cans, were shipped to the laboratory by express. Immediately after arriving there, they were ground in a meat cutter, and thoroughly mixed, in preparation for the analytical work.

METHODS OF ANALYSIS.

Moisture, protein, fat, ash, and phosphorus were determined in the fresh samples. Carbohydrates were calculated by difference from the other values.

Protein was found by multiplying the total nitrogen value by the factor 6.25. Total nitrogen was determined by the Kjeldahl-Sherman method.

Moisture was estimated by drying 5 to 10 grams of the sample *in vacuo* over sulphuric acid to constant weight.

Fat was determined by extracting the dried material from the moisture determination with anhydrous ether for 72 hours in a Soxhlet apparatus, and weighing the extract thus obtained.

In estimating the percentage of ash or mineral matter, a suitable sample (12 to 20 grams) was dried and charred at low heat. The charred mass was extracted with water. The insoluble residue was dried and burned in a muffle furnace to remove all organic matter. The water extract was then added to the burned residue, evaporated to dryness, and the combined mass was ignited at a low red heat until the ash was white or gray, and until constant weight had been obtained.

The difference between the total dry substance and the sum of protein, fat, and ash was taken for the carbohydrate value.

Phosphorus was determined in the residue from the ash determination. The ash was treated with concentrated nitric acid on the water bath. The mixture was diluted and filtered. The phosphorus was first precipitated with acid ammonium molybdate solution. This precipitate was dissolved in ammonia and the phosphorus was reprecipitated as magnesium ammonium phosphate. It was weighed as the pyrophosphate.

All determinations were made in triplicate, and, except when the difference was very great, the average of all three values was taken.

The fuel energy value of the diet was calculated by multiplying the number of grams of protein and carbohydrates by four and the number of grams of fat by 8.9, these factors representing the available fuel value of the nutrients per gram total nutrients. (Atwater.)

Food Consumption.

The percentage composition of the various composite samples, and the total quantities of nutrients contained in the food used, wasted, and actually eaten, are summarized in Table 6. The quantities consumed per man per day were found by dividing the total quantities consumed by the average daily population of the cottage multiplied by seven. The average daily population varied somewhat from day to day on account of transfers to and from other wards. The number of subjects composing the group, who received their meals only in the dining room where the experiment was carried on, is shown in the following table:

Table 5. Number of Subjects.—Dietary Study No. 1.

Date.	Breakfast.	Dinner.	Supper.	Average.
Wednesday, September 7	54	54	53	53 2-3
Thursday, September 8	53	53	52	52 2-3
Friday, September 9	53	53	53	53
Saturday, September 10	53	53	53	53
Sunday, September 11	53	53	53	53
Monday, September 12	53	53	53	53
Tuesday, September 13	53	53	53	53
Average for week	.....	.....	.....	53 1-21

The average quantities of nutrients actually consumed per man per day were found to be: Protein, 73.51 grams; carbohydrates, 444.34 grams; and fat, 55.77 grams. The total fuel value of these amounts is 2568 calories. Each man ingested per day 23.23 grams mineral substance (ash), 1.07 grams of which were phosphorus.

INTAKE PER KILO BODY WEIGHT.

The subjects of this group were not weighed during the time of this experiment. They are, however weighed twice a month by the attendants in charge of the cottage. Such weights for September 1 and September 15 were secured and averaged with the following results. The average weight of the group on September 1 was 148.0 pounds, or 67.3 kilos; on September 15, 147.2 pounds, or 66.9 kilos. It is probably safe to assume that the mean of these two values, 67.1 kilos, is not far from the average weight of the group during the time of the experiment. Accepting it as the average weight, the intake of the various nutrients, energy, and mineral substances per kilo body weight per day was found to be: protein, 1.10 grams; carbohydrates, 6.62 grams; fat, 0.83 gram; energy, 38.3 calories; ash, 0.35 gram; phosphorus, 0.016 gram.

TABLE NO. 6—SUMMARY. DIETARY STUDY NO 1. GENERAL DIET.

Laboratory No.	Food material.	Weight of food used—Kilos.	Protein.		Carbohydrates.		Fat (ether extract).		Fuel value—Calories.	Ash (mineral matter).		Phosphorus.	
			Per cent.	Quantity—Grams.	Per cent.	Quantity—Grams.	Per cent.	Quantity—Grams.		Per cent.	Quantity—Grams.	Per cent.	Quantity—Grams.
20039	Animal foods	58.53	13.99	8,188.35	3.59	2,101.23	12.33	7,216.75	.....	2.12	1,240.84	0.162	94.82
20040	Vegetable foods	374.81	1.87	7,008.95	16.26	60,944.11	0.37	1,386.80	.....	1.09	4,085.43	0.041	153.67
20041	Bread	134.17	8.49	11,391.03	57.40	77,013.58	0.63	845.27	.....	1.19	1,596.62	0.095	127.46
20042	Mixed foods	77.31	1.96	1,515.28	15.11	11,681.54	1.42	1,097.80	.....	0.97	749.91	0.036	27.83
20043	Coffee and tea	294.36	0.04	117.74	0.99	2,914.16	0.03	88.31	.....	0.06	176.62	.....	.....
20044	Milk	24.07	3.12	750.98	4.96	1,193.87	2.56	616.19	.....	0.74	178.12	0.094	22.63
20045	Butterine	12.48	0.44	54.91	.....	.....	88.21	11,008.61	.....	3.30	411.84	0.014	1.75
20047	Syrup	26.44	0.16	42.30	76.17	20,139.35	0.07	18.51	.....	1.25	330.50	0.007	1.85
20050	Salt	0.65	.....	.....	.....	.....	.....	.....	.....	99.75	648.37	.....	.....
	Total in food used	.....	.....	29,069.54	.....	175,987.84	.....	22,278.24	.....	.....	9,418.25	.....	430.01
20048	Waste food	34.15	3.18	1,085.97	19.62	6,700.23	2.73	932.30	.....	1.37	467.86	0.064	21.86
20049	Waste food	19.71	3.48	685.91	21.77	4,290.87	3.24	638.60	.....	1.64	323.24	0.047	9.26
	Total in waste food	.....	.....	1,771.88	.....	10,991.10	.....	1,570.90	.....	.....	791.10	.....	31.12
	Amount actually consumed[1]	.....	.....	27,297.66	.....	164,996.74	.....	20,707.34	.....	.....	8,627.15	.....	398.89
	Average—per man per day	.....	.....	73.51	.....	444.34	.....	55.77	2,568	.....	23.23	.....	1.07
	Average—per kilo body weight[2]	.....	.....	1.10	.....	6.62	.....	0.83	38.3	.....	0.35	.....	0.016

[1] Net amount for 7 days, 53 1-21 subjects.
[2] Average weight of subjects, 67.1 kilos.

TABLE NO. 7—SUMMARY OF DIETARY

Description.	Investigator.
Scotch almshouses for pauper lunatics	Dunlop
Excessive dietaries—males—average 11 studies	
Dietaries approximating standards—males—average 13 studies	
Deficient dietaries—males—average 15 studies	
Excessive dietaries—females—average 25 studies	
Dietaries approximating standards—females—average 8 studies	
Deficient dietaries—females—average 6 studies	
Average male dietaries	
Average female dietaries	
Kankakee Asylum—per person per day	Wentworth
Northern Michigan Asylum—per person per day	Munson
Boston institutions	Richards
Austin Farm—inmates and employés	
Pierce Farm—inmates and employés	
New York State Hospitals for the Insane	Atwater
Binghamton Hospital	
Buffalo Hospital	
Hudson River Hospital	
Long Island Hospital	
Manhattan Hospital	
Middletown Hospital	
Rochester Hospital	
St. Lawrence Hospital	
Utica Hospital	
Willard Hospital	
Average preceding ten	
Dietary studies—Long Island, Willard and St. Lawrence Hospitals	Atwater
Chronic patients—infirm males—average 8 studies	
Chronic patients—infirm females—average 7 studies	
Light workers and disturbed—males—average 2 studies	
Light workers and disturbed—females—average 4 studies	
Restless, active, disturbed—males—average 2 studies	
Restless, active, disturbed—females—average 4 studies	
Workers—males—average 10 studies	
Workers—females—average 3 studies	
Acute, recent admissions—males—average 2 studies	
Acute, recent admissions—females—average 2 studies	
Acute and sick chronic—males—average 2 studies	
Acute and sick chronic—females—average 2 studies	
Connecticut Hospital for the Insane	Atwater
Patients, quiet, demented (males, 184; females, 205) and employés (males, 13; females, 20)	
Patients, (males, 268; females, 285) and employés, (males, 45: females, 52)	
Government Hospital, Washington, D. C	Pratt and Milner
Dietary studies with patients. Middle to old age, largely chronic, orderly and quiet—few workers—average 10 studies	
Acute, nervous and disturbed—non-workers—average 3 studies	
Negroes, non-workers, alone } (one study, values for sub-groups estimated)	
Negroes, workers alone }	
Sick, infirm, and bed-ridden, average 2 studies	
Some curable, part workers, younger and more active class, average 2 studies	
Better class, on "first section diet", average 2 studies	
Unclassified, average 2 studies	
Average of all patients	

STUDIES IN INSTITUTIONS FOR THE INSANE.

Reference number.	Number of subjects.	Nutrients. Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Energy—Calories.	Remarks.
1						Probably ration allowance.
		149			3,789	
		136			3,340	
		119			2,998	
		119			3,057	
		108			3,695	
		95			2,488	
					3,335	
					2,890	
2		111	108	429		Total food supply less 10 per cent for waste.
2		114	112	460		
3						Calculated from food supply.
		110	114	449	3,327	
		138	180	471	4,171	
4						Calculated from food supplies and average population, 1897-98. Quantities per day. Total waste amounted to ¼ to ½ but not allowed for in figures given.
		113	139	439	3,555	
		110	142	414	3,470	
		116	144	403	3,470	
		111	135	425	3,455	
		121	141	517	3,930	
		106	130	342	3,045	
		108	132	379	3,225	
		129	148	513	4,010	
		109	131	398	3,295	
		110	130	437	3,450	
		113	137	427	3,490	
6						Quantities per person per day in food actually eaten.
		69	63	332	2,230	
		52	49	238	1,645	
		73	65	345	2,318	
		56	53	243	1,719	
		95	81	391	2,746	
		58	59	278	1,926	
		103	91	404	2,925	
		51	65	227	1,744	
		65	86	363	2,555	
		35	54	175	1,363	
		66	80	364	2,507	
		48	73	251	1,905	
7						Quantities per person per day in food actually eaten.
		84	84	377	2,675	
		84	116	334	2,790	
8						All studies with male patients. Quantities per man per day in food actually eaten.
	952	88	105	370	2,767	
	94	84	97	350	2,599	
	89	90	73	348	2,402	
	80	108	96	352	2,694	
	166	97	106	297	2,519	
	59	104	125	347	2,917	
	22	125	149	393	3,398	
	127	76	86	385	2,609	
		90	102	359	2,704	

Table No. 7

Description.	Investigator.
Baltimore institutions, Bayview Almshouse	Knight, Pratt and Langworthy
Regular inmates, males	
Chronic inmates, males	
Receiving ward inmates, males	
Average three studies (males)	
Women inmates, per woman per day	
Women inmates, per man per day basis	
Average four studies	

—Concluded.

Reference number.	Number of subjects.	Nutrients.				Remarks.
		Protein—Grams.	Fat—Grams.	Carbohydrates—Grams.	Energy—Calories.	
9	.....	.....	.....	.....	.....	In food actually eaten.....
.....	136	144	.....	.....	2,901	
.....	82	93	.....	.....	2,076	
.....	82	111	.....	.....	2,274	
.....	.....	121	.....	.....	2,504	
.....	111	85	.....	.....	1,924	
.....	111	106	.....	.....	2,405	
.....	411	117	.....	.....	2,453	

Discussion of Dietary Study No. 1. General Diet.

Food requirements of the insane.

In Table 7 is given a summary of the results of dietary studies obtained by other investigators in hospitals and institutions for the insane, both in this country and in Europe. Compared to the vast amount of work that has been done in the scientific study of the nutrition of man in health, or even to the investigations of the food supplies of public institutions in general, but little has been accomplished in this direction in the institutions for the insane. Of the dietary studies here summarized, not all are comparable to each other or to those described in this report. Practically all of the earlier results represent food supplies or ration allowances and were determined from the statistics of the food supplies and average populations taken from the books of the institutions. They do not present any accurate data regarding actual food consumption and therefore are hardly comparable to the results based on experimental dietary studies. In some cases, allowances for shrinkage and waste are made, but losses due to these causes can be determined accurately only by actual experiment.

The differences that the method of study makes in the results obtained is illustrated very well by the values obtained by Atwater. In the beginning of the work in the New York Hospitals, he calculated the values of the food supplied per person per day in each of the state hospitals. (4.) Later, he conducted experimental dietary studies in several of the hospitals and, from the results, estimated the average consumption of nutrients and energy per person per day (6). The first results were about 33 1-3 percent higher than the others. An inspection of the data in Table No. 7 shows these differences at once.

Among the results summarized, those of Dunlop (1) Wentworth (2) Munson (2) and Richards (3) are based on statistics of food supplies and populations taken from the books of the institutions. In no case was the amount of food eaten found by actual dietary studies.

Eliminating these from further consideration, there are left the results reported by Atwater (4, 5, 6, and 7), Pratt and Milner (8), and Knight, Pratt, and Langworthy (9). These are based on accurate dietary studies in which the food actually eaten was weighed. The composition of the foods, however, was assumed from previous analyses of similar materials. On the whole, they are comparable to the best of the large number of dietary studies made in this country and abroad. In fact, they form a part of the extensive nutrition investigation of the United States Department of Agriculture, that part dealing with the dietaries of public institutions. They are extensive in themselves and represent the most accurate and complete information available concerning dietetics as related to hospitals for the insane.

Basing his conclusions upon the results obtained in the New York hospitals, Atwater has proposed the following standard dietary for insane institutions; 85 grams protein and 2500 calories per person per day or 100 grams protein and 2950 calories per man per day. These quantities are greater than those that actually would be consumed and allow for a satisfactory margin over the actual needs. They are supposed to represent the physiological demands of the whole population, including employees, and are not ration allowances. The ration allowance should contain an additional amount sufficient to cover losses due to shrinkage and waste.

Whether or not Atwater's standard is adequate, is a fact that has not yet been proved. Much work is needed before it can be accepted with any degree of finality. It has been based on the assumption that the food requirements of the insane are governed by the same factors as are those of people in health, the chief of which is work or physical activity. The concensus of opinion among those who have studied the nutrition of the insane is that this assumption holds. Atwater is inclined to think that the physiological demand of the insane for nourishment is on the whole smaller than that of normal people with corresponding physical activity.

This is stated not as a fact tried and proved but merely as a general observation based upon the results obtained in the New York hospitals. He has discussed the subject at some length and has endeavored to classify the patients in his studies according to their physical activity. This theory assumes that mind plays an inferior role in metabolism. The relation of mind to food consumption is little known. It has been declared recently that the chief function of the brain is to regulate metabolism. No clear evidence of this fact is at hand, however. According to L. Mohr in Van Noorden's "Metabolism and Practical Medicine" (10), much clinical evidence has been accumulated to show that nervous and mental diseases play an important part in many disorders of metabolism but the experimental data are of little value owing to difficulties of technique. In general, it is difficult to determine whether the disturbance of metabolism is due to the nervous disorder or whether the disorder is due to the metabolic disturbance. It has been shown that mental activity itself probably does not influence metabolism, or, if it does, changes caused by it are too small to be measured.

What are needed in this very important problem, are thorough and complete metabolism experiments. Such work would no doubt be exceedingly difficult, considering the character of the subjects, but until it is done no clear idea of the food requirements of the insane can be had.

ADEQUACY OF THE GENERAL DIET.

The nutritive values of the food consumed in the first study at the Peoria hospital, 73.51 grams of protein, and 2,568 calories per man per day, are considerably lower than the standard proposed by Atwater, 100 grams protein and 2,950 calories per man per day. This standard, however, was based on a food consumption (calculated) of 73 grams protein and 2,305 calories per person per day, quantities which would be equivalent to about 86 grams protein and 2,700 calories per man per day. These figures are for the entire hospital population, including employés. Compared to the results obtained with certain individual groups of patients in Atwater's work, the values found in this study assume a different position. A class of patients in the New York hospitals to which the group receiving the general diet might be compared favorably, is the one described as "light workers and disturbed." This class consumed 73 grams of protein and 2,318 calories per man per day, practically the same quantity of protein but 250 calories energy less than was eaten by the patients on the general diet. In the Connecticut hospital (Atwater 7), the values obtained, 84 grams of protein and 2,675 calories and 84 grams protein and 2,790 calories, are somewhat larger than those reported here, but the studies there included employés and it is safe to assume that the patients received less on the average than the quantities reported. The average of the studies with patients at the Government Hospital at Washington, D. C., was 90 grams protein and 2,704 calories per man per day. The fact that the diets in this institution are better than those usually found in public institutions of this kind would account for a higher food consumption. At the Baltimore almshouse, the average of three studies with men was 121 grams protein and 2,504 calories per man per day, a very much higher protein content than that found in the diet here reported.

It is difficult to make fair comparisons of the results reported in the investigations referred to. Differences in the classifications of subjects, in the character of the diets, and in the methods used, account, in part, for the lack of uniformity in the results. On the whole, the diet here studied contains less nutrients than the others and is low especially in protein.

Dietary standards, for adults in health to which, on the basis of physical activity, the values obtained with the General Diet might be compared, are represented by the following, taken from Atwater's series.

	Per man per day.	
	Protein—Grams.	Energy—Calories.
Man with moderately active muscular work	125	3,400
Man with light to moderate muscular work	112	3,050
Man with sedentary work	100	2,700
Man with very little exercise	90	2,450

Compared to these, 73.5 grams protein and 2,568 calories, the values here reported, appear deficient.

Whether the large quantities of protein and energy called for by the dietary standards are necessary is a question that has received considerable discussion quite recently. Many investigators have been able to maintain nitrogen equilibrium on quantities of protein much smaller than the standard requirements and with varying amounts of energy producing nutrients. The work of these investigators has been compiled and discussed by Magnus-Levy (11). In many of the experiments, a low protein intake was accompanied by a high energy value. Most of the experiments were conducted for short periods, "and do not quite correspond to the conditions of daily life." Foremost among the low protein advocates is Chittenden (12). His work is not open to the criticism of the others for his diets were normal with regard to the energy content and his experiments extended over long periods and were conducted with a large number of subjects of different types with respect to occupation and physical and mental activity. Chittenden's conclusions were that "a daily metabolism of proteid matter equal to an exchange of 0.10-0.12 gram of nitrogen per kilogram of body weight is quite adequate for physiological needs, provided a sufficient amount of non-nitrogenous foods —fats and carbohydrates—is taken to meet the energy requirements of the body." In terms of protein, this amounts to 0.62 to 0.75 gram per kilo body weight. The required intake of protein is placed at 0.85 gram, and of energy at 40 calories, per kilo body weight for the average man. On this basis, the General Diet contains an excess of protein, supplying 1.10 grams per kilo body weight.

Regarding low protein diets, Magnus-Levy says: "It will be willingly granted by all that a greater simplicity of diet, and a reduction of the protein intake, may be of the greatest benefit, especially in the case of individuals who are in the habit of eating too much. In the case of those suffering from illness, the liver, kidneys, and perhaps above all, the nervous system, may be injuriously affected by such a diet."

In the nutrition investigations carried on at the University of Illinois in 1906 and 1907 under the direction of Grindley (13), with men in normal health, results were obtained which are intermediary between the high and low standards discussed above. The average consumption of nutrients and energy of twenty-one men for a period of 220 consecutive days, on a normal diet and under normal conditions of living, was as follows: protein, 83 grams; fat, 130.9 grams; carbohydrates, 368 grams; energy, 307 calories. Per kilo body weight, 1.25 grams protein and 46.2 calories energy were ingested per day. These quantities were amply sufficient to maintain a positive nitrogen balance and, practically, constant body weight. In other words, they were entirely adequate to the needs of the men. Compared to these values, the quantities ingested by the patients on the General Diet under discussion are deficient, both in protein and energy.

In many of the dietary studies, the fact that the subjects left food which they might have eaten has been taken as an indication that the food they did eat was sufficient for their requirements. In this study there was left uneaten food (waste food) containing, per man per day, 4.77 grams protein, 29.6 grams carbohydrates, and 4.23 grams fat, equivalent to 175 calories

energy. It might appear from this that the quantities actually eaten were entirely adequate. On the other hand, the food consumption is influenced by other factors than the amount supplied. The character of the food exerts a decided influence both on the total quantity eaten and on the relative amounts of nutrients ingested. That a diet on a higher plane will cause a greater ingestion of nutrients is shown by the results of the other dietary studies at the Peoria State Hospital where the Corn and Corn-free Diets were used.

The need of more knowledge regarding the dietetic requirements of the insane has been pointed out above. Until more is known regarding them, it is difficult to say whether the food eaten in this study was adequate to the demands of the subjects or not. On the whole, it probably was. It must be remembered, however, that the values obtained represent average consumption of a considerable number of men. How many of these received more than the figures indicate and how many received less, it is impossible to say. If any received much less than the average amounts it would seem that they were very likely receiving too little. For the protection of such, it seems best to insist upon a generous supply for the entire group.

Not all the food that is ingested is digested and utilized by the body. Animal foods are, as a rule, more digestible than vegetable foods. On the ordinary mixed diet, it is generally considered that 92 per cent of the protein and 91 percent of the energy are capable of being utilized by the body. Captain McCay (14) in his work on the Bengal jail dietaries, found that only about 50 percent of the protein was metabolized on a purely vegetable diet. Other conditions influence the digestion and utilization of the ingested nutrients, e. g., the care with which the food has been prepared, the degree of mastication, and certain pathological conditions, including, possibly, insanity or certain forms of it. Just what proportion of the diet studied in this investigation was available could only be determined by actual metabolism experiments. It would be of interest, however, to determine the source of the various nutrients.

DISTRIBUTION OF NUTRIENTS.

Such information is summarized in Table 8. Here the distribution of the various nutrients among the different foods and classes of foods is given quantitatively and proportionately. It will be noticed that the percentages are based on *total food used* and not on the *amount actually consumed.* It was impossible to separate the waste food into its components and, therefore, the sources of the nutrients in the waste and also in the food actually consumed cannot be definitely determined. It is very probable, however, that the differences in the composition of the waste, compared to the total food used, are not sufficient to alter the values obtained very much, and that the percentage figures represent the character of the diet quantitatively.

The foods are classified according to their origin, i. e., vegetable or animal. Such classification is not absolute, however, for the samples were taken from cooked foods which contain materials derived from both sources. Total animal foods include milk and the foods designated *animal foods* (meat and cheese). Total vegetable foods include syrup, coffee and tea, broad, and the miscellaneous foods chiefly of vegetable origin. Total mixed foods include butterine[1] and other substances which contain appreciable amounts of both animal and vegetable material. Table salt occupies a place by itself in the table.

[1] The butterine used was an oleomargerine which contained cottonseed oil.

TABLE 8—DISTRIBUTION OF NUTRIENTS. DIETARY STUDY NO. 1. GENERAL DIET.

Laboratory No.	Food material.	Fresh food.			Dry substance.			Protein.			Carbohydrates.		
		Quantity—Kilos.	Per cent of total.	Per man per day—Grams.	Quantity—Kilos.	Per cent of total.	Per man per day—Grams.	Quantity—Grams.	Per cent of total.	Per man per day—Grams.	Quantity—Grams.	Per cent of total.	Per man per day—Grams.
20039	Animal foods	58.53	5.84	.....	18.75	7.92	.....	8,188.35	28.17	.....	2,101.23	1.19	.....
20044	Milk	24.07	2.40	.....	2.74	1.16	.....	750.98	2.58	.....	1,193.87	0.68	.....
	Total animal foods	82.60	8.24	222.44	21.49	9.08	57.86	8,939.33	30.75	24.07	3,295.10	1.87	8.87
20040	Vegetable foods	374.81	37.38	.....	73.42	31.03	.....	7,008.95	24.11	.....	60,944.11	34.63	.....
20041	Bread	134.17	13.38	.....	90.85	38.39	.....	11,391.03	39.19	.....	77,013.58	43.76	.....
20043	Coffee and tea	294.36	29.35	.....	3.30	1.39	.....	117.74	0.40	.....	2,914.16	1.66	.....
20047	Syrup	26.44	2.64	.....	20.53	8.68	.....	42.30	0.15	.....	20,139.35	11.44	.....
	Total vegetable foods	829.78	82.75	2,234.61	188.10	79.49	506.56	18,560.02	63.85	49.98	161,011.20	91.49	433.61
20042	Mixed foods	77.31	7.71	.....	15.04	6.36	.....	1,515.28	5.21	.....	11,681.54	6.64	.....
20045	Butterine	12.48	1.24	.....	11.34	4.79	.....	54.91	0.19	.....	.....	.....	.....
	Total mixed foods	89.79	8.95	241.81	26.38	11.15	71.06	1,570.19	5.40	4.23	11,681.54	6.64	31.46
20050	Salt	0.65	0.06	1.75	0.65	0.27	1.75	.....	.....	.....	.....	.....	.....
20048	Total food used	1,002.82	100.00	2,700.62	236.62	100.00	637.22	29,069.54	100.00	78.28	175,987.84	100.00	473.94
20049	Waste food	53.86	5.37	145.05	15.12	6.39	40.73	1,771.88	6.10	4.77	10,991.10	6.25	29.60
	Amount actually consumed	948.96	94.63	2,555.57	221.50	93.61	596.49	27,297.66	93.90	73.51	164,996.74	93.75	444.34

Table 8—Concluded.

Laboratory No.	Food material.	Fat.			Fuel value.		Ash.			Phosphorus.		
		Quantity—Grams.	Per cent of total.	Per man per day—Grams.	Per cent of total.	Per man per day—Calories.	Quantity—Grams.	Per cent of total.	Per man per day—Grams	Quantity—Grams.	Per cent of total.	Per man per day—Grams.
20039	Animal foods	7,216.75	32.39	.....	.....	.....	1,240.84	13.17	.....	94.82	22.05	0.26
20044	Milk	616.19	2.77	.....	.....	.....	178.12	1.89	.....	22.63	5.26	0.06
	Total animal foods	7,832.94	35.16	21.09	11.63	319	1,418.96	15.06	3.82	117.45	27.31	0.32
20040	Vegetable foods	1,386.80	6.22	.....	.....	.....	4,085.43	43.37	.....	153.67	35.74	0.41
20041	Bread	845.27	3.79	.....	.....	.....	1,596.62	16.95	.....	127.46	29.64	0.34
20043	Coffee and tea	88.31	0.40	.....	.....	.....	176.62	1.87	.....	.....	.....	.....
20047	Syrup	18.51	0.08	.....	.....	.....	330.50	3.51	.....	1.85	0.43	0.01
	Total vegetable foods	2,338.89	10.49	6.30	72.58	1,991	6,189.17	65.71	16.67	282.98	65.81	0.76
20042	Mixed foods	1,097.80	4.93	.....	.....	.....	749.91	7.96	.....	27.83	6.47	0.07
20045	Butterine	11,008.61	49.41	.....	.....	.....	411.84	4.37	.....	1.75	0.41	0.01
	Total mixed foods	12,106.41	54.34	32.60	15.79	433	1,161.75	12.33	3.13	29.58	6.88	0.08
20050	Salt	.....	.....	.....	.....	.....	648.37	6.88	1.75	.....	.....	.....
	Total food used	22,278.24	100.00	60.00	100.00	2,743	9,418.25	100.00	25.36	430.01	100.00	1.16
20048 20049	Waste food	1,570.90	7.05	4.23	6.38	175	791.10	8.40	2.13	31.12	7.24	0.08
	Amount actually consumed	20,707.34	92.95	55.77	93.62	2,568	8.627.15	91.60	23.23	398.89	92.76	1.07

Without going into details, the information offered by table 8 may be stated in a few words. By far the greater proportion of the food energy and nutrients, with the exception of the fat were derived from the total vegetable foods. In the case of fat, butterine, classed with the total mixed foods, supplied nearly half the total amount. The vegetable nature of the diet is apparent.

A few explanations of some of the results are in order. Small quantities of protein are attributed to coffee and tea, and syrup. The protein values were obtained by multiplying the total nitrogen values by the factor 6.25. Now, all the nitrogen of the tea and coffee, and syrup, as well as some of practically all other foods, is not derived from protein material. However, the error introduced in this way is very small and since it is not usually taken into consideration in dietary studies, no attempt has been made to correct it here.

The values for fat represent crude fat or ether extract and are probably somewhat greater than they should be. The small quantities of ether extract from coffee and tea and from syrup are included with fat, although for the greater part, it probably is made up of other substances.

The total animal foods are represented as supplying 1.87 percent of the total carbohydrates. A large part of this is derived from the milk, some probably from the cheese and a considerable portion from the flour added to beef stew in making the gravy. The last, of course, is derived from vegetable sources. The carbohydrates attributed to coffee and tea are probably derived entirely from the sugar added to these in the preparation.

DISTRIBUTION OF DIFFERENT FOOD MATERIALS AND NUTRIENTS IN THE AVERAGE AMERICAN DIET.

In connection with the dietary studies made under the auspices of the United States Department of Agriculture, the data from about 400 dietary studies have been summarized and arranged to show "the proportionate amounts of different foods which make up the diet of the average American home and the relative proportion of the total nutrients and energy which the principal foods and food groups supply." The data in the following table are abstracted from this information given by Langworthy (32).

TABLE 9—PROPORTIONS OF NUTRIENTS FURNISHED BY DIFFERENT FOOD MATERIALS IN THE AVERAGE AMERICAN DIETARY.

Food material.	Total food—Per cent.	Protein—Per cent.	Fat—Per cent.	Carbohydrates—Per cent.
Animal foods—				
Total meats	16.0	29.7	58.8	.....
Fish	1.8	3.5	1.0	.....
Eggs	2.1	4.1	2.9	.....
Total dairy products	18.4	10.0	25.7	3.6
Unclassified animal foods	0.2	0.2	0.2	0.3
Total animal foods	38.5	47.5	88.6	3.9
Vegetable foods—				
Total cereals	30.6	40.0	9.1	61.8
Sugar, molasses, etc	5.4	.....	.....	17.6
Legumes, tubers, and other vegetables	20.3	8.7	1.0	12.0
Fruits (including nuts)	4.4	0.5	0.5	3.7
Unclassified vegetable foods	0.5	0.1	0.2	0.7
Total vegetable foods	61.2	52.3	10.8	95.7
Miscellaneous food material	0.3	0.2	0.6	0.4
Total food material	100.0	100.0	100.0	100.0

COMPARISON OF THE AVERAGE DIET AND THE GENERAL DIET.

Comparing these values with similar ones for the diet studied in this investigation, the vegetable nature of the latter is apparent. In the average American dietary, the total animal foods constitute 38.5 percent and the total vegetable foods 61.2 percent of the total food material. In this diet, only 8.24 percent of the total food consists of animal foods, and 82.75 percent of vegetable foods. It might be expected that a diet containing such a large proportion of vegetable foods would be less digestible than the average American diet. On the other hand, since the total energy of the diet, 2568 calories per man per day, is not excessive, the result of the low proportion of animal foods may be simply to decrease the nutritive value of the diet, and, primarily, the protein content. In the absence of data regarding the digestibility and availability of such a diet as this, it would be best to accept the second view and to conclude not that there is an excess of vegetable foods but that there is possibly a deficiency in animal foods.

An increase of animal foods to a level approaching that of the average American diet would increase the protein content, primarily, and also the energy value. An increase in the fuel value would not be objectionable. A larger quantity of protein would be desirable. In the average American dietary, the animal foods supply 47.5 percent and the vegetable foods 52.3 percent of the total protein. In the nutrition investigations conducted recently at the University of Illinois and referred to above (13), 61.0 percent of the total ingested protein was derived from animal foods. This was the average value for the entire experiment (21 men—220 days). The coefficient of digestibility of protein for the entire experiment was 90.55 percent. In the diet here reported, only 30.75 percent of the total protein was derived from animal foods and 79.49 percent from vegetable foods.

If an increase in animal foods were made, the added material need not necessarily be meats, although this diet does not contain an excessive amount of such foods. Milk, dairy products, and eggs are excellent food materials. The cost might be an objection to their use, but it is certain that they might be added to the diet, in small quantities at least, to great advantage.

Dietary Study No. 2—Corn Diet.

Two groups of patients at the institution received special diets known as the Corn and Corn-free Diets. The Corn-free Diet, as the name indicates, contained no corn products or corn foods of any kind. The Corn Diet, on the other hand contained a considerable quantity of foods derived from corn such as corn bread, corn meal mush, puddings and custards made from corn starch, etc. The purpose of feeding these diets was to determine the relation of corn and corn products to pellagra. At the time of this study, the groups had received these diets for about one year.

The primary object of the studies on these diets was to determine their nutritive value. Since they were both on a somewhat higher plane of nutrition than the General Diet, any information regarding their utilization, compared to that of the General Diet, must necessarily be of interest and value.

It was planned to conduct studies on both diets simultaneously, but this plan was found to be impracticable and the study on the Corn Diet alone was completed.

THE DIETS.

The menus for the week of the study for both Corn and Corn-free Diets are arranged parallel to those for the General Diet during the week it was studied, in Table No. 2. It will be noticed at once that the Corn and Corn-free Diets were much superior to the General Diet.

THE PATIENTS.

The following description is taken from the report of Dr. Rachel A. Watkins, the physician in charge of the two groups during the year that

they were receiving the special diets. The patients were selected from the "medium of the demented, untidy class, ranging in age from 21 to 79 years, with an average of 45 years. Most of them showed more or less marked dementia with fairly good physical condition making a fair average of the demented asylum inmate."

The fifty-six patients receiving the Corn Diet were weighed by the attendants on October 6. The weights ranged from 106 to 206 pounds. The average for the group was 138 pounds or 62.7 kilos.

PLAN OF THE EXPERIMENT.

This study was conducted in practically the same manner as the first. A separate sample was made of the foods containing corn or corn products of any kind. Otherwise the samples were composited as before. Data regarding the weights of foods used, composite samples, and proportions of foods used taken for samples are tabulated on the following pages.

TABLE 9—DESCRIPTION OF COMPOSITE SAMPLES AND QUANTITIES OF FOOD USED IN DIETARY STUDY NO. 2—CORN DIET.

Laboratory No.	Food sample.	Date.	Meal.	Kind of food.	Weight of food used—Kilos.	Amount taken for composite sample equal to—
20051	Animal foods	Sept. 29	Dinner	Beef stew	14.75	One-fourth of amount used.
		..do	Supper	Cheese	3.36	
		Sept. 30	Breakfast	Beef stew	14.34	
		Oct. 1	Dinner	Sausage	7.40	
		Oct. 2	Breakfast	Frankfurters	4.11	
		Oct. 3	..do	Beef stew	14.01	
		Oct. 5	..do	Boiled beef	15.59	
	Total				73.56	
20056	Milk	Sept. 29	Breakfast	Milk	7.85	One-eighth of amount used.
		..do	Supper	..do	7.06	
		Sept. 30	Breakfast	..do	12.63	
		..do	Supper	..do	10.15	
		Oct. 1	Breakfast	..do	10.93	
		Oct. 2	Supper	..do	7.22	
		Oct. 3	Breakfast	..do	11.84	
		Oct. 4	..do	..do	12.82	
		Oct. 5	..do	Hot milk	8.57	
	Total				89.07	
20052	Vegetables	Sept. 29	Dinner	Cabbage	16.87	One-eighth of amount used.
		..do	..do	Whole tomatoes	11.72	
		..do	Supper	Stewed tomatoes	15.14	
		Sept. 30	Dinner	Creamed potatoes	10.92	
		..do	..do	String beans	8.12	
		..do	Supper	Stewed prunes	10.16	
		Oct. 1	Breakfast	Oat meal	10.41	
		..do	Dinner	Navy beans	13.55	
		..do	Supper	Stewed tomatoes	14.06	
		Oct. 2	Dinner	Boiled cabbage	16.42	
		..do	..do	Mashed potatoes	9.61	
		..do	..do	Whole tomatoes	10.38	
		..do	Supper	Lima beans	10.49	
		Oct. 3	Dinner	Steamed potatoes	9.04	
		..do	..do	Lentils	11.13	
		..do	Supper	Macaroni and tomatoes	13.87	
		Oct. 4	Breakfast	Oat meal	13.62	
		..do	Dinner	Baked potatoes	8.20	
		Oct. 5	..do	Boiled cabbage	16.62	
		..do	..do	Boiled potatoes	16.51	
		..do	..do	Whole tomatoes	10.52	
		..do	Supper	Stewed prunes	8.24	
		Sept. 29-Oct. 5		Vinegar	0.79	
		..do		Sugar	2.02	
	Total				268.41	

Table No. 9—Continued.

Laboratory No.	Food sample.	Date.	Meal.	Kind of food.	Weight of food used—Kilos.	Amount taken for composite sample equal to—
20053	White bread, etc.	Sept. 29	Breakfast	White bread	7.00	One-eighth of amount used.
		..do	Dinner	..do	6.22	
		Sept. 30	Breakfast	..do	6.71	
		..do	Dinner	Crackers	1.55	
		..do	Supper	White bread	7.00	
		..do	..do	Ive cookies	2.99	
		Oct. 1	..do	White bread	4.54	
		..do	..do	Ginger bread	5.84	
		Oct. 2	Breakfast	White bread	7.38	
		Oct. 3	..do	..do	6.27	
		..do	Supper	..do	5.03	
		..do	..do	Biscuits	5.29	
		Oct. 4	Dinner	White bread	6.75	
		..do	..do	Crackers	1.56	
		..do	Supper	White bread	6.30	
		..do	..do	Ive cookies	2.85	
		Oct. 5	Breakfast	Toast	1.36	
		..do	..do	White bread	7.41	
		..do	Supper	..do	4.80	
		..do	..do	Coffee cake	3.61	
	Total				100.46	
20055	Coffee and tea	Sept. 29	Breakfast	Coffee	24.27	One-eighth of amount used
		..do	Dinner	..do	25.22	
		..do	Supper	Tea	23.09	
		Sept. 30	Breakfast	Coffee	20.79	
		..do	Supper	Tea	23.81	
		Oct. 1	Breakfast	Coffee	22.78	
		..do	Dinner	..do	25.44	
		..do	Supper	Tea	25.26	
		Oct. 2	Breakfast	Coffee	27.95	
		..do	Dinner	..do	29.15	
		..do	Supper	Tea	25.51	
		Oct. 3	Breakfast	Coffee	25.98	
		..do	Dinner	..do	25.64	
		..do	Supper	Tea	26.80	
		Oct. 4	Breakfast	Coffee	22.90	
		..do	Supper	Tea	29.00	
		Oct. 5	Breakfast	Coffee	25.08	
		..do	Dinner	..do	23.95	
		..do	Supper	Tea	22.57	
	Total				475.19	
20054	Mixed foods	Sept. 29	Supper	Tapioca	15.04	One-eighth of amount used.
		Sept. 30	Dinner	Beef soup	18.98	
		Oct. 1	..do	Bread pudding	9.97	
		Oct. 2	..do	Squash pie	4.62	
		..do	Supper	Rice pudding	17.01	
		Oct. 4	Dinner	Beef soup	20.46	
	Total				86.08	

Table No. 9—Concluded.

Laboratory No.	Food sample.	Date.	Meal.	Kind of food.	Weight of food used—Kilos.	Amount taken for composite sample equal to—
20058	Corn foods	Sept. 29	Breakfast	Hominy	15.87	One-eighth of amount used.
		..do	Dinner	Canned corn	10.15	
		..do	Supper	Corn bread	15.31	
		Sept. 30	Breakfast	Corn flakes	1.66	
		..do	Dinner	Corn bread	13.50	
		..do	Supper	Corn starch pudding	14.63	
		Oct. 1	Breakfast	Corn bread	19.90	
		..do	Dinner	..do	12.61	
		..do	Supper	Corn starch pudding	10.87	
		Oct. 2	Breakfast	Corn meal mush	12.92	
		..do	Dinner	Corn bread	15.07	
		..do	Supper	..do	13.79	
		Oct. 3	Breakfast	Corn flakes	1.59	
		..do	Dinner	Corn bread	13.98	
		..do	..do	Toast in custard	8.18	
		..do	Supper	Scalloped corn	12.40	
		Oct. 4	Breakfast	Corn bread	13.40	
		..do	Dinner	Stewed corn	13.81	
		..do	Supper	Corn fritters	6.85	
		..do	..do	Cocoanut pudding	12.38	
		Oct. 5	Breakfast	Hominy	17.55	
		..do	Dinner	Corn bread	13.26	
		..do	Supper	Corn starch pudding	14.01	
	Total				283.69	
20059	Syrup	Sept. 29-Oct. 5		Syrup	10.72	
20061	Salt	Sept. 29-Oct. 5		Salt	0.35	
20057	Butterrine	Sept. 29	Breakfast	Butterine	0.57	One-fourth of amount used.
		..do	Dinner	..do	0.55	
		..do	Supper	..do	0.60	
		Sept. 30	Breakfast	..do	0.58	
		..do	Dinner	..do	0.70	
		..do	Supper	..do	0.86	
		Oct. 1	Breakfast	..do	0.68	
		..do	Dinner	..do	0.57	
		..do	Supper	..do	0.67	
		Oct. 2	Breakfast	..do	0.71	
		..do	Dinner	..do	0.62	
		..do	Supper	..do	0.60	
		Oct. 3	Breakfast	..do	0.63	
		..do	Dinner	..do	0.77	
		..do	Supper	..do	0.67	
		Oct. 4	Breakfast	..do	0.62	
		..do	Dinner	..do	0.65	
		..do	Supper	..do	0.66	
		Oct. 5	Breakfast	..do	0.61	
		..do	Dinner	..do	0.69	
		..do	Supper	..do	0.83	
	Total				13.84	

The study was begun with breakfast on Thursday, September 29th, and continued for seven days ending with supper on Wednesday, October 5th.

The number of men composing this group remained constant during the week and was fifty-six.

Coffee and tea, milk, butterine, syrup, and salt were sampled at the hospital as before. The remainder of the material, contained in eleven ten-gallon milk cans was shipped to the laboratory and treated as those in the first study.

The same determinations were made as in the previous investigation. The results are summarized in table 10.

TABLE 10—SUMMARY—DIETARY STUDY NO. 2—CORN DIET.

Laboratory No.	Food materials.	Weight of food used—Kilos.	Protein.		Carbohydrates.		Fat (ether extract).			Ash (mineral matter).		Phosphorus.	
			Per cent.	Quantity—Grams.	Per cent.	Quantity—Grams.	Per cent.	Quantity—Grams.	Fuel value—Calories.	Per cent.	Quantity—Grams.	Per cent.	Quantity—Grams.
20051	Animal foods	73.56	10.37	7,628.17	4.68	3,442.61	11.30	8,312.28	.....	1.97	1,449.13	0.113	83.12
20052	Vegetable foods	268.41	2.03	5,448.72	13.61	36,530.60	0.73	1,959.39	.....	1.18	3,167.24	0.046	123.47
20053	White bread, etc	100.46	9.52	9,563.79	56.63	56,890.50	2.87	2,883.20	.....	1.25	1,255.75	0.116	116.53
20054	Mixed foods	86.08	1.94	1,669.95	14.44	12,429.95	0.69	593.95	.....	0.65	559.52	0.032	27.55
20055	Coffee and tea	475.19	0.03	142.56	1.32	6,272.51	0.02	95.04	.....	0.05	237.60	.....	.....
20056	Milk	89.07	3.10	2,761.17	4.87	4,337.71	2.67	2,378.17	.....	0.71	632.40	0.093	82.84
20057	Butterine	13.84	0.53	73.35	.....	.....	87.25	12,075.40	.....	3.66	506.54	0.016	2.21
20058	Corn foods	283.69	4.05	11,489.44	29.47	83,603.44	2.75	7,801.48	.....	1.57	4,453.93	0.105	297.87
20059	Syrup	10.72	0.16	17.15	76.00	8,147.20	0.05	5.36	.....	1.05	112.56	0.006	0.64
20061	Salt	0.35	.....	.....	.....	.....	.....	.....	.....	99.77	349.20	.....	.....
	Total in food used	.....	.....	38,794.30	.....	211,654.52	.....	36,104.27	.....	.....	12,723.87	.....	734.23
20060	Waste food	148.47	3.10	4,602.57	20.48	30,406.66	3.56	5,285.53	.....	1.20	1,781.64	0.062	92.05
	Amount actually consumed[1]	.....	.....	34,191.73	.....	181,247.86	.....	30,818.74	.....	.....	10,942.23	.....	642.18
	Average per man per day	.....	.....	87.22	.....	462.37	.....	78.62	2,898	.....	27.91	.....	1.64
	Average per kilo body weight[2]	.....	.....	1.39	.....	7.37	.....	1.25	46.2	.....	0.45	.....	0.026

[1] Net amount for 7 days, 56 subjects.
[2] Average body weight, 62.7 kilos.

FOOD CONSUMPTION.

The average quantities of the various nutrients consumed by the group receiving the Corn Diet were, per man per day; protein, 87.22 grams; carbohydrates, 462.37 grams; and fat, 78.62 grams. The fuel value of these is 2,698 calories. On an average each man ingested per day, 27.91 grams mineral matter (ash) of which 1.64 grams was phosphorous.

Per kilo body weight, the average consumption per man per day is equal to 1.39 grams protein, 7.37 grams carbohydrates, 1.25 grams fat, 46.2 calories energy, 0.45 gram ash and 0.026 gram phosphorus.

DISCUSSION OF RESULTS OF DIETARY STUDY NO. 2.

These values are considerably higher than those obtained with the General Diet. Compared to Atwater's standard for insane institutions and, possibly, to his standard for normal people engaged in equivalent muscular activity ("man with light to moderate muscular work"), the diet is somewhat deficient in protein but practically adequate in fuel value. But Atwater's standard for the insane is based on a food consumption of 86 grams protein and 2,700 calories, values which are not as great as those obtained with the Corn Diet. Compared with the results obtained in the New York, Connecticut, and Washington, D. C. institutions, the Corn Diet appears entirely satisfactory.

In the investigations with normal men at the University of Illinois (13), smaller quantities of protein and the same quanties of energy were found entirely adequate.

Considering the character of the patients, however, and the fact that the results obtained represent the average of a large number of subjects, some of whom were undoubtedly receiving less than the average, it is fair to assume that the amounts of nutrients and energy actually consumed cannot be considered excessive. A fair conclusion regarding the Corn Diet would seem to be that, in so far as the data go, it was satisfactory and adequate, as far as total nutrients are concerned.

DISTRIBUTION OF NUTRIENTS.

The distribution of nutrients among the different foods and classes of foods has been determined as in the case of the General Diet. The data are arranged in table 11.

TABLE 11—DISTRIBUTION OF NUTRIENTS—DIETARY STUDY NO. 2—CORN DIET.

Laboratory No.	Food material.	Fresh food.			Dry substance.			Protein.			Carbohydrates.		
		Quantity—Kilos.	Per cent of total.	Per man per day—Grams.	Quantity—Kilos.	Per cent of total.	Per man per day—Grams.	Quantity—Grams.	Per cent of total.	Per man per day—Grams.	Quantity—Grams.	Per cent of total.	Per man per day—Grams.
20051	Animal foods	73.56	5.25	.....	20.83	6.96	.....	7,628.17	19.66	.....	3,442.61	1.63	.....
20056	Milk	89.07	6.36	.....	10.11	3.38	.....	2,761 17	7.12	.....	4,337.71	2.05	.....
	Total animal foods	162.63	11.61	414.87	30.94	10.34	78.93	10,389.34	26.78	26.50	7,780.32	3.68	19.84
20052	Vegetable foods	268.41	19.15	.....	47.11	15.75	.....	5,448.72	14.05	.....	36,530.60	17.26	.....
20053	White bread, etc	100.46	7.17	.....	70.59	23.60	.....	9,563.79	24.65	.....	56,890.50	26.88	.....
20055	Coffee and tea	475.19	33.91	.....	6.75	2.26	.....	142.56	0.37	.....	6,272.51	2.96	.....
20059	Syrup	10.72	0.76	.....	8.28	2.77	.....	17.15	0.04	.....	8,147.20	3.85	.....
	Total vegetable foods	854.78	60.99	2,180.56	132.73	44.37	338.60	15,172.22	39.11	38.70	107,840.81	50.95	275.10
20054	Mixed foods	86.08	6.14	.....	15.25	5.10	.....	1,669.95	4.30	.....	12,429.95	5.87	.....
20057	Butterine	13.84	0.99	.....	12.51	4.18	.....	73.35	0.19	.....	.....	.....	.....
20058	Corn foods	283.69	20.24	.....	107.35	35.89	.....	11,489.44	29.62	.....	83,603.44	39.50	.....
	Total mixed foods	383.61	27.37	978.60	135.11	45.17	344.67	13,232.74	34.11	33.76	96,033.39	45.37	244.98
20061	Salt	0.35	0.02	0.89	0.35	0.17	0.89	.....	.....	.....	.....	.....	.....
	Total food used	1,401.37	100.00	3,574.92	299.13	100.00	763.09	38,794.30	100.00	98.96	211,654.52	100.00	539.94
20060	Waste food	148.47	10.59	378.75	42.08	14.07	107.33	4,602.57	11.86	11.74	30,406.66	14.37	77.57
	Amount actually consumed	1,252.90	89.41	3,196.17	257.05	85.93	655.75	34,191.73	88.14	87.22	181,247.86	85.63	462.37

Table No. 11—Concluded.

Laboratory No.	Food material.	Fat.			Fuel value.		Ash.			Phosphorus.		
		Quantity—Grams.	Per cent of total.	Per man per day—Grams.	Per cent of total.	Per man per day—Calories.	Quantity—Grams.	Per cent of total.	Per man per day—Grams.	Quantity—Grams.	Per cent of total.	Per man per day—Grams.
20051	Animal foods	8,312.28	23.02	.....	.....	.....	1,449.13	11.39	.....	83.12	11.32	0.21
20058	Milk	2,378.17	6.59	.....	.....	.....	632.40	4.97	.....	82.84	11.28	0.21
	Total animal foods	10,690.45	29.61	27.27	12.68	428	2,081.53	16.36	5.31	165.96	22.60	0.42
20052	Vegetable foods	1,959.39	5.43	.....	.....	.....	3,167.24	24.89	.....	123.47	16.82	0.31
20053	White bread, etc	2,883.20	7.99	.....	.....	.....	1,255.75	9.87	.....	116.53	15.87	0.30
20055	Coffee and tea	95.04	0.26	.....	.....	.....	237.60	1.87	.....	.....	.....	.....
20058	Syrup	5.36	0.01	.....	.....	.....	112.56	0.88	.....	*0.64	0.09	0.00
	Total vegetable foods	4,942.99	13.69	12.61	40.50	1,367	4,773.15	37.51	12.18	240.64	32.78	0.61
20054	Mixed foods	593.95	1.65	.....	.....	.....	559.52	4.40	.....	27.55	3.75	0.07
20057	Butterine	12,075.40	33.45	.....	.....	.....	506.54	3.98	.....	2.21	0.30	0.01
20058	Corn foods	7,801.48	21.60	.....	.....	.....	4,453.93	35.00	.....	297.87	40.57	0.76
	Total mixed foods	20,470.83	56.70	52.22	46.82	1,580	5,519.99	43.38	14.08	327.63	44.62	0.84
20061	Salt	.....	.....	.....	.....	.....	349.20	2.75	0.89	.....	.....	.....
	Total food used	36,104.27	100.00	92.10	100.00	3,375	12,723.87	100.00	32.46	734.23	100.00	1.87
20060	Waste food	5,385.53	14.64	13.48	14.13	477	1,781.64	14.00	4.55	92.05	12.54	0.23
	Amount actually consumed	30,818.74	85.36	78.62	85.87	2,898	10,942.23	86.00	27.91	642.18	87.46	1.64

TABLE 12—COMPARISON OF THE CORN AND GENERAL DIETS.
Expressed as quantities per man per day.

		Fresh food.		Dry substance.		Protein.		Carbohydrates.		Fat.		Energy.	
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Calories.	Calories.
Total animal foods.	General diet	222.44		57.86		24.07		8.87		21.09		319	
	Corn diet		414.87		78.93		26.50		19.84		27.27		428
Total vegetable foods.	General diet	2,234.61		506.56		49.98		433.61		6.30		1,991	
	Corn diet		2,180.56		338.59		38.70		275.10		12.61		1,367
Total mixed foods.	General diet	241.81		71.06		4.23		31.46		32.60		433	
	Corn diet		978.60		344.67		33.76		244.98		52.22		1,580
Salt.	General diet	1.75		1.75									
	Corn diet		0.89		0.89								
Total food used.	General diet	2,700.62		637.22		78.28		473.94		60.00		2,743	
	Corn diet		3,574.92		763.09		98.96		539.94		92.10		3,375
Waste food.	General diet	145.05		40.73		4.77		29.60		4.23		175	
	Corn diet		378.75		107.33		11.74		77.57		13.48		477
Amount actually consumed	General diet	2,555.57		596.49		73.51		444.34		55.77		2,568	
	Corn diet		3,196.17		655.75		87.22		462.37		78.62		2,898

The remarks regarding the protein, fat, and carbohydrate values that were made in describing table 10, (General Diet) apply to these results also.

The corn foods are classed with the mixed foods because they included many dishes, such as puddings and custards, which contained eggs and milk. The total mixed foods, then, derive considerable of their nutrients from animal sources, a fact to be remembered in judging the diet. Only an approximate separation of food and nutrients into animal and vegetable classes is possible, and it is therefore difficult to compare this diet with the General Diet and the average American diet from the standpoint of their animal and vegetable food contents. It is certain, however, that this diet approaches much nearer the average American dietary than does the General Diet.

An interesting point in this connection is the place milk occupies in this diet. The Corn Diet contained a larger amount of milk than did the General Diet and the result is evident in the larger proportion of all nutrients, including ash and phosphorus, credited to this food material.

COMPARISON OF THE TWO DIETS.

In table 12, the quantities of food, dry substance, energy and nutrients, per man per day, as derived from the different classes of foods, are arranged for the two diets studied, so as to facilitate a comparison. The most noticeable facts are:

1. The group receiving the Corn Diet were served more food and more nutrients and energy per man per day than the group on the General Diet.
2. Larger quantities of animal foods were supplied by the Corn Diet than by the other. This is more evident when it is remembered that a considerable proportion of the corn foods, classed with the mixed foods, is derived from animal substances.
3. The amount of food wasted (left uneaten at the tables) is much greater on the Corn Diet than on the General Diet.
4. The amount of food actually eaten (total food, energy, and nutrients) is much greater on the Corn Diet than on the General Diet.

An observation of the menus of the two diets for the periods in which the studies were made shows at once that the Corn Diet is much superior to the General Diet. There is a greater variety of food. It contains more dishes of the kind that appeal to the appetite and taste—such as custards and puddings—and more of that valuable food material, milk. This does not mean that the General Diet was not a good diet or that it did not contain good wholesome food. It did possess those necessary qualities. What it lacked was the variety of the Corn Diet. And it was due, in all probability, to the greater variety in the Corn Diet that those who received it consumed more food than those receiving the General Diet. In both studies food was left uneaten that might have been consumed, and in both studies the food was good and wholesome. This might be taken to mean that the food actually eaten was adequate to the needs of the subjects. However, since other conditions were practically the same, the greater consumption on the Corn Diet must be attributed to the superior character of this diet.

It is not sufficient alone, to supply good wholesome food. Variety must be introduced into the diet and monotony prevented, if the consumption of adequate quantities of food and nutrients is to be assured.

Dietary Study No. 3. Corn-free Diet.

It is to be regretted that it was impossible to conduct a complete dietary study on the Corn-free Diet. Such work was begun and carried on for two days. No samples were kept and no analyses made, but the quantities of food sent to the dining room, returned, wasted and actually eaten during the two days were determined. These make possible, in a very general way, comparisons with the other two diets.

The Corn-free Diet differed from the Corn Diet only in that it contained no corn or corn products of any kind. When such a food was used in the one diet, some other food of equal value was served in the Corn-free Diet. Both diets were about on the same plane of nutrition as can be readily seen by consulting the menus for the week (Table No. 2).

The patients were of the same type as those receiving the Corn Diet. There were fifty-seven subjects in this group.

The weights of food used, wasted, and actually eaten have been calculated to a man per day basis. For comparison the same thing has been done for the first two days of the Corn Diet. These results are given in Table 13.

They show a somewhat higher consumption on the Corn-free Diet than on the Corn Diet. Since both were on about the same nutritive plane, this fact suggests the possibility that the groups on the Corn-free Diet were ingesting more nutrients than the others. The data are not sufficient to allow such a broad conclusion however, but it seems safe to say that the two groups were probably equally well nourished.

These figures tend to corroborate the conclusion stated above in comparing the Corn and General Diet, viz, that the character of the diet is a most important factor in determining the amount of food consumed.

TABLE 13—COMPARISON OF CORN AND CORN-FREE DIETS.

Quantities of Food Used, per Man, per Day, During the First Two Days of Experiments.

Kind of food.	Weights of food used—Per man per day (grams).	
	Corn diet.	Corn-free diet.
Animal foods	289.73	301.23
Milk	336.52	352.98
Coffee and tea	1,046.25	1,099.56
Butterine	34.46	45.44
Other foods[1]	1,736.60	1,984.82
Total foods used	3,443.56	3,784.03
Waste food	366.79	470.70
Amount actually consumed	3,076.77	3,313.33

[1] Includes for:

Corn diet.	Grams.	Corn-free diet.	Grams.
Vegetable foods	651.16	Vegetable foods	983.68
White bread, etc	280.98	White bread, etc	430.88
Mixed foods	169.46	Mixed foods	570.26
Corn foods	635.00		
Total	1,736.60	Total	1,984.82

THE MINERAL SUBSTANCE IN THE GENERAL AND CORN DIET.

Very little definite information is available regarding the requirements of man for the mineral substances. Their importance is well known and the relations of certain elements or salts to various pathological conditions have been studied. Under normal conditions of diet and living, there may be little danger of a lack of the mineral substance or of their proper adjustment. For this reason, perhaps, they are not usually considered in dietary studies. But, when the diet is not of the ordinary mixed kind, there may be danger of providing too small quantities of these essential food constituents,

and the chances of such a thing happening are greater in institutions where a large number are fed and where the inmates have no choice in the selection of their food, than in smaller groups.

Langworthy (15) gives an estimate of the mineral matter required per man per day, based upon the conclusions of Von Noorden and Sherman. They are as follows:

Phosphoric acid (P_2O_5)	3	to	4	grams
Sulphuric acid (SO_3)	2	to	3.5	grams
Potassium oxide	2	to	3	grams
Sodium oxide	4	to	6	grams
Calcium oxide	0.7	to	1.0	gram
Magnesium oxide	0.3	to	0.5	gram
Iron	0.006	to	0.012	gram
Chlorine	6	to	8	grams

Upon this basis and providing that the various substances are present in the proper proportions, the mineral matter in both diets studied appears to be sufficient. On the General Diet, 23.23 grams (Table 6) and on the Corn Diet, 27.91 grams (Table 10) of total mineral matter were consumed per man per day.

PHOSPHORUS.

The only constituent of the ash determined in these studies was phosphorus. Calculated as the element (P), the subjects receiving the General Diet ingested daily 1.07 grams (Table 6) and the subjects on the Corn Diet 1.64 grams (Table 10). These quantities are equivalent to 2.45 and 3.82 grams phosphoric acid, respectively.

Sherman and associates (16) have studied the question of phosphorus in nutrition and have calculated the quantities of phosphoric acid in twenty typical American dietaries. Regarding their work the authors say: "From the results here obtained as well as from the average results of experiments by other observers, it would appear that a healthy man, accustomed to full diet of the ordinary mixture of animal and vegetable materials, required for the maintenance of his ordinary store of phosphorus compounds about 1.5 grams phosphorus or nearly 3.5 grams of phosphoric acid, per day, though under special conditions or with a specially selected dietary, equilibrium may be maintained on much less. Many of the dietaries studied show so much less than 3.5 grams phosphoric acid per man per day as to raise a question whether the people may not have been undernourished in this respect, even though they may have had ample protein, fats, and carbohydrates. This question merits further investigation."

Grindley et al. (13) in the work already referred to, determined the phosphorus intake of the 21 men for the entire period of 220 days. The average quantity, ingested for the entire experiment was 1.455 grams per man per day. Per kilo body weight, each man received per day 0.0218 gram.

Compared to these values, the 1.07 grams phosphorus per man per day, or 0.016 gram per kilo body weight received by the group on the General Diet (Dietary Study No. 1) would seem to be inadequate.

The Corn Diet, judged by the values quoted, is satisfactory in regard to its phosphorus content.

Of a special interest in the consideration of phosphorus in the diets, is the relation of this element to beri beri. There seems to be considerable evidence that beri beri or certain forms of beri beri, is caused by a lack of phosphorus in the diet, or phosphorus starvation. In countries where rice is the principle food stuff, this deficiency is caused by the preparation of the rice (polishing) in which the phosphorus containing portion of the grain (bran) is removed. The feeding of polished rice to chickens causes a polyneuritis which can be prevented or cured by the addition of rice bran or phosphorus compounds to the food. Aron and Hocson (17) have studied the nitrogen and phosphorus requirements of the body in their investigations on beri beri. They found that a diet furnishing 40 calories, 0.15 gram

nitrogen and 0.025 gram P_2O_5 per kilo body weight was too poor in nitrogen and phosphorus and caused a loss of both from the body. A diet furnishing 37 calories, 0.2 gram nitrogen and 0.032 gram P_2O_5 per kilo body weight was sufficient to keep a man in nitrogen and phosphorus equilibrium. The subjects of their experiments were Filipinos. These values are much smaller than those found to be necessary by American and European investigators.

The General Diet supplied 38.3 calories, 1.10 grams protein and 0.037 gram P_2O_5 per kilo body weight, values which are practically equivalent to those that Aron and Hocson found necessary to maintain nitrogen and phosphorus equilibrium. They are much lower, however, than the quantities of phosphorus called for as necessary by European and American investigators [Magnus-Levy (11), Sherman, et al (16)], viz: 3 to 4 grams P_2O_5 per day.

To return to a method of interpretation used before; the following conclusion seems reasonable. The quantity of phosphorus, 1.07 grams per man per day (equivalent to 2.45 grams phosphoric acid per man per day) is low compared to what is usually considered necessary. It represents the average daily ingestion of a large group of subjects. Some of these were probably receiving less than the average. In that case, they were very likely receiving too little, and from this point of view, must have been in phosphorus starvation.

Phosphorus starvation has been associated with a disease of nervous origin (beri beri). The importance of this element cannot be over-estimated especially when dealing with the insane. It is highly desirable that more work be done along this line to determine the requirements for this element.

The Corn Diet supplied 3.82 grams P_2O_5 per man per day, or 0.061 gram phosphorus per kilo body weight. Since the quantities of protein and energy, 1.39 grams and 46.2 calories per kilo body weight, are sufficient, this diet is adequate with respect to the phosphorus content.

SOURCES OF PHOSPHORUS.

Tables 8 and 11 give the distribution of the phosphorus among the various foods and classes of foods, proportionately and quantitatively. On the General Diet, 65.81 percent of the total phosphorus was derived from the total vegetable foods, 27.31 percent from the total animal foods, and 6.88 percent from the total mixed foods. On the Corn Diet, the total vegetable foods supplied 32.78 percent of the total phosphorus; the total animal foods, 22.60 percent; and the total mixed foods 44.62 percent. The greater proportion in the total mixed foods of the Corn Diet is due to the corn foods which alone supplied 40.57 percent of the total. The greater quantity, per man per day, furnished by the Corn Diet, compared to the General Diet, is derived from two foods entirely, the corn foods and milk. The corn foods alone supplied 0.76 gram per man per day and the milk 0.21 gram per man per day. Possibly considerable of the phosphorus in the corn foods comes from animal material (eggs and milk) used in the preparation of many of the foods included under this head. Milk is an excellent source of phosphorus.

In the nutrition investigation of Grindley et al (13), the phosphorus of the average diet was derived as follows: from animal foods, 54.73 percent; from vegetable foods, 31.74 percent; from mixed foods, 13.52 percent. The chief source of phosphorus was milk, which supplied 32.76 percent of the total amount. Meats were the next important source, supplying 16.03 percent.

These facts are of interest and value in suggesting means for increasing the phosphorus in such a diet as the General Diet.

SUMMARY.

The lack of definite information regarding the food requirements and the metabolism of the class of subjects experimented upon has made it difficult to interpret the results obtained in these studies. In addition to

this fact, the experimental work here reported is in itself brief, and is not extensive enough to allow any broad interpretation. Bearing these facts in mind, the results of these dietary studies may be summarized as follows:

I. THE GENERAL DIET.

1. Measured by the quantities consumed by a group of average patients, fifty-three in number, for a period of seven days, the General Diet supplied per man per day, 73.51 grams protein, 444.34 grams carbohydrates, 55.77 grams fat, 2568 calories energy and 23.23 grams mineral matter, of which 1.07 grams was phosphorus.
2. With the exception of protein and phosphorus, these quantities are probably adequate.
3. It is difficult to judge the adequacy of the protein content because very little information is available regarding the food requirements of the insane. On the whole, the quantity is probably sufficient, but it is probably not in the least excessive, and, since it represents the average intake of a large number, some of whom were very likely receiving less than the average, an increase in the amount would seem desirable.
4. The phosphorus intake on the General Diet is much smaller than the amount ordinarily considered necessary. For this reason, an increase in this element in the diet would seem to be desirable.
5. A study of the distribution of the nutrients among the animal and vegetable foods shows that the diet is chiefly vegetable in nature, much more so than the average American dietary. The influence of this could be determined only by metabolism experiments. However, an increase in animal foods in the diet would result in an increase in the protein and phosphorus contents. Such added animal foods need not necessarily be meat but might include such materials as milk, eggs, and dairy products, if the cost would permit.

II. CORN DIET.

1. The quantities of nutrients, energy, and mineral substances ingested per man per day by the patients receiving the Corn Diet were: protein, 87.22 grams; carbohydrates, 462.67 grams; fat, 78.62 grams; energy, 2898 calories; total mineral matter, 27.91 grams; phosphorus, 1.64 grams.
2. These quantities were probably adequate to the needs of the patients receiving them but they cannot be considered excessive.

III. CORN-FREE DIET.

To judge by the little evidence at hand, the Corn-free Diet seems to have been at least equal in nutritive value to the Corn Diet.

IV. IMPORTANCE OF THE CHARACTER OF THE DIET.

The character of the diet is an important factor in determining the quantities of food and nutrients that will be consumed. Other things being equal, the diets that possessed the greater variety (Corn and Corn-free Diets) brought about a larger consumption of nutrients, energy, etc., than the diets lacking much variety (General Diet), although in all cases the food was good and wholesome and more was provided than was eaten.

V. THE NEED FOR MORE WORK.

The need for more experimental work has been repeatedly noted. Such work is necessary before any definite conclusions can be made regarding the dietetic requirements of the insane. It should take the form of complete and thorough dietary studies and metabolism experiments in which the mineral elements, as well as the nutrients ordinarily considered in dietary studies, should be determined.

Conclusion.

Until more information is available, any standard diet for the State hospitals for the insane should be proposed only as a tentative one. Such a tentative standard seems advisable, and the following is suggested.

Per man per day—protein, 90 grams; energy, 2,700 calories.

Per woman per day—protein, 72 grams; energy, 2,200 calories.

These quantities may be considered sufficiently large to allow a safe margin over the actual requirements. They are intended to represent the requirements (1) of the patients only and not of the hospital population as a whole, and (2) of the class of patients comprising the subjects in the work reported and not such cases as the acute or recent admissions, the invalid, etc.

The standards proposed do not represent the ration allowances. These should allow a margin for waste and shrinkage. The amounts that should be added for losses due to these causes can not be stated definitely since they would vary in different institutions and would depend upon the care with which the food supplies were managed. When due care is taken, they should not amount to more than 12½ to 15 percent of the total. Accepting these values in a very general way, minimum standard rations, corresponding to the standard diets proposed, would be as follows:

Per man per day—protein, 105 grams; energy, 3,150 calories.

Per woman per day—protein, 84 grams; energy, 2,550 calories.

Considering the character of the people for whom this standard is designed, it is imperative that it be qualified in several respects.

1. At least 45 to 50 percent of the protein of the diet should be derived from animal foods. By animal foods, however, is not meant meats exclusively. Eggs and milk and other dairy products should be included.

The standard ration would call for a minimum of 47 grams protein per man per day or 38 grams per woman per day derived from animal foods. Considering these quantities on a meat basis and assuming that the meat as purchased contains 16 percent of protein, the standard ration should include 10 oz. meat per man per day or 8 oz. meat per woman per day, or the equivalent, in part, of other animal foods.

2. The diet should at all times possess variety. Especially should it contain an abundance of fresh fruits and vegetables, in season, to insure the proper quantities of the mineral elements.

Since practically each institution in this State has its own large gardens and farms, it ought not to be a difficult matter to do this. The importance of this point makes it worthy of special emphasis.

3. The preparation and serving of the food should be given careful attention. The food should be well cooked, and served warm and in as attractive a manner as possible. The dining room should be clean, well ventilated, and pleasing in appearance. Sufficient help should be employed to insure each patient all the assistance and attention necessary.

References.

1. Dunlop, J. C.—Report on dieting of pauper lunatics in asylums and lunatic wards of poorhouses in Scotland. Supplement to the 43d Annual Report of the General Board of Commissioners in Lunacy for Scotland, Glasgow, 1902.

2. Munson, J. D.—American Journal Insanity, 52 (1895-96), p. 58.

3. Richards, Mrs. E. H. and Wentworth, Miss A. E.—Institutions Commissioner's Report (1897), Boston.

4. Atwater, W. O.—Dietaries for Hospitals for the Insane. Preliminary Report. Tenth Annual Report. State Commission in Lunacy, New York, 1897-98.

5. Atwater, W. O.—Dietaries for Hospitals for the Insane. Second Report. Eleventh Annual Report, State Commission in Lunacy, New York, 1898-99.

6. Atwater, W. O.—Dietaries for Hospitals for the Insane. Final Report. Thirteenth Annual Report, State Commission in Lunacy, New York, 1900-01.

7. Atwater, W. O.—Dietary Studies in the Connecticut Hospital for the Insane. Annual Report, Conn. Storrs. Agri. Exp. Sta., 1899.
8. Pratt, H. A. and Milner, R. D.—Dietary Studies at the Government Hospital for the Insane. Bull. 150, Office Expt. Sta.'s, U. S. D. A., 1904.
9. Knight, Pratt, and Langworthy. Dietary Studies in Public Institutions in Baltimore, Md. Bul. 223, Office Expt. Sta., U. S. D. A., 1910.
10. Mohr, L., von Noorden's "Metabolism and Practical Medicine." Chap. XVI, Nervous and Mental Diseases. Vol. III, pp. 1243-1260.
11. Magnus-Levy, Adolf., von Noorden's "Metabolism and Practical Medicine." Vol. I, The Physiology of Metabolism.
12. Chittenden, Russell A.—The Nutrition of Man., New York, 1907; Physiological Economy in Nutrition, New York, 1904.
13. Grindley, H. S. et al.—Studies in Nutrition. In press.
14. McCay, Capt. D.—Investigations on Jail Dietaries. Scientific Memoirs, Gov't. of India. No. 37, Calcutta, 1910.
15. Langworthy, C. F.—Food and Diet in the United States. Year Book of the Department of Agriculture, 1907.
16. Sherman, H. S., Mettler, A. J., and Sinclair, J. E.—Calcium, Magnesium, and Phosphorus in Food and Nutrition. Bul. 227, Office Exp. Sta., U. S. D. A., 1910.
17. Aron, H. and Hocson, F.—Phosphorus Starvation with Special Reference to Beri-beri. Phillipine Journ. Science. Sect. B, Vol. V, No. 1.

Part II—The Corn Meal From the State Institutions.

(A. F. Wussow and H. S. Grindley.)

Samples of corn meal (100 lb. bags) were received from eight institutions during April and May. These were analyzed chemically for moisture and acidity. For purposes of comparison, the same determinations were made upon nineteen other samples of corn meal from various sources. The results obtained are included herewith in tabulated form. To make the acidity values comparable they have been calculated to a moisture-free basis. The acidity is expressed in number of cc. of N/10 NaOH solution required to neutralize the alcoholic extract of 100 grams of meal.

The eight samples from the State institutions are numbered 20003-20007 and 20010-20012. The moisture content of these varies from 12.14 percent to 16.26 percent; the acidity, from 25cc. to 4.2cc. The average values for the eight samples are: Moisture, 13.99 percent; acidity, 35.0cc.; acidity on dry basis, 40.7cc.

Number 20002 is a sample of corn meal received from Kankakee. The lot from which it was taken had become heated in the sacks, smelled rather moldy and was therefore not used as food for the patients. Its moisture content was 15.69 percent; acidity, 50.8cc.; acidity on dry basis, 60.3cc.

Three samples of meal, (No. 20013-20015) representing three different brands, were purchased at a local grocery store. These differ considerably from each other. No. 20015 has the smallest moisture content, 11.21 percent, but the largest acidity value, 71.1cc. The average for these three samples are: Moisture, 12.58 percent; acidity, 45.0cc.; acidity on dry basis, 51.3cc.

Numbers 20008, 20009, and 20016 are samples made from 20002 by sterilizing and inoculating with pure molds. They represent very badly spoiled corn meal. The average moisture of these three is 65.06 percent; acidity, 59.9cc.; acidity on moisture-free basis, 174.7cc. Compared to No. 20002, the increase in acidity due to the growth of molds is apparent, an increase from 60.3cc. to 174.7cc.

Six samples of meal received from Italy are represented by No. 20020 and 20026-20030. No. 20026 was marked "sound meal" but was in very bad condition when received. No. 20020 was marked "waste meal of maize," and the other four, "damaged meal." The average moisture of the six samples is 15.76 percent; acidity, 94.4cc.; acidity on moisture-free basis, 112.1cc.

Six samples were sent by Dr. Siler from Alabama. Three of these, Nos. 20033-20035, were samples of good meal; the other three, Nos. 20036-20038, were damaged meal. The average values for the good meal are: Moisture, 11.74 percent; acidity, 57.4cc.; acidity on moisture-free basis, 65.1cc. For the damaged meal these values are moisture 11.83 percent; acidity, 99.6cc.; acidity on moisture-free basis, 113.0cc.

Regarding the importance of the moisture content and the acidity of corn meal, an Austrian investigator reports that a law in his country, "passed to combat the spread of pellagra," forbids from being sold any corn meal containing more than 15 percent of water. He says that sound corn and corn meal should require less than 30cc.—generally 15 to 25cc.—N/10 NaOH solution to neutralize the alcoholic extract of 100 grams of the meal. When more than 30cc. are necessary, the meal is suspicious.

The official standard in this country requires "that maize meal, corn meal, or Indian corn contain not more than 14 percent of moisture."

Of the eight samples from the State institutions, five contain less and three more than 14 percent moisture. Six have an acidity greater than that quoted above as being normal—i. e., 30cc. N/10 NaOH per 100 grams. On an average, the moisture is normal and acidity slightly high.

Comparing the average acidity on a moisture-free basis with the corresponding averages of the other sets of samples, it is found to be the lowest. Placing them in order, they rank as follows:

Corn meal from state institutions (8 samples)	40.7cc.
Corn meal from local grocery store (3 samples)	51.3cc.
Slightly spoiled meal from Kankakee (1 sample)	60.3cc.
Good meal from Alabama (3 samples)	65.1cc.

Damaged meal from Italy (6 samples) ..... 112.1cc.
Damaged meal from Alabama (3 samples) ..... 113.0cc.
Very badly spoiled and moldy meal (3 samples) ..... 174.7cc.

Insects were found in five samples. Only one of these was of the eight received from the State institutions. No. 20004, sent from Elgin, contained a few moth larvae on one side and apparently attached to the bag. No. 20013, an excellent yellow meal purchased at a local grocery store, contained many beetles of the saw-tooth variety. The three samples of damaged meal from Alabama were fairly alive with beetles, weevils, and larvae.

Cultures were made from all parts of the samples for molds. No quantitative determination of the molds present was attempted. Of all the samples, only one contained no molds, No. 20006, a fine white meal from the Anna State Hospital. Both moisture and acidity of this sample were low, the acidity, 25cc. being the lowest of all the twenty-seven samples examined. Other organisms were found in all, and these, as well as the molds, in greater or lesser number depending on the sample.

Conclusion.

Judged by the moisture content, acidity, the presence of molds and other micro-organisms, and the presence of insects, the corn meal used in the State institutions, as represented by one 100 lb. sample from each, is, on an average, of very good grade. It was found to be of better quality than the corn meal obtained from a number of other sources (including three samples purchased in the local market, six samples from Alabama and six from Italy).

Moisture and Acidity of Corn Meal.

Laboratory No.	Date received —1910.	Source.	Moisture per cent.	Acidity cc. N-10 NaOH per 100 grams.	Acidity on dry basis cc. N-10 NaOH per 100 grams.	Remarks.
20002	Apr. 12	Kankakee	15.69	50.8	60.3	Yellow meal; spoiled; not used as food for patients.
20003	Apr. 28	Peoria	16.26	38.4	45.9	White meal
20004	Apr. 29	Elgin	13.00	34.7	39.9	Yellow meal; contained some moth larvae
20005	Apr. 30	Kankakee	15.95	40.2	47.8	White meal
20006	May 4	Anna	12.91	25.0	28.7	..do
20007	May 5	Jacksonville	12.93	37.4	42.9	..do
20010	May 11	Chester	13.62	43.2	50.0	..do
20011	May 11	Lincoln	15.12	34.9	41.1	..do
20012	May 18	Watertown	12.14	25.8	29.5	Yellow meal
		Average	13.99	35.0	40.7	
20013	May 23	Local grocery store	12.67	30.7	35.2	Yellow meal; contained many "saw-toothed" beetles
20014	May 23	Local grocery store	13.87	33.3	38.7	White meal
20015	May 23	Local grocery store	11.21	71.1	80.1	..do
		Average	12.58	45.0	51.3	
20008		Very badly spoiled meal	68.31	78.4	247.4	Sterilized meal from Sample No. 20002 upon which pure culture molds were allowed to grow for 18 days. These molds were, for 20008, blue green penicillium; 20009, green penicillium; 200016, white mucor. Later evidence indicated that the meal had not been entirely sterile and that bacteria or other organism had also developed. The three samples represent, however, very badly spoiled corn.
20009		Very badly spoiled meal	63.35	55.6	151.7	
20016		Very badly spoiled meal	63.52	45.6	125.0	
		Average	65.06	59.9	174.4	

Moisture and Acidity of Corn Meal—Concluded.

Laboratory No.	Date received—1910.	Source.	Moisture per cent.	Acidity c. N-10 NaOH per 100 grams.	Acidity on dry basis cc. N-10 NaOH per 100 grams.	Remarks.
20020	May 13	Italy	15.07	103.8	122.2	Waste meal of maize
20026	May 13	Italy	15.06	79.6	93.7	Sound meal (very moldy, etc., when received)
20027	May 13	Italy	16.87	96.5	116.1	Damaged meal
20028	May 13	Italy	15.80	96.2	114.3	..do
20029	May 13	Italy	15.44	97.3	115.1	..do
20030	May 13	Italy	16.33	92.8	110.9	..do
		Average	15.76	94.4	112.1	
20033	Aug. 16	Lafayette, Ala	11.91	64.4	73.1	White meal
20034	Aug. 19	Troy, Ala	11.78	54.1	61.3	..do
20035	Aug. 19	Troy, Ala	11.70	53.7	60.8	..do
		Average	11.74	57.4	65.1	
20036	Aug. 19	Troy, Ala	11.85	87.6	99.4	Damaged meal; contained many beetles, weevils, and larvae
20037	Aug. 19	Troy, Ala	11.80	102.9	116.7	
20038	Aug. 19	Troy, Ala	11.85	108.3	122.9	
		Average	11.83	99.6	113.0	

Part III—The Influence of Molds on Corn Meal.

(A. F. Wussow and H. S. Grindley.)

The changes brought about by the action of molds on corn meal were studied with special reference to the formation of toxic substances. For this purpose portions of corn meal were sterilized and inoculated from pure cultures of molds. After a good growth had been secured, the moldy meal was extracted with 90 percent alcohol for three to four hours at a temperature of 65 to 70° C. The alcohol extract was filtered off (using the centrifuge when necessary) and evaporated in vacuo over sulphuric acid to dryness. The dried residue was next extracted with absolute alcohol and the extract filtered. This filtrate was likewise evaporated to dryness in vacuo over sulphuric acid. The residue thus obtained was extracted with water, the water solution made alkaline with sodium carbonate and extracted with ether. The ether solution was allowed to evaporate spontaneously. As this is essentially the Stas-Otto method for the extraction of ptomaines, the residue from the ether extract should contain the toxic substances originally present. Other residues and fractions were also tested, however, and in those cases where toxic products were found it was in fractions other than the last residue described. An outline of the method and the system for numbering the solutions and products obtained is given on the next page.

Outline of Method.

CORN MEAL.

(Extracted with strong (90 per cent) alcohol).

- Residue (1). Extracted meal.
- Solution (A). Alcohol extract (evaporated to dryness in vacuo and residue taken up with absolute alcohol).
  - Residue (2). Soluble in 90 per cent alcohol. Insoluble in absolute alcohol. (Dried in vacuo.)
  - Solution (B). Absolute alcohol extract (evaporated to dryness in vacuo and residue extracted with water).
    - Residue (3). Soluble in alcohol. Insoluble in water. (Dried in vacuo.)
    - Solution (C). Water solution (made alkaline with sodium carbonate and extracted with ether).
      - Solution (4). Water solution (freed from ether and evaporated to small volume in vacuo).
      - Ether solution (allowed to evaporate spontaneously).
        - Residue (5).

The toxicity of the products was determined by injecting solutions or emulsions of them into guinea pigs.[1]

Synopsis of Results.

Laboratory Number 20008. Blue Green Penicillium.

This mold was obtained from a sample of ear corn which was suspected of having caused the death of some cattle.

Residues 2 and 3 when injected into guinea pigs caused death.

Laboratory Number 20019. Blue Green Penicillium. Same as No. 20008. Check experiment. Found non-toxic.

The differences in the results obtained in the two experiments with the same mold were explained by the fact that No. 20008 had probably become contaminated by some other organism or organisms. This seemed probable from the character of the moldy meal and the products obtained, compared to No. 20019, and from the fact that it was found difficult to keep the large quantities of corn meal used sterile.

The purity of the growth in No. 20019 was determined before the extraction was made.

No. 20008 may be taken to represent badly spoiled corn and was undoubtedly toxic.

Laboratory Numbers 20068 and 20069. Penicillium and Monascus purpureus.[2]

These two molds were obtained from some moldy ensilage which had killed several farm horses. Death had been sudden and was due to severe gastro-intestinal disturbances. Extracts of the moldy ensilage itself killed guinea pigs when injected subcutaneously. The molds were grown on sterile corn meal for 40 days and extracted by the usual method. Residue (2) was tested for toxicity. The Monascus extract proved toxic; the Penicillium was harmless.

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[1] The injections and the subsequent examinations of the dead animals were made by Dr. MacNeal and Miss Kerr.

[2] These molds were isolated and identified by Dr. J. T. Barrett, mycologist, State Experiment Station.

Portions of the very moldy meal, mixed with cracked corn and chopped grass were fed to guinea pigs. The Penicillium meal caused no harmful effects. The Monascus meal caused a loss of weight, loss of appetite, and a sluggish condition.

Although this work should properly be repeated, the evidence seems to point to the fact that the Monascus mold is capable of producing toxic substances when growing on corn meal.

Laboratory No. 20009—Green Penicillium. Source—same as No. 20008. No toxic products found.

Laboratory No. 20016—Mucor. Obtained from a sample of yellow corn meal. No toxic products found.

The Growing of Molds on Corn Meal Under Sterile Conditions—As stated above, some difficulty was experienced in the earlier part of this work in keeping the material free from contamination. The most satisfactory method was found to be as follows. One hundred grams of meal were placed in a two liter Erlenmeyer flask and sterilized in an autoclave at 10 to 12 lbs. pressure for 30 minutes.

Conclusions.

Of the five molds examined, only one, Monascus purpureus, gave a toxic substance when grown on corn meal in pure form.

Another lot of meal upon which a blue green species of Penicillium had grown, but which had become contaminated by other organisms, was very toxic.

XIII.

MEAT USED IN THE STATE HOSPITALS.

(H. Douglas Singer.)

When the work of this commission was planned it was hoped that it would be possible to study the general diet at each hospital in the same manner as that actually carried out at the Peoria State Hospital. This, however, has unfortunately been found to be impossible owing to lack of time and assistance. The findings at Peoria detailed in the last section of this report revealed deficiency in the amount of animal protein served to each patient. Since the main source of this constituent was provided in the meat it was thought that a comparison of the meat supplied to each institution daily per capita might afford some sort of basis for conclusions as to the sufficiency of animal protein at the other hospitals. A request was therefore made of the State Board of Administration that they furnish the Pellagra Commission with figures showing the total amount of meat consumed in each institution for each of the four years included in the period from July 1, 1907 to July 1, 1911, and the average daily population, including both patients and employés, who had been maintained upon this supply for each period of 12 months. The Board of Administration very kindly issued the necessary orders and these figures were supplied by the several superintendents to whom we beg to offer our hearty thanks for the work entailed in collecting the necessary data. Similar figures were also furnished by the courtesy of the superintendent of the Cook County Institutions at Dunning. These latter figures cover practically the same four years with the exception that the fiscal year starts on December 1st instead of July 1st as in the State hospitals and consequently the 1911 period is not complete. However, this makes no difference in the results as we are figuring entirely in averages.

AVERAGE DAILY AMOUNT OF MEAT IN OUNCES SUPPLIED TO EACH INDIVIDUAL, INCLUDING BOTH PATIENTS AND EMPLOYES.

	July, 1907, to July, 1908.	July, 1908, to July, 1909.	July, 1909, to July, 1910.	July, 1910, to July, 1911.	Average.
Peoria	5.3	5.8	5.9	8.2	6.3
Anna	11.3	10.9	10.6	9.8	10.65
Chester	6.4	5.0	4.5	6.4	5.6
Elgin	7.1	7.7	6.9	5.9	6.9
Jacksonville	10.6	10.9	11.3	10.5	10.8
Kankakee	8.7	7.8	8.0	8.2	8.2
Watertown	8.2	7.9	8.4	8.3	8.2
Dunning	6.5	6.5	6.6	7.5	6.8

In considering these figures it must be remembered that the weights represent almost entirely uncooked and undressed meats. Secondly, the employés while being absolutely fewer in numbers, receive relatively much

larger abounts of meat. It would be quite impossible to determine exactly what the relative proportion is and since the proportion of employés to patients is approximately the same in the different institutions it is quite permissible to make comparisons on the figures as they stand. It will be noticed that there is a big increase in the Peoria figures between the first three years and the fourth. In part this was due to an actual increase in the amount of meat supplied to each patient but it is also in part to be explained by the fact that during this period many of the attendants who used to live off the grounds of the hospital have been required to take up their residence within the institution.

The actual analysis of the food at the Peoria State Hospital was made during the fourth period July, 1910-July, 1911, so that this figure 8.2 must be used as a basis of comparison. From the results of the analysis by Prof. Grindley and Mr. Wussow we are forced to conclude that the animal protein constituent of the dietary provided at all the State hospitals, with the possible exception of that at Jacksonville, needs to be very considerably raised. It should be remembered that this need not be meat but may be given in the form of milk and eggs and further that the proportion of the protein ingested which is actually used by the body increases with greater variety of food. There is a great tendency, almost necessary from the conditions, to monotony in the daily menus but it should always be borne in mind that this must necessarily mean greater waste.

Without drawing any definite conclusions it may be noted that the number of cases of pellagra have diminished at Peoria and Dunning coincidently with increased meat and have increased at Elgin with diminished meat. This alone is not sufficient to justify their relation as cause and effect and we mention it only as giving food for thought.

XIV.

GENERAL SUMMARY.

(1) Pellagra in Illinois.

A conservative estimate of the number of individuals affected with pellegra in this State from July, 1909, when it was first recognized to September, 1911 would be five hundred. The vast majority of these cases have occurred in the State and County Hospitals for the Insane, notably at the Peoria State Hospital. There has been a progressive diminution in the total numbers of new cases in the three years under consideration in these institutions. It is, however, becoming increasingly evident that there are a considerable number of cases outside the State hospitals although we have no figures which will justify any statement as to the actual numbers. Two somewhat striking foci seem to exist in Chicago and Peoria but it is probable that the disease is prevalent over wide areas.

(2) Clinical Manifestations and Pathology.

Pellagra is a systemic disease characterized by a skin eruption, symptoms of gastro-intestinal disturbances, and more or less well marked general debility and emaciation. The only reliable diagnostic symptom is the skin eruption which begins as a bright red erythema generally upon the backs of the hands. This color becomes more copper-colored in the course of a few days with thickening of the epidermis especially about the knuckles and often with fissures which bleed easily. In severe types bullae form which may rupture and thus give rise to superficial ulcers. In the course of two or three weeks the color becomes gradually darker from increased pigment deposits and begins to desquamate. This stage lasts a variable time from a few weeks to several months at the end of which the appearance is pink and delicate-looking like that of an infant. Following this it gradually returns to a normal condition. The chief points in diagnosis are the course; the more or less absolute symmetry on the two sides of the body; the sharp line of demarcation from the healthy skin; and the absence of marked itching and pain. The commonest sites are the backs of the hands and lower parts of the forearms often extending as a cuff around the wrist just above the palm; the elbows and areas on the inner sides of the arms and forearms; the forehead and cheeks; the neck and finally the dorsa of the feet. At times the eruption is widespread over the whole body. Denudation and swelling of the tongue with sometimes ulceration, inflammation and even ulceration of the mucosa of the cheeks, gums, and lips should probably be regarded as similar manifestations to the skin eruption. Excoriations about the anus and genitalia, with inflammation of the mucosa of the vagina are fairly common.

The gastro-intestinal symptoms are very frequent but not always marked and may be absent. They consist of diarrhoea with liquid putrescent stools of peculiar odor, which is thought by some to be characteristic. More or less anorexia is present as a rule but sometimes appetite is excessive.

Emaciation and general weakness are present in a degree more or less corresponding with the severity of the gastro-intestinal symptoms.

Besides these features there is a great tendency to the development of mental disorder of delirious type and in the late stages to the occurrence of the central neuritis syndrome.

The *course* of the disease is extremely variable. In many cases it consists of annual exacerbations lasting one or two months with apparent recovery in the intervals. Some patients seem to have one attack and then to recover, at any rate without recurrence during one pellagrous season. The percentage of recurrences in individuals recovering from an attack in 1909 was 31.25 in 1910 and 13.24 in 1911. Of the 1910 attacks which did not prove fatal only 8.6 percent recurred in 1911.

Death may result in any attack whether the first or a later recurrence. This may transpire during the acute phase apparently from general exhaustion, or at a later period after all characteristic pellagrous lesions have disappeared, with symptoms of central neuritis. Pathologically one case dying during the acute stage presented lesions resembling those of central neuritis although the characteristic clinical syndrome was not observed during life. The mortality has been very high in this State Pellagra being given as the immediate cause of death in 49.61 percent of the 258 cases at the Peoria State Hospital. Of the 408 cases recorded 189 or 46.3 percent are dead although in some of these instances intercurrent disease seemed to be the actual cause.

Symptoms which appear to be of bad *prognostic import* are the early appearance and severe degree of gastrointestinal and mouth symptoms, marked emaciation, and the occurrence of nervous symptoms such as delirium and signs of central neuritis.

Treatment has seemed to have but little if any influence upon the course of the disease. Arsenic has been used in various forms but the cases so treated do not seem to have shown any more favorable outcome than those without it. We can recommend only general measures such as careful nursing and diet, the avoidance of exposure to the sun which seems to aggravate the skin lesions together with the copious administration of fluids, which may if necessary be given by hypodermoclysis.

In many cases, very little local treatment is required. Where the inflammatory reaction is marked, soothing lotions, such as the zinc-oxide and aqua-calcis lotion, are beneficial:

Zinci oxidi	20
Pulv. amyli	15
Sodii biborat	10
Aqua calcis	120
Aqua rosae qs	240

M. et Sig. Ext. Use.

In certain cases, equal parts of olive oil and lime water, applied during the irritative stages either as a wet dressing or directly to the skin, make a useful dressing. In case pyogenic infection follows, this is best treated with wet dressings of either normal-salt solution or boracic-acid solution to promote drainage. This may be later followed by a mild white precipitate ointment. At a later stage, as the inflammatory process becomes subacute, protective ointments and pastes, such as the zinc-oxide ointment or the Lassar paste, serve a useful purpose:

MODIFIED LASSAR PASTE.

Acidi salicylici	1
Pulv. amyli	25
Zinc oxidi	25
Lanolini	25
Ung. petrolat. qs	100

M. et Sig. Ext. Use.

There are many cases, however, in which no local treatment is indicated, as the process runs its course and subsides without inconvenience to the patient.

Feces—The stools of pellagrins are exceedingly variable in character. In general, there is a marked diarrhœa during the acute attack, with frequent watery evacuations, nearly always very foul-smelling. Later, the stools become less fluid, and contain abundant mucus. Blood and epithelial cells are frequently observed in severe cases.

The numerical relationships of the normal forms of fecal bacteria are more or less disturbed, and new forms of bacteria of several different kinds appear in the feces in appreciable numbers. Protozoa, especially amebae and flagellates, are frequently found.

Cultures of the fecal bacteria in the various stages of pellagra also indicate disturbances of the normal relationships of the intestinal bacteria. In addition to this, some forms of bacteria not ordinarily found in the feces of healthy men are found here in appreciable numbers.

There is some evidence indicating that some of these bacterial and protozoal forms play a part in producing some of the pathological changes observed in the cases of pellagra which we have studied. Whether any of them is a primary factor in the disease itself, or whether they are all secondary invaders with no essential causal relation to pellagra, cannot be decided from the evidence at hand. For those forms which have been studied more particularly by us the latter hypothesis seems to be the more probable. Nevertheless, these bacteria and protozoa seem to be worthy of further attention.

Blood—Moderate anaemia is the rule with a color index which is frequently normal or even slightly above. Leucocytosis occurs occasionally in severe cases but as a rule the number of white cells is within normal limits. There appears to be no characteristic change in the relative proportions of the different varieties of white cell.

No abnormalities are noticeable in the size, shape and staining properties of the red cells. No abnormal bodies have been found either in fresh or in stained specimens. Cultures have been almost all sterile.

Urine—Indican has been increased and there are variations in color, quantity, specific gravity and composition. A trace of albumen with hyaline casts are not uncommon.

Cerebro-spinal fluid shows no increase of cell elements or albumen content and cultures have been uniformly sterile.

Complement fixation tests with the blood serum of pellagrins as an amboceptor and extracts of pellagrous liver, tongue, and spleen as antigen have given results which cannot be regarded as specific at present. Negatives with positive cases, and positives with normal sera have been encountered too frequently to permit of any interpretation.

Anaphylactic tests by von Pirquet's method using extracts of healthy and damaged maize have proved uniformly negative.

The *post mortem* findings are those of a generalized intoxication. Fatty degeneration of the liver with inflammation and ulceration of the intestinal mucosa and the occurrence of islets of subacute inflammatory exudate in the portal canals of the liver suggest an intoxication of intestinal origin which may be either primary or secondary. There is nothing characteristic of pellagra in the lesions found in the nervous system, they can only be regarded as evidence of an intoxication.

(3) Animal Experimentation.

Inoculations of monkeys and other animals with tissue emulsions and body fluids have been entirely unsuccessful.

Feeding with the dejecta of human pellagrins has given rise to no symptoms. Similar negative results were obtained from inoculation with organisms isolated from the stools.

Feeding experiments with maize both healthy and in a spoiled condition have been without result.

Injection of extracts from maize contaminated with five different moulds was found to be toxic in one instance only, the organism being Monascus purpureus. Another sample containing a blue-green Penicillium and contaminated with bacteria was highly toxic.

(4) Diet.

Maize has formed but a small part of the hospital dietaries and the quality used has been excellent. Careful observations of a squad of individuals fed with a large excess of corn products for a period of 12 months compared with a similar number given a strictly corn-free diet revealed no differences in the number of cases or the severity of pellagra which developed in both.

Detailed study of the general diet of the Peoria State Hospital reveals a deficiency in protein constituents and especially in animal protein. Comparisons between the average amount of meat supplied to the inmates of the Peoria and other State hospitals suggest a greater or less degree of deficiency in animal protein in all. It is also noticeable, although it may be quite accidental, that pellagra has diminished in Peoria and Dunning, coincidently with an increase in meat supply while at Elgin the number of pellagrins has increased with a decrease in the amount of meat provided per capita.

The *chemical analysis* of one pellagrous brain shows no deficiency in sulphur or phosphorus but only a disturbance in the combinations of the former. This is quoted here only in relation to the possibility of a deficiency in certain elements in the diet which has been suggested as a cause for pellagra.

General Discussion of Theories as to Etiology.

The various conceptions as to the etiology of pellagra have already been enumerated under the head of "Current Views upon Pellagra" as the basis upon which the work of this commission was planned. It is therefore only necessary here to discuss the bearing of the work accomplished upon these different theories. This can with advantage be arranged under the same two main headings.

1. *In Relation to Maize*—It may be said that all work directed to this question has uniformly yielded negative results. The evidence collected in this report all tends to discredit any such assumption and while we fully appreciate that negative findings can never be accepted as positive proof for or against any given proposition, it nevertheless seems to us that the burden of proof must rest with the zeists. The following facts may be especially emphasized as tending to discredit any causal relations between maize and pellagra: (1) *Sound maize* (a) Excessive corn feeding was not accompanied by more pellagra than was observed in individuals kept upon a strictly corn-free diet other conditions being, as far as possible, identical as regards the age, sex, mental and bodily condition, habits and occupation of the patients and the size, location and general arrangement of the buildings, although cases developed under both conditions. (b) Maize products constituted only a moderate proportion of the general diet of those affected. (c) Cutaneous tests in pellagrins with extracts of corn gave rise to no anaphylactic symptoms. (2) *Damaged Maize.* (a) The corn used in the State institutions has been of high grade. (b) All experimental work has necessarily been performed upon animals. In none have there been any pellagra-like manifestations and in fact with few exceptions the toxicity has been low. (c) Cutaneous anaphylaxis tests with extracts from damaged corn were negative.

If one adds to these direct observations the keen critical analysis by Sambon of the foundations upon which the maize hypothesis rests one cannot but feel that the arguments in its favor are extremely slender.

2. *Antizeist Theories*—As long ago as 1905 Sambon[1] discussed the probability that pellagra was an infective disease, the causative agent of which was carried by some blood-sucking insect. His reasoning is based upon analogies with other infections of that character. The main grounds are: (1) The seasonal recurrence. (2) The existence of endemic foci while apparently the disease is not contagious. (3) The fact that recurrences occur in previously infected individuals even after they have been removed from the infected locality. These recurrences occur at the same seasons of the year.

All investigations carried out by us with the object of demonstrating the presence of a blood parasite have so far failed. Nevertheless, it is quite possible that a parasite may live and propagate in the blood but require special methods for its demonstration, not yet discovered. The failure to produce pellagra in animals with such infected blood may well be the consequence of various reasons. For instance it is quite possible that, as Sambon supposes, some second phase of existence in an intermediate host such as the biting insect, may be necessary. Again the animals used for experimentation may not be susceptible. It is thus quite obvious that the negative findings so far enumerated cannot be accepted as entirely controverting this theory.

Post mortem findings do suggest a possible nidus for the growth of an organism in the intestine, a suggestion which might be considered as especially plausible from the clinical picture. Nevertheless, it must always be remembered that the infection of the intestinal tract may be secondary to, and not causative of, pellagra. We have studied the fecal flora with especial care and do not consider that our findings justify us in making any claim for them as primary causal factors.

The relation of simulia to pellagra, hypothecated by Sambon, finds but little support from the researches we have been able to make. The particular variety, S. Reptans, which he claims to be of world-wide distribution is said by Professor Forbes to be unknown in North America as yet except in Greenland.

Quite recently and therefore not included in the statistical studies, we have had the opportunity to observe two cases, both apparently first attacks, in which pellagra developed during the winter months following several weeks of intensely cold weather. One of these arose at the Kankakee State Hospital, the first symptoms being observed on December 24, 1911. This patient had been an inmate of the hospital more than a year and had shown no previous signs of pellagra. The attack was severe and ended fatally. The second case developed on December 31, 1911 at the Jacksonville State Hospital. This man had also been under observation in the hospital for over a year. Professor Forbes informs us that the latest date on which Simulia have been captured in the adult form in Illinois is October 24th. It would therefore be necessary to concede an extremely long incubation period in order to explain these cases upon the theory that the causa morbi is borne by these insects.

This discussion would not be complete without consideration of the problems of prevention. The evidence seems conclusive that poor nutrition is an important factor in predisposing to the disease although we fully admit and can confirm the occurrence of pellagra in persons well nourished and apparently robust. The investigation of the dietaries of the State institutions reveals no defect in quality or quantity but only a low animal protein content. The Italian peasantry have suffered more from pellagra than any other people and their diet consists almost exclusively of maize in the form of polenta. They eat practically no meat, fish, milk or eggs. In fact it may

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[1] British med. journ., vol. II, 1905, p. 1272.

be said that meat becomes a luxury in all conditions of poverty. Maize has a large protein value but this apparently cannot satisfactorily take the place of animal protein altogether. It may be then, that conditions in which the animal protein constituent of the diet is low, constitute a predisposing factor to infection with pellagra. We emphatically do not wish to be misunderstood in making this suggestion. The dietaries of the State hospitals in Illinois are fully up to the usual standards in such institutions elsewhere and we do not consider that pellagra is due to lack of food or even to deficiency in any particular constituent of the food. Our impression is rather that pellagra is due to infection of the body with some micro-organism. It does seem possible, however, that a diet deficient in animal protein may so alter the body that the infecting organism has a better chance to grow.

XV.

CONCLUSIONS AND RECOMMENDATIONS.

In closing this report we feel that certain conclusions are advisable for the purpose of representing our views upon the lines which should be followed in further studying and dealing with this problem. They are purposely expressed in general terms:

(1) According to the weight of evidence pellagra is a disease due to infection with a living micro-organism of unknown nature.

(2) A possible location for this infection is the intestinal tract.

(3) Deficient animal protein in the diet may constitute a predisposing factor in the contraction of the disease.

(4) The number of cases of known pellagra renders this disease a decided menace to the public health of this State.

(5) Careful search for, and investigation of, suspected cases outside the State hospitals for the insane is extremely desirable in view of experience elsewhere.

We therefore beg respectfully to recommend:

(1) That a new commission be appointed and funds provided for a continuance of this investigation with adequate assistance.

(2) That as a prophylactic measure the animal protein content of the State Hospital dietaries be increased.

(3) That the State Board of Health be advised to require notification of all cases of pellagra.

(4) That this commission be relieved of its duties.

Respectfully submitted,

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