PELLAGRA

FIRST PROGRESS REPORT

OF THE

THOMPSON-McFADDEN PELLAGRA COMMISSION

OF THE

NEW YORK POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL

BY

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Through the instrumentality of Dr. George N. Miller, at that time president of the New York Post-Graduate Medical School, funds were donated by Col. Robert M. Thompson of New York City and Mr. J. H. McFadden of Philadelphia to support a research expedition for the investigation of pellagra in the United States. It was decided that if possible a commission of three would be formed, one member to be designated by the Surgeon-General of the Army, one by the Surgeon-General of the Navy and one by the authorities of the New York Post-Graduate Medical School. Dr. Jonathan Wright, director of laboratories at the medical school, was requested by the school authorities to act in an advisory capacity. The commission was constituted as follows: Captain J. F. Siler, Medical Corps, U. S. Army, representing the Medical Corps of the U. S. Army; Passed-Assistant Surgeon P. E. Garrison, U. S. Navy, representing the Medical Corps of the U. S. Navy, and Dr. W. J. MacNeal, Professor of Bacteriology and Pathology and Assistant Director of Laboratories, New York Post-Graduate Medical School, representing the New York Post-Graduate Medical School.

It was decided that the investigation should be conducted along two lines: first, an epidemiologic study of pellagra in an endemic area of the South; and, second,

* From the Division of Tropical Medicine, Department of the Laboratories, New York Post-Graduate Medical School and Hospital. Read at the Pellagra Meeting at Spartanburg, S. C., Sept. 3, 1913.

biologic, pathologic and chemical studies in New York City and elsewhere. The epidemiologic studies were undertaken by Passed Assistant Surgeon P. E. Garrison of the U. S. Navy and J. F. Siler, Captain Medical Corps, U. S. Army.

A field headquarters was established in the South early in June, 1912, and the field studies were continued until Oct. 15, 1912. The Bureau of Entomology of the U. S. Department of Agriculture, early in the spring of 1912, detailed Mr. A. H. Jennings and Mr. W. V. King to investigate the possible etiologic relationship between insects and pellagra. These entomologists were in South Carolina when the field headquarters of the commission was established, and through the courtesy of Dr. L. O. Howard, Chief of the Bureau of Entomology, it was arranged that these investigators and this commission should undertake cooperative work in the same territory.

Biologic, pathologic and chemical studies were undertaken in the laboratories of bacteriology, pathology and pathologic chemistry of the New York Post-Graduate Medical School under the supervision of Dr. Jonathan Wright, Director of Laboratories, and Dr. W. J. MacNeal, a member of the commission. The researches along these lines were carried out by Dr. W. J. MacNeal, Dr. O. S. Hillman, Dr. R. M. Taylor, Dr. V. C. Myers and Dr. M. S. Fine. In order to obtain material for these investigations, selected patients were sent to New York from the endemic area, pathologic material was collected in the field, and other material was supplied to the commission through the courtesy of Dr. J. W. Babcock of Columbia, S. C. Studies of the pathologic material are being undertaken by Dr. H. Douglas Singer of the Illinois State Psychopathic Institute.

Several detailed papers constituting a preliminary or progress report have been published during the past year. It is the purpose of this present paper to summarize briefly the observations recorded in these separate reports, to discuss their bearing on the various theories concerning the causation of pellagra and to express in a tentative fashion some of our opinions which are based thereon.

THE FIELD WORK IN SPARTANBURG, S. C.

The epidemiologic studies have led to the accumulation of a very large mass of data concerning the occurrence and distribution of pellagra in Spartanburg County,

S. C., in regard to the cases themselves and their conditions in life. Some of this material has been presented in a preliminary fashion in a paper by Siler and Garrison.[1] They have summarized the matter as follows:

1. Pellagra shows a striking inequality of distribution in ten townships within the county, the township rate of prevalence per ten thousand of population varying from 0 to 71. The city of Spartanburg, with a population of 17,517, gave a rate of 49 per ten thousand against 34 per ten thousand for the remainder of the country.

2. Density of population, while showing a tendency to conform to the relative prevalence of the disease, does not alone offer an explanation of the geographic inequalities of its distribution within the county.

3. The cotton-mill village population gives a rate of prevalence of 104 per ten thousand against 19 per ten thousand for the remainder of the county and against 16 per ten thousand for the rural sections alone.

4. The variations in the rates of prevalence in the ten townships are in a measure proportional to the presence or absence of a large mill-village population. Excluding the mill-village population, there is still a marked discrepancy between the townships, the rate of prevalence in the rural population ranging from 0 to 29 cases per ten thousand of population. The excessive prevalence among the farming classes is found in the townships which have a relatively large mill-village population.

5. The white population of the county gives a prevalence of 45 cases per ten thousand; the negro population a prevalence of 9.5 per ten thousand. Excluding the mill-village population which is practically all white, the remaining white population still gives a rate of prevalence (25.2 per ten thousand) over two and one-half times that among the negroes.

6. The rate of prevalence per ten thousand for males in the county is 17; for females, 50.5. White males give a rate of 22.95 per ten thousand; white females, 87.5 per ten thousand; negro males, 3.9 per ten thousand; negro females, 14.9 per ten thousand.

7. The rate of prevalence among children under 10 years of age and among adults aged 45 years and older, is practically equal in the two sexes.

8. The rate of prevalence drops among males between the ages of 19 and 45 years, whereas for females there is a remarkable excess of prevalence between these ages.

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1. Siler and Garrison: An Intensive Study of the Epidemiology of Pellagra, Report of Progress, Am. Jour. Med. Sc., July, 1913, p. 42, and August, 1913, p. 238.

9. In both males and females there is a striking fall in prevalence between the ages of 10 and 20 years.

10. The most significant fact with regard to occupation is the excessive prevalence of pellagra among women employed in housework.

11. The excessive prevalence of pellagra in the mill-village population is found largely among women and children at home during the day. Among actual mill-workers the rate of prevalence in the two sexes appears to be about equal.

12. One-half of the cases occurred singly in one family; about one-fourth occurred two in one family; the remaining fourth occurred in groups of three, four or five in one family. The question of the possible relative importance of family relationship and household association is still under investigation.

13. Among cases occurring singly in families, the proportion of children of both sexes under 10 years of age is low and that of adult females excessively high. Among cases occurring two or more in one family the proportion of young children is relatively high, especially among males.

14. While apparently authentic sporadic cases of pellagra within the county can be traced back to as early as 1894, the disease does not appear to have occurred in any great number of cases in any year until 1908. Since 1908 the incidence rate appears to have rapidly increased each year to 1911. The number of new cases developing in 1911 appears to have been slightly greater than in 1912.

15. There was no evidence pointing to any spring and fall recrudescence of the disease in the population, so frequently referred to in the literature of pellagra. There is no particularly marked tendency for the seasonal recurrence to appear in an individual during the same month, year after year.

16. Influence of Climate: Climatic conditions appear to influence the development of symptoms of the disease. If during the spring months precipitation is high, temperature low and number of rainy days excessive, the appearance of acute symptoms, more particularly those involving the skin, is delayed.

17. Symptomatology: It would appear that three or four years ago a large proportion of the cases observed in the county presented intestinal and nervous symptoms of great severity. In 1912, in many instances, symptoms were quite mild and sometimes were confined almost exclusively to the cutaneous system, the disease appearing to be of a less virulent type in 1912 than in previous years.

18. Economic Status: In the majority of cases (85 per cent.) economic conditions are poor and the disease is most prevalent among people of insufficient means.

19. Predisposing Diseases: General health conditions in childhood do not appear to warrant consideration as etiologic factors when the disease develops in adult life. In a number of cases the development of pellagrous symptoms in children was preceded by one of the acute exanthematous diseases of childhood. About one-fourth of the cases gave a history of a preceding chronic disease in adult life. In more than one-half of the cases (62 per cent.) the history was that of good health. Among adult females, those most affected were married women (86 per cent.) and 86 per cent. of the married women had borne children. A history of illness immediately preceding the development of pellagra was elicited in 59 per cent. of the cases.

20. Hygiene and Sanitation of Houses and Premises: The most insanitary condition found in the county is the absence of properly constructed privies. Outside of a part of the city of Spartanburg, which is supplied by a water-carriage sewage system, there is no effective provision in the county for the proper disposal of human excreta. A second striking insanitary condition is the almost complete absence of effective screening of dwellings. These two conditions present a situation highly favorable to the transmission of disease organisms eliminated in the excreta, both by direct contamination of food and person and by insects. This situati is naturally aggravated in the mill-villages and small towns by the greater congestion of houses. The absence of effective screening for dwellings gives rise to conditions conducive to the possible transfer of diseases transmitted by biting insects.

21. Dietary: Observations on the habitual use of the more common foodstuffs failed to discover any points of difference between pellagrins and non-pellagrins in the county or any facts which would seem to explain the strikingly greater prevalence of pellagra among certain classes of the population.

The most striking defect in the general dietary of the working classes, appears to be the limited use of fresh meats, the animal protein being supplied largely in the form of cured meats, of which salt pork (especially bacon) is the most important.

Unhygienic preparation of food appears to be a probable important factor in the general health of the population.

Investigation of the kind, quantity and quality of corn and corn products used in the county, failed to bring to light any epidemiologic evidence pointing to the agency of corn as an etiologic factor in the disease. The presence of two cases in our series giving a definite history of no corn consumption within two years prior to the onset of symptoms, together with several other cases* in which corn products were eaten, if at all, only in small quantity and at extremely rare intervals, would seem to argue strongly against any hypothesis that corn products alone are the causative agent of the disease.

In intimate collaboration with the field party of the commission, Mr. A. H. Jennings and Mr. W. V. King, members of the staff of the Bureau of Entomology, U. S. Department of Agriculture, have pursued thorough studies of the insects which seemed worthy of attention as possible carriers of pellagra in Spartanburg County. The results obtained by these investigators have been presented in two papers.[2]

The following is quoted from their conclusions:

Ticks, lice, bed-bugs, cockroaches, horse-flies, fleas, mosquitoes, buffalo gnats *(Simulium)*, house-flies and stable-flies *(Stomoxys)* were under consideration. Of these, horse-flies have nothing and cockroaches little to support them.

Ticks and fleas are excluded on account of their scarcity and the nature of their biting habits. In view of these characteristics, it is doubtful if even the existence of an animal reservoir of infection would bring the groups into prominence.

Lice and bedbugs do not account for the sex or age incidence or the rural nature of the disease; the scarcity of the former species is an additional reason for its exclusion.

The rarity of mosquitoes here and the lack of coincidence between their distribution and that of pellagra for the state in general, together with the night-biting habits of the local species, which fail to account for the sex incidence, seem sufficient cause for their elimination.

House-flies *(Musca domestica)* should be active if the malady is an intestinal infection in which the germ is passed with the feces, with contaminated food acting as the vehicle of infection.

The buffalo gnats *(Simulium)* should be eliminated, principally on account of their biting habits and lack of intimate association with man, also possibly by their comparatively moderate abundance (in our territory). We find that in Spartanburg County they are hardly known as a pest of man and when they do attack him, the nuisance is local and largely confined to field workers. Had Sambon's theory not been advanced, these flies could hardly have attracted suspicion of any connection with pellagra in this country.

The stable-fly *(Stomoxys calcitrans)* displays certain salient characteristics which seem to qualify it for the rôle of a transmitter of pellagra.

The range of this one species covers and exceeds that of pellagra; its seasonal activity, likewise, is coincident with that of the disease and, although its period of greatest abun-

2. Jennings and King: The Journal A. M. A., Jan. 25, 1913, p. 271; Am. Jour. Med. Sc., September, 1913, p. 411.

dance is somewhat later than the maximum intensity of pellagra, its appearance in spring precedes that of most of the spring recurrences and new cases, at which time it is already abundant; it is an abundant species, its abundance being most manifest in rural districts, thus corresponding with the rural nature of pellagra, its numbers amply fulfilling our conception of those necessary to effective disease transmission; it bites by day only, thereby offering an explanation of the phenomenon of sex incidence and the related one of age distribution; it is intimately associated with man and habitually infests his vicinity and enters his dwellings; it bites man frequently and persistently; its longevity seems sufficient for the development of a hypothetic causative organism; it is readily and frequently carried long distances and might thus account for the occurrence of sporadic cases of the disease.

THE LABORATORY WORK IN NEW YORK

The material for the studies made in New York was obtained by sending patients suffering from pellagra from the field headquarters in South Carolina to the Post-Graduate Hospital in New York City. Altogether fifteen patients were sent to New York during the summer. All these patients showed a typical eruption on the skin and there was considerable variation among them as to the severity of the disease, stage of eruption, general physical vigor and financial status. The detailed observations on these patients have not yet been published. One of them remained under observation in the hospital only two days and was then removed to the house of relatives near New York. The other fourteen patients remained under observation until the acute manifestations of pellagra had disappeared and the physical condition of the patients warranted their return home. No specific medication was employed during the attack of pellagra in any of the cases but arsenic was given to two of the patients, after the acute manifestations of the disease had passed, in the form of sodium cacodylate in one case and as Fowler's solution in the other. The detailed observations on these cases and their subsequent history we hope to present in a later report.

The material for laboratory examination was largely obtained from these patients, but in addition samples of blood-serum, blood-films and some other material were obtained from patients in South Carolina and sent to the laboratory in New York.

The histology of the blood was studied by Dr. O. S. Hillman, Lecturer in Pathology at the New York Post-Graduate Medical School, and his report has already appeared.[3] He found a variable degree of chloranemia—not constituting, however, a prominent feature of the disease—and not infrequently a leukocytosis, apparently inexplicable in the light of our present knowledge of the disease. Lymphocytosis was present in the great majority of cases and may be correlated with the general cachexia of the patients and with the presence of digestive disorders. No characteristic or constant variations were detected in the large mononuclear leukocytes or in the eosinophil cells.

The chemical studies on the patients in New York were carried out by Prof. V. C. Myers and Dr. M. S. Fine and have been reported in detail.[4] The study includes analyses of the gastric juice, quantitative estimation of the food intake and quantitative analysis of the urine and feces of the patients during certain periods of their stay in the hospital. The results of this work have been summarized as follows:

The ability of individuals suffering from pellagra to utilize the various foodstuffs as indicated by our series of fifteen experiments appears to be only slightly if at all below the normal.

The elimination of mineral and nitrogenous constituents in the urine is such as would be anticipated under the dietary and physical conditions of the individuals. A lowered physiologic efficiency is indicated by the low creatinin coefficients and the elimination of small amounts of creatin in the urine. The presence of a few hyaline casts in about 45 per cent. of the cases points to some possible irritation of the kidney.

Anacidity is a condition common in pellagra, found in eight of our fourteen cases. It is generally associated with an entire absence of pepsin, or with pepsin in only very minute quantities.

Individuals suffering from pellagra show a marked indicanuria, which is excessive in the cases with gastric inefficiency. Though the ethereal sulphate hardly parallels the indoxyl-potassium sulphate, the quantities eliminated are much higher where anacidity exists and they furthermore hold a higher ratio to the inorganic sulphates.

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3. Hillman: Some Hematologic Findings in Pellagra, Am. Jour. Med. Sc., April, 1913, p. 507.

4. Myers and Fine: Metabolism in Pellagra, Am. Jour. Med. Sc., May, 1913, p. 705.

The feces contain decidedly abnormal amounts of indol and skatol, especially the latter.

The presence of excessive amounts of indican in the urine, associated with a high elimination of ethereal sulphates, when considered in connection with the abnormal amounts of indol and skatol in the feces, points to some unusual bacterial conditions in the intestine. From the data at hand this putrefaction would appear to take place rather high up in the intestine.

The bacteriologic studies[5] were directed more particularly to the possible relation of intestinal bacteria to pellagra and a large number of agglutination tests were made with various bacterial strains. One of these seemed to react with the blood of pellagrins more frequently than with blood of other individuals, but we have not succeeded in establishing a specific relation of this organism to the disease. The quantitative changes in the bacterial flora of the feces are such as might be expected in irritation of the digestive tract. Numerous attempts to produce the disease in monkeys (*Macacus rhesus*) by the injection of defibrinated blood were without definite result.

RELATION OF THE REPORTED OBSERVATIONS TO THE VARIOUS THEORIES CONCERNING THE ETIOLOGY OF PELLAGRA

The theory that pellagra is due to the ingestion of maize or maize products, either good or spoiled, seems to us wholly inadequate to explain the distribution of the disease actually observed in Spartanburg County, S. C., in 1912, not only because typical severe cases of the disease were observed in those who had abstained from the ingestion of corn for a considerable time, but also because there could be discovered no essential difference in respect to the consumption of corn between those suffering from pellagra and those free from the disease.

The conception that pellagra is an infectious disease in some way transmissible from person to person seems to us to be strongly supported by many of the field observations. The higher incidence of pellagra in the more populous districts and the indications of its occurrence in definite foci are in accord with this idea, and, furthermore, the definite tendency to self-limitation of the attack in the absence of specific therapy and during the

5. MacNeal: Observations on the Intestinal Bacteria in Pellagra, Am. Jour. Med. Sc., June, 1913, p. 801.

continuance of a corn diet bears a very suggestive resemblance to the course of an infectious disease. All the members of the commission and every one of the investigators associated with us in the work have come to regard pellagra as an infection in all probability and many of us would state that as our opinion without any reservation whatever.

Concerning the particular mode of transmission of the disease, the observed evidence does not appear to us to be at all conclusive. The theory of Sambon that pellagra is transmitted by a blood-sucking fly of the genus *Simulium* is based on epidemiologic evidence and apparently to a large degree on the conception that pellagra is a disease of field workers and those who go frequently into the fields. In Spartanburg County pellagra appears to be more especially prevalent in the factory villages and has a higher incidence in the City of Spartanburg itself (population 17,517) than in the less thickly populated remainder of the county. Furthermore, the adult males (the class of the population from which the field workers are largely drawn) show a striking relative freedom from the disease in our statistics. Indeed, one may go farther and say that pellagra in Spartanburg County, although it shows a tendency to attack all classes of the population, is more especially a disease of the women and children in the villages of the cotton-mills. Furthermore, it may be stated that in spite of the abundance and universal occurrence of *Simulium* in the area studied, we have been unable to elicit a history of frequent biting of man by buffalo gnats or black flies in Spartanburg County and this point has been inquired into with special care in the cases of pellagra observed. The experience of the field workers of the commission itself, who have spent day after day in the homes and environs of the pellagrins in Spartanburg County, has failed to note a single instance in which anyone of them personally has been attacked by a fly of the genus *Simulium* during the season of 1912.[6]

A comprehensive consideration of the insect life in the county undertaken by Mr. A. H. Jennings and Mr. W. V. King of the Bureau of Entomology, U. S. Department of Agriculture, has led them to the conclusion that if the distribution of pellagra is to be accounted for by a blood-sucking insect, the observed facts in Spartanburg

6. During 1913 two instances of biting by gnats of the genus *Simulium* have been noted by the investigators.

County point to *Stomoxys calcitrans* as the most probable insect carrier. This opinion is shared by the members of the commission. We do not regard the evidence of transmission of pellagra by a blood-sucking insect in this county as at all conclusive, but we do consider it an important field for further observation.

The possible relation of an insufficient diet to the occurrence of pellagra has received careful consideration and we are inclined to ascribe considerable importance to it, not as the sole or essential cause of pellagra, but as a predisposing factor. The foods rich in animal protein, namely, meat, milk and eggs, although apparently used in abundance by a few individual pellagrins in our series, are, nevertheless, conspicuous by their deficiency in many of the cases. The use of these foods may perhaps be regarded as an index of economic condition and the variation in the incidence of pellagra be explained as due to economic factors in general. We are inclined, however, to regard the relation of nutrition to pellagra as a more direct one. The thesis that deficiency in the quality and quantity of food can be regarded as the essential cause of pellagra seems to us not to be supported by our studies. The fact is that a poorly nourished community generally shows a higher incidence of pellagra than one on a higher plane of nutrition, and, further, that those individuals in a community who are more poorly nourished seem more liable to develop pellagra. There is abundant evidence that other weakening factors, such as exanthematous disease, childbirth and tuberculosis, may play important rôles as predisposing factors. We are inclined to lay stress on the indication apparent in our statistics that poor nutrition or other predisposing cause results in pellagra only when the individual in question has lived in a relatively close association with a previous case of pellagra. The great mass of the population living under the same general conditions of environment and using the same food but living at a greater distance from cases of pellagra escapes the disease.

Our ideas concerning the location of a hypothetic infectious agent in the body of the pellagrin and the exact mode or means by which it gains the body of a new victim are very indefinite. The possibility of transmission by blood-sucking insects has already been considered. This hypothesis calls for the presence of the parasite in the blood or in the superficial tissues of the body.

We are not aware of other important reasons for supposing that the hypothetic parasite exists in either of these situations. The gross and microscopic appearances and the distribution of the skin lesions as well as the histologic changes in the nervous system have been generally regarded by pathologists as reactions to a general intoxication rather than to local infections.[7] No micro-organisms have been recognized in these lesions. The possibility that such may exist there cannot, however, be excluded.

The possible localization of the hypothetic parasite in the digestive tract has seemed to us to be worthy of careful consideration. The observed distribution of the disease in Spartanburg County is in accord with the conception that pellagra may be transmitted through contamination of food with the excretions of pellagrins. Its greatest prevalence is in those places without adequate provision for the disposal of human wastes. The agreement between the distribution of the open surface privy close to the unscreened dwellings and the distribution of pellagra is in many instances rather striking. The quite constant presence at necropsy of pathologic lesions in the intestine, acute or chronic inflammation, ulceration and atrophy of the intestinal walls in the later stages, as well as the common occurrence of gastro-intestinal symptoms early in the course of the disease are in accord with this hypothesis, although of course they may also be explained as secondary phenomena. In our opinion the view that pellagra is an intestinal infection, transmitted by contaminated food, to which the individual is rendered more susceptible by malnutrition, poorly selected or poorly prepared food and by the common gastro-intestinal disturbances resulting from errors in diet, is a conception worthy of much further study.

These views are expressed at this time to serve as a general summary and conclusion to the series of papers which constitute the first progress report of this commission. Many, but not all of the observed facts on which it is based have been presented in detail in these separate papers. We hope to supplement and extend the observations during the second year of the investigation and

7. Ormsby and Singer: Clinical and Pathologic Studies, Rep. of Pellagra Commission of State of Illinois, Springfield, Ill., 1911, p. 16; Singer and Pollock: The Histopathology of the Nervous System in Pellagra, The Archives Int. Med., June, 1913, p. 565; Mott: The Histologic Changes in the Nervous System of Dr. Box's Case of Pellagra, Brit. Med. Jour., July 5, 1913, p. 4.

expect to present in a later report results of all the work in greater detail, together with ample discusssion.

SUMMARY

1. The supposition that the ingestion of good or spoiled maize is the essential cause of pellagra is not supported by our study.

2. Pellagra is in all probability a specific infectious disease communicable from person to person by means at present unknown.

3. We have discovered no evidence incriminating flies of the genus *Simulium* in the causation of pellagra, except their universal distribution throughout the area studied. If it is distributed by a blood-sucking insect, *Stomoxys calcitrans* would appear to be the most probable carrier.

4. We are inclined to regard intimate association in the household and the contamination of food with the excretions of pellagrins as possible modes of distribution of the disease.

5. No specific cause of pellagra has been recognized.

Twentieth Street and Second Avenue.

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II.

AN INTENSIVE STUDY OF THE EPIDEMIOLOGY OF PELLAGRA. REPORT OF PROGRESS.[1]

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I. GENERAL PLAN OF THE WORK. Although the Thompson-McFadden Pellagra Commission will continue its work in the field during 1913, it is considered advisable and warranted to set forth at this time in a brief preliminary report certain results of the epidemiological study made in 1912.

It was decided that an intensive study of the disease as it occurred among the population of a limited area would yield more valuable epidemiological information than a more superficial investigation over an extended area, conducted by correspondence and by brief studies in a number of different localities. No such intensive epidemiological study within a small area seems to have been previously undertaken in pellagra, while much data gathered by the more general methods are already available in the literature.

For the collection of data a blank booklet was prepared, covering points considered of possible significance regarding the patients themselves, their families, their residences, and the neighborhood in which they lived. In order to secure these data, each patient was visited one or more times in his or her own home.

In this preliminary report only summarized data will be included. The detailed epidemiological data for each case, and certain more intensive studies made in selected localities within the county, will appear in the report to be issued on completion of the investigation.

[1] Reprinted from the American Journal of the Medical Sciences, July and August, 1913 Nos. 1 and 2, vol. cxlvi, pp. 42 and 238.

The problem immediately before the commission in all its work was the etiology of pellagra and not its symptomatology or therapeutics, except as these subjects might throw light upon the essential nature of the disease. In view of the essential importance of diagnosis in our work, the conservative position was taken that a positive diagnosis would be made only when the characteristic skin lesion was evident or its earlier presence could be definitely ascertained by the testimony of patient and physician, though this requirement might, and ultimately did, exclude from our records cases which in all probability were suffering from pellagra without showing evidences of its cutaneous manifestation.

II. Acknowledgments. It is not practicable to make personal acknowledgment in each case to the many physicians to whom we are under great obligations for their interest and coöperation. The Spartanburg County Medical Society supported us in all our work, and we wish to express our high appreciation of its active part in furthering the investigation. Our only way of approaching patients was through their local physicians, and in no case did we find anything but the most ready coöperation on the part of the physicians, while many actively associated themselves in the work at a considerable expenditure of time and effort. In the more intensive studies in selected localities, which will appear in a future report, opportunity will be given us to make acknowledgment of these special services.

We are indebted to Dr. J. W. Babcock for the privilege of consulting with him from time to time during the work, and for many special services, especially for data concerning pellagrins admitted to the State Hospital for the Insane from Spartanburg County and for pathologic material collected at autopsies in that institution.

To Dr. J. A. Hayne, secretary and health officer of the South Carolina State Board of Health, we are under obligations for his interest and coöperation in our investigations, and particularly for furnishing from his office vital statistics concerning pellagra.

III. The Territory Selected. Spartanburg County is situated in the northern or Piedmont section of South Carolina. It is forty miles long in a north-south direction, thirty miles from east to west, and contains 762 square miles. Its surface is hilly and broken by a network of small streams and by four small rivers which, with their tributaries, flow across the county in a southeasterly direction, one of these rivers forming the county line on the south. The elevation above sea level at Spartanburg, the county seat, is 875 feet. To the northwest the slope is upward, the northwest corner of the county being situated at the foot of the Blue Ridge Mountain range, while to the south and east the elevation becomes somewhat lower than at Spartanburg, but with no precipitate fall, the whole county thus resting upon a plateau about 700 feet above sea level.

TABLE I.—Population Spartanburg County Census 1910.

		Total.	One year.	One to four years.	Five years.	Six to nine years.	Ten to fourteen years.	Fifteen to seventeen years.	Eighteen to nineteen years.	Twenty years.	Twenty-one to forty-four years.	Forty-five years and over.	Unknown.
Total population	..	83,465	2,733	10,091	2,370	8,852	10,402	5,710	3,878	1,870	26,239	11,161	159
	M.	41,719	1,425	5,167	1,171	4,490	5,270	2,840	1,903	893	12,822	5,652	86
	F.	41,746	1,308	4,924	1,199	4,362	5,132	2,870	1,975	977	13,417	5,509	73
Native white—native parents	..	56,536	1,918	6,842	1,587	5,834	6,742	3,874	2,576	1,254	17,677	8,149	83
	M.	28,472	991	3,526	793	2,969	3,464	1,907	1,280	612	8,820	4,063	47
	F.	28,064	927	3,316	794	2,865	3,278	1,967	1,296	642	8,857	4,086	36
Native white—foreign parents	..	309	5	28	8	29	31	27	8	6	111	54	2
	M.	150	2	15	6	11	12	14	3	2	55	30	
	F.	159	3	13	2	18	19	13	5	4	56	21	2
Foreign-born white	..	203	..	1	..	1	4	6	7	5	98	80	1
	M.	136	..	...	..	..	3	5	6	5	64	53	
	F.	67	..	1	..	1	1	1	1	..	34	27	1
Black	..	21,944	637	2,675	635	2,445	3,018	1,486	1,098	506	6,910	2,467	67
	M.	10,893	335	1,338	299	1,244	1,489	762	530	236	3,289	1,335	36
	F.	11,051	302	1,337	336	1,201	1,529	724	568	270	3.621	1,132	31
Mulatto	..	4,466	172	544	140	543	607	316	189	99	1,441	409	6
	M.	2,065	97	288	73	266	302	152	84	38	593	169	3
	F.	2,401	75	256	67	277	305	164	105	61	848	240	3
Indian	..	4	1	1	..	..	...	..	..	..	1	1	
	M.	1	..	...	..	..	...	..	..	..	...	1	
	F.	3	1	1	..	..	...	..	..	..	1		
Chinese	..	2	..	...	..	..	...	..	..	..	1	1	
	M.	2	..	...	..	..	...	..	..	..	1	1	
	F.												
Japanese	..	1	..	...	..	..	...	1					
	M.												
	F.	1	..	...	..	..	...	1					

The annual mean temperature, as recorded at Spartanburg, is 60° F. While the winters are mild, killing frosts are apt to occur from November to March inclusive, and the normal mean temperature for the months of December, January, and February is about 42° F.

The total population of the county is 83,465. Spartanburg, with a population of 17,517, is the only city in the county, the remaining population (65,948) being distributed upon farms, in cotton-mill villages, and among eleven small towns, only two of which have over 1000 inhabitants. The density of population, as a whole, is 109 per square mile; for the rural population (that is, outside of Spartanburg City) it is 86.5. While in South Carolina, as a whole, the negroes form 55 per cent. of the total population, in Spartanburg County the whites predominate numerically in the proportion of somewhat over two whites to one negro—there being a white population of 57,055, and 26,410 negroes—the percentage being 68.4 per cent. whites and 31.6 per cent. negroes. The distribution of the population of the county by race, nativity, age, and sex, according to the United States Census of 1910, is set forth in greater detail in Table I.

The chief industry, and almost the only industry conducted upon a large scale, is that connected with the cotton mills. There are about twenty-eight cotton mills in the county, each mill supporting its mill-village. These mills give employment to approximately 10,000 operatives, representing about 4000 families, and a total mill-village population of about 20,000. As the mill operatives are whites exclusively, it follows that something over 35 per cent. of the white population of the county is found in the mill-villages and is supported by the cotton-mill industry. The mill-village population contains no foreign element, but is drawn altogether from the general native-born population of South Carolina, North Carolina, Tennessee, Kentucky, Georgia, and other nearby States. An effort is made by the mill operators to secure families with the maximum number of individuals capable of employment as operatives. The income of the mill workers ranges from about 75 cents per day to $2 or even more, averaging about $1.25 per day.

The chief agricultural pursuit throughout the county is cotton culture, though in recent years more and more land has been turned over to corn and other grain crops. The average value of farm lands, $36.04[2] per acre, is considerably above that found in many sections of the Southern States.

IV. Prevalence of Pellagra in the County. Altogether, 282 cases of pellagra were studied in detail during the period the commission was working in the county, that is, from June 1 to October 15, 1912, and these 282 cases are the basis for the greater part of our study. For the purposes of certain special lines of inquiry, such as the history of pellagra in the county, the geographic distribution of the disease at different periods, the sequence of cases in different local areas, and the possible increase or subsidence of the malady with regard to both frequency and virulence, records were secured of cases known to the physicians of the county, but which had died or moved beyond the county limits. It should be said also that the 282 cases on our list as present in the county in 1912 represent the minimum figures for the county in this period.

Accepting 282 as the minimum number of cases, we have in Spartanburg County, in 1912, a minimum morbidity rate for the population, as a whole, of 0.35 per cent. or 35 cases of pellagra for each 10,000 of the population.

Including 94 additional cases of which we secured definite knowledge in the county in 1912, but were not able to visit, usually because of their early death or their commitment to the State Hospital, the total number of cases in the county becomes 376, or 44.9 per

[2] United States Census Bureau.

10,000 of population. We believe this rate represents very nearly the actual prevalence of pellagra in 1912 in the territory studied.

In view of the fact that this rate is considerably higher than has previously been reported in any single territory of like area, it should be distinctly understood that in no other territory in the United States has so intensive a study been made and pellagrins so thoroughly sought out. Abundant evidence was gathered that the disease is at least equally prevalent in adjoining counties of South Carolina and in certain parts of adjoining States. Furthermore, in Lavinder's extensive compilations of statistics of pellagra in 9 Southern States, 4 States show a greater number of cases than does South Carolina, and 2 States a higher rate per 10,000 of population. Referring to Spartanburg County, Lavinder justly recognizes the exceptional interest displayed by the physicians of the county in the disease, and considers his reports from this county to be exceptionally complete. He was able to get reports of 226 cases up to the beginning of 1912. Our more intensive search, confined to the one county, discovered a total of 398 cases prior to 1912. The difference of 172 cases might be considered surprisingly small were it not for the unquestionable fact that the reports obtained by Lavinder from Spartanburg County were exceptionally complete. There can be no question that the excessive number of cases for Spartanburg County, which appears in both Lavinder's figures and ours, represents more complete returns, and not a greater prevalence of pellagra than is present in other localities from which reports are less satisfactory.

V. Geographical Distribution of Pellagra Within the County. In order first to investigate the possibility of any geographical inequality in the distribution of the disease within the bounds of the county itself, we have considered the incidence of the disease in each of its ten townships separately.

By referring to Map 2 it is seen that the township rate per 10,000 of population ranges from no cases in township H to 71 cases per 10,000 of population in township D. It is noteworthy, further, that the three townships C, D, and E, stretching across the middle of the county, give rates of 43, 71, and 58 cases respectively, or a combined average of 55 per 10,000; while townships A and B to the north and F, G, H, I, and J to the south give 20, 15, 19, 8, 0, 11, and 15 respectively and a combined average of only 14 per 10,000.

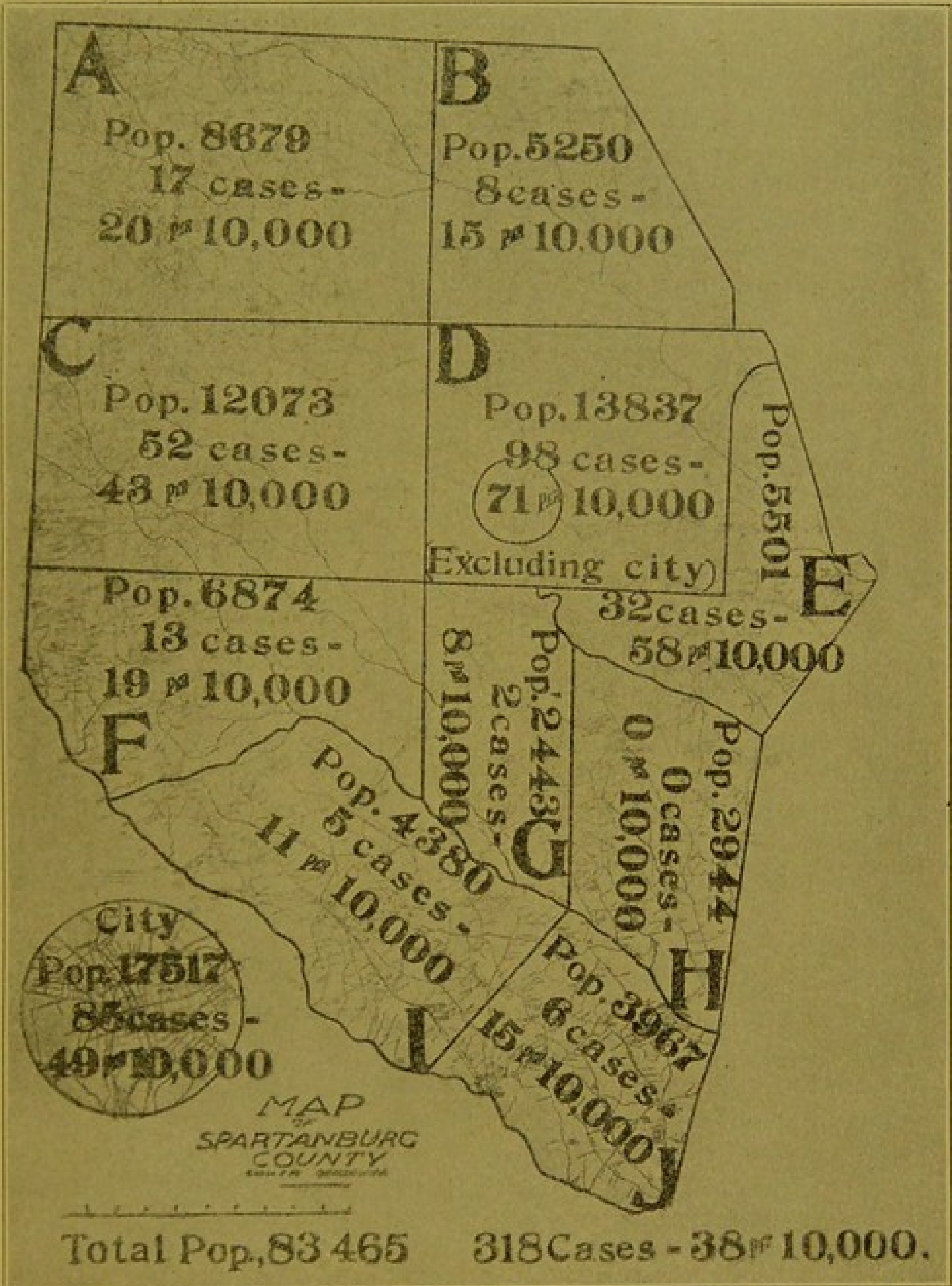
The incidence rate of pellagra within the city of Spartanburg was 49 per 10,000, considerably lower than the total rate (58) for township D, in which it is situated. The combined average rate of townships C, D, and E, exclusive of Spartanburg City, is 58 against only 14 in the remaining townships.

The population of the county may be still further divided geographically into three parts: (1) the rural population; (2) the mill-village population; (3) the urban population of Spartanburg City. The rural population is found upon the farms and in eleven

MAP 1.—Geographical distribution of cases in county and city of Spartanburg in 1912.

small towns, one of which has 1880 inhabitants, another 1101, and the remaining nine from 100 to 500 or 600.

Approximately one-fourth of the population of the county live in the cotton-mill villages. There are twenty-eight of these villages in the county, their individual population ranging from about 200 to about 2000. Within the city of Spartanburg there are two



Map 2.—Distribution of cases by townships with rate per 10,000 of population.

mill-villages, with a joint population of approximately 2950, the remaining 14,567 constituting the city population proper. Such a distribution of the population affords an opportunity to carry farther the analysis of the geographic distribution within the territory of each township by considering separately the prevalence of the disease among the rural, urban, and mill-village population respectively. The results of this analysis are shown in Table II and are graphically displayed by Chart 1.

TABLE II.—Rural, Mill-village, and Urban Distribution of Cases by Townships.

Township.	Total population.			Rural population.			Mill-village population.			Excess in mill-village over rural population.
	Population.	Cases of pellagra.	Rate per 10,000.	Population.	Cases of pellagra.	Rate per 10,000.	Population.	Cases of pellagra.	Rate per 10,000.	
A	8,679	17	20	8,179	13	15	500	4	80	65
B	5,250	8	15	4,650	7	13	600	1	17	4
C	12,073	52	43	9,173	17	20	2,900	35	121	101
D[3]	13,837	98	71	7,504	21	28	6,333	77	120	92
E	5,501	32	58	2,751	8	29	2,750	24	87	58
F	6,874	13	19	6,174	8	13	700	5	71	58
G	2,443	2	8	2,443	2	8	0	0	0	
H	2,944	0	0	2,944	0	0	0	0	0	
I	4,380	5	11	3,580	3	8	800	2	25	17
J	3,967	7	18	2,967	4	13	1,000	3	30	23
City	17,517	85	49	(14,567[4])	(43[4])	(29[4])	2,950	42	142	113
County	83,465	319	38	50,365	83	16	18,533	193	104	88

With one exception, in each of the eight townships with a mill-village population, the prevalence of pellagra among the mill-villages is markedly in excess of its prevalence among the rural population, this excess ranging from 17 per 10,000 in township I to 101 per 10,000 in township C, and reaching even a still higher figure (113) in the city of Spartanburg. In the county, as a whole, the mill-village population shows an excess of 50 per 10,000 over the total county average and of 88 per 10,000 over the rural districts alone. The apparent exception presented by township B, in which the excess among the mill-village population was only 4, disappears in view of the fact that the one mill in that township had been in operation only a month or so. The rate per 10,000 in the urban population of Spartanburg City, exclusive of the mill-village population of the city, is about equal to the combined rate among the rural population of townships C, D, and E, exclusive of their mill-village population, while the mill-village population in Spartanburg City (2950) shows 142 per 10,000, the maximum rate in our figures.

Excluding both urban and mill-village population, and considering the rural population alone, we find that the three townships C, D, and E still show a prevalence of pellagra twice that of the remainder of the county, the combined average rural rate for these townships being 24 per 10,000, while for the rural population of the remainder of the county it is only 12.

[3] Exclusive of city.

[4] City population exclusive of mill-village.

There are two factors which may possibly offer an explanation of this difference. In the three townships (C, D, and E) showing the excessive rate, with a total population of 19,428, the mill-village population (9833) makes up 50 per cent. of the total population (excluding the city of Spartanburg), while in the remainder of the

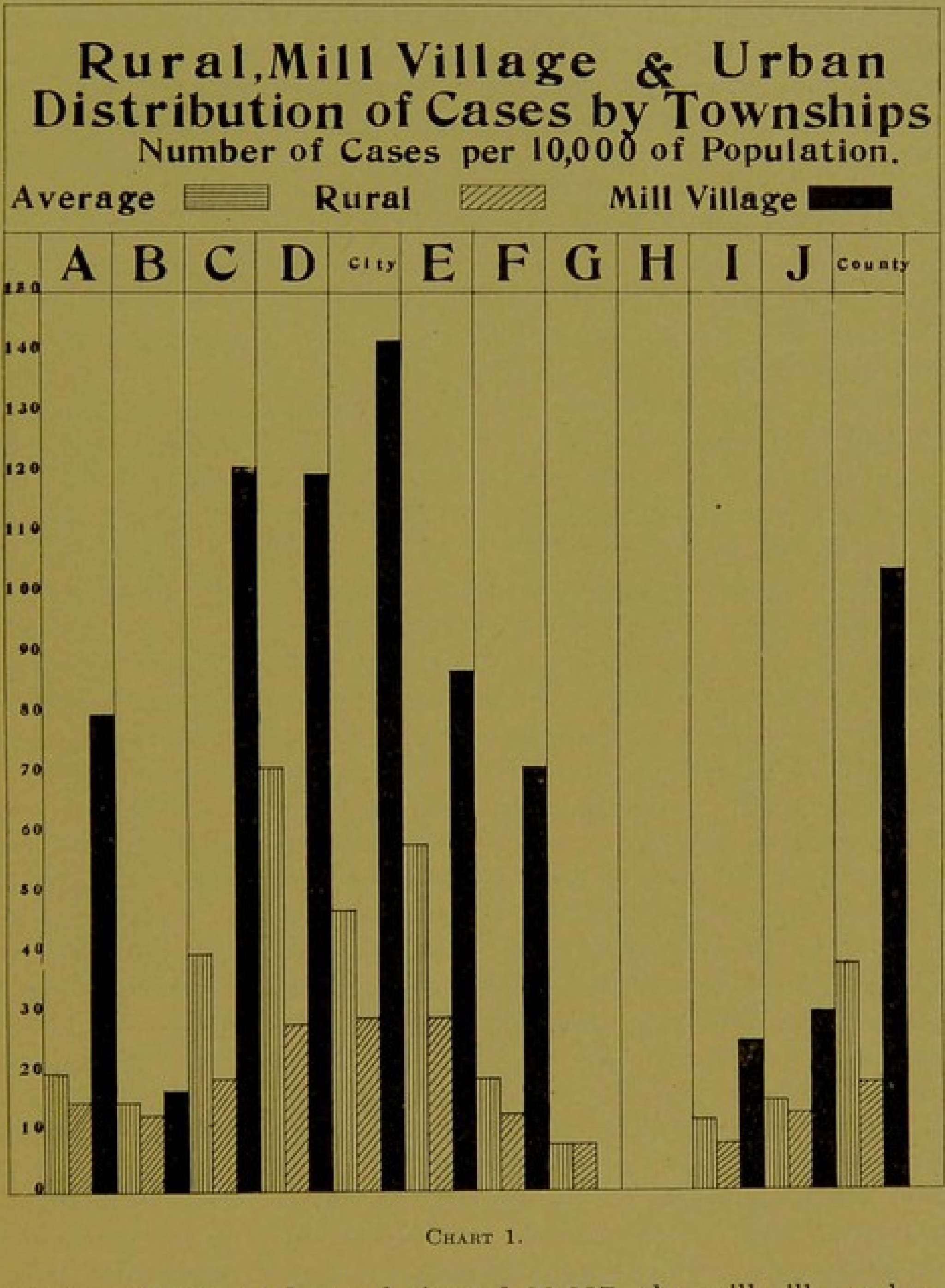


CHART 1.

county, with a total population of 30,937, the mill-villages have a population of only 3600, or 12 per cent. of the whole. It might be supposed that a large mill-village population showing a relatively high prevalence would tend to increase the prevalence of the disease in the surrounding rural districts.

The apparent fact that cases of pellagra are excessively prevalent in the mill-villages where the population is congested, suggests the question whether the congestion of population itself may not have an important influence upon the incidence of the disease. The average density of population for the county as a whole is 109 per square mile, while for the rural districts, exclusive of Spartanburg City, it is 86.5. For the rural population, exclusive of the mill-villages, it is 60.3. In the three townships C, D, and E, which show a striking excess of pellagra among the rural population compared with the rural population of the eight other townships, the density of rural population is 72 per square mile, and in the remaining townships it is only 56, a difference in density of 16 per square mile. While the greater density of population in townships C, D, and E might be a causative factor in the greater prevalence of pellagra in the rural population of those townships, the rate of prevalence does not vary strictly as the relative density of population in each township, though it shows some tendency to do so.

Further evidence that density of population alone is not accountable for the greater prevalence of the disease in mill-villages is found within Spartanburg City itself. There the mill-villages, which are continuous with and an integral part of the city, present a rate of 142 per 10,000, whereas the remainder of the city population, living under approximately the same condition of congestion, gives only 29 per 10,000. Furthermore, the non-mill-village population within the city, with a density which is certainly over 3000 per square mile, shows almost exactly the same prevalence of pellagra per 10,000 as does the strictly rural population of the surrounding township, with only 90 inhabitants per square mile.

These figures would seem to indicate that while congestion of population may play a part in the prevalence of the disease, it alone does not explain the marked inequality of distribution between the mill-villages and the strictly rural population.

VI. Racial Distribution. The distribution of the cases of pellagra in the county between the races presents a second marked inequality. While in South Carolina as a whole the number of whites and negroes is about equal, the negroes being slightly in excess, in Spartanburg County the whites predominate numerically in about the proportion of two to one, the actual figures being; whites 57,055, negroes 26,410 (Table III). The 57,055 whites gave 257 cases of pellagra, or at the rate of 45 per 10,000; the 26,410 negroes gave 25 cases of pellagra, or at the rate of 9.5 per 10,000. In other words, while whites are present in the population in the proportion of two whites to one negro, there are ten white pellagrins to one negro pellagrin.

One fact of fundamental importance in the racial comparison is the practical absence of negroes from the mill population. It follows that a more accurate comparison between the races can be made by comparing the rate of prevalence among negroes with the rate among whites, exclusive of the mill population. We have seen that the rate among the total population, exclusive of the mill-villages, was 18 per 10,000. Subtracting the negro population and the negro pellagrins we have remaining a white population, exclusive of mill-village population, of 38,522, which gave 97 cases of pellagra, or 25.2 per 10,000 against 9.5 per 10,000 among the negroes. In other words, in Spartanburg County the disease appears to be 4.7 times as prevalent among all whites as among negroes, and 2.6 times as prevalent among whites, exclusive of the cotton mill-villages.

Table III.—Distribution of Pellagrins among Whites and Negroes.

	Population.	Cases of pellagra.	Rate per 10,000.	Excess of whites over negroes per 10,000 of population.
All whites	57,055	257	45.0	35.5
Whites outside of mill-villages	38,522	97	25.2	15.7
Negroes	26,410	25	9.5	

The racial incidence was carefully investigated with a view to determine whether the racial variation might be due to failure to discover cases of pellagra among negroes as readily as among whites. The practising physicians throughout the county were questioned as to the comparative prevalence among the negroes in their particular section, and as to its comparative prevalence in this race in the past. Without exception we were informed that pellagra in negroes was of comparatively infrequent occurrence. In this connection it is well to state that many of these physicians have lived and practised medicine in the same place for many years; that they are personally acquainted with practically the entire population in their particular field of work, both whites and negroes, and that they are in general thoroughly capable of correctly diagnosticating the disease.

The two colored physicians in Spartanburg were closely questioned as to the occurrence of pellagra in their practice at present and in the past, and the cases cited by them are included in our statistics. Furthermore, the information furnished by them relative to the occurrence of cases in the past is in accord with these statistics. When negroes suffering with pellagra were visited a particular effort was made to secure from them information as to the occurrence of the disease in others of their own race. A number of names were secured in this way, and many negroes suspected of having the disease were visited. Many of the planters owning large plantations and having as tenants or laborers a large number of negroes were closely questioned as to the prevalence of the disease, and in some instances canvasses were made. Notwithstanding the efforts made to discover the disease in negroes, it was impossible to find more than twenty-five cases.

It is not believed that the number of cases overlooked could materially alter the relative incidence of nearly five cases in whites to one in negroes, and the racial variation is evidently a real one, though it may possibly be explained in part by the absence of negroes from the mill-village population, which, as we have seen, shows a marked excess of pellagra compared with the remainder of the white population.

TABLE IV.—Racial Distribution of Population and Racial Distribution of Pellagra with Percentages.

State.	Population statistics.[5]				Pellagra statistics.					
	White.		Negro.		White.		Negro.		Pellagra per 10,000 of population.	
	Number.	%	Number.	%	No.	%	No.	%	W.	N.
Virginia	1,389,809	67.4	671,096	32.6	476	76	152	24	3	2
North Carolina	1,500,513	68.0	697,843	31.6	1744	81	407	19	12	6
South Carolina	697,162	44.8	835,843	55.2	1129	71	471	29	16	6
Georgia	1,431,816	54.9	1,176,987	45.1	3127	80	741	20	22	6
Kentucky	2,027,951	88.6	261,656	11.4	442	92	39	8	2	4
Alabama	1,228,832	57.5	908,282	42.4	1138	58	813	42	9	9
Mississippi	786,119	43.7	1,009,487	56.6	1387	55	1156	45	18	11
Louisiana	941,086	56.8	713,874	43.1	338	56	269	44	4	4

Table No. IV is an analysis of population by race, and of the incidence of pellagra by race for eight Southern States. The pellagra statistics in this table were secured by correspondence and, as Lavinder states, are very incomplete.

In Spartanburg County there is a marked difference in racial incidence, but any suggestion that this depends upon the factor of race alone may seriously be questioned. In Table IV it may be seen that the case incidence in the two races in the States of Alabama and Louisiana shows little difference; while in South Carolina and Georgia, and to a less extent in North Carolina, there is a marked preponderance in whites. It is possible that industrial conditions in these States account largely for this variation.

VII. SEX DISTRIBUTION. The population of the county is divided practically equally between males and females, the females being only 27 in excess. The total male population of 41,719 gave 71 cases of pellagra, or at the rate of 17 per 10,000. The female population gave 211 cases, or at the rate of 50.5 per 10,000 (Table V). In other words, pellagra appears nearly three times more frequently

[5] Population statistics are those of the Thirteenth Census (1910). The pellagra statistics were compiled from those reported by Lavinder in reprints from Weekly Public Health Reports, No. 106.

among females than among males. Among the white population alone this proportion between males and females remains about the same, while among the negroes the relative prevalence among males and females is nearly four females to one male. This inequality between the sexes is brought out more strikingly and in greater detail if the figures are analyzed by dividing the population according to age.

TABLE V.—Distribution by Sex.

		Number in population.[6]	Cases of pellagra.	Rate per 10,000.	Excess per 10,000 among females.
Whites:	Male	28,758	66	22.95	
	Female	28,290	191	67.5	44.5
Negroes:	Male	12,958	5	3.9	
	Female	13,452	20	14.9	11.0
Both races:	Male	41,716	71	17.0	
	Female	41,742	211	50.5	33.5
Total population		83,458[6]	282	33.8	

TABLE VI.—Age Distribution of Two Hundred and Eighty-two Cases.

Age.	Total population.[7]	Cases of pellagra.	Rate per 10,000.
0 to 5	15,194	21	10.8
6 to 9	8,852	22	24.9
10 to 19	21,860	28	12.8
20 to 44	26,239	158	60.2
45+	11,161	53	47.5

VIII. AGE DISTRIBUTION. First, considering the prevalence of pellagra according to age, without reference to sex, we find the inequalities shown in Table VI, and graphically presented in Chart 2.

In this and the following tables dealing with age distribution, in which the prevalence of pellagra is expressed in rate per 10,000 of the population, our age groups are necessarily made to conform to the age statistics for the population of Spartanburg County which could be secured from the United States Census Bureau—namely, the population of the county under six years of age, from six to nine years, ten to nineteen years, twenty to forty-four years, and forty-five years or older. The actual number of cases in these groups means little because of the wide difference in the size of the groups, both with regard to the number of years and the number of individuals concerned. A striking excess in the rate of prevalence is apparent in the group twenty to forty-four years of age (60.2 per 10,000). The rate among those over forty-four years of age is much higher than in any other group excepting that between

[6] Exclusive of 4 Indians, 2 Chinese, and 1 Japanese.

[7] Exclusive of 159 persons of unknown age.

twenty and forty-four years. These two groups taken together, that is, the entire population over nineteen years of age compared with the entire population under twenty years of age gives the following result: Twenty years and older, 211 cases, or 56.4 per 10,000; nineteen years and younger, 71 cases, or 15.5 per 10,000.

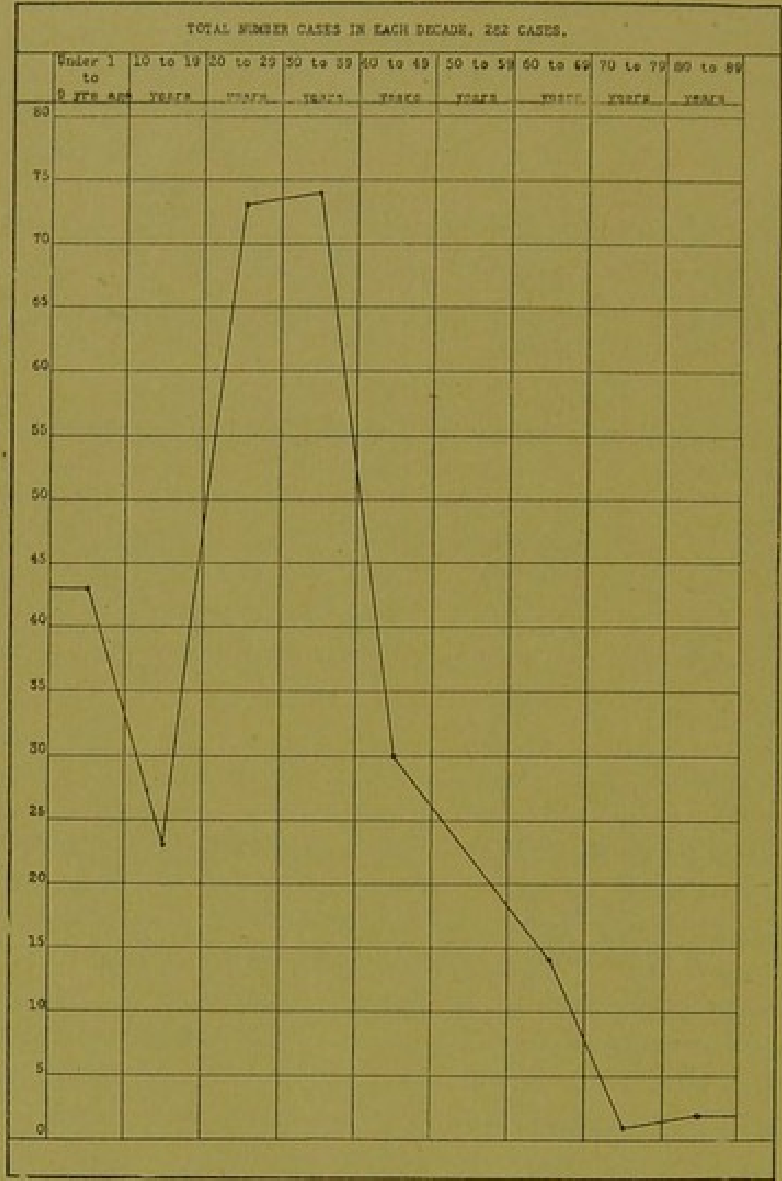


CHART 2.—Total number of cases in each decade.

Dividing the younger group we find that children under ten years of age gave a total of 43 cases, or 17.9 cases per 10,000; those from ten to nineteen years of age gave 28 cases, or 12.8 per 10,000. Furthermore, this higher prevalence for children under ten years is found entirely among the children between the ages of five and ten years who alone gave a rate of 24.9 per 10,000, while the younger group under five years of age gives only 10.8 per 10,000, the lowest rate found in any group.

In Chart 2 the distribution of pellagra by the number of cases in each age group is shown, dividing the cases into age decades. By comparing this chart with Table VI it is evident that the curve would be considerably modified if it expressed the rate per 10,000 of population instead of the actual number of cases in our figures. The prevalence among children under ten years would not be quite so high compared with that in other groups. The relative prevalence in groups over forty years would be higher. The two groups of from twenty to forty years would still show a striking excess over all other decades. It may be said here that the marked fall in the prevalence of pellagra in the groups ten to nineteen years appears throughout our statistics, and will come out strikingly in the consideration of the family distribution of the disease.

IX. Distribution by Age and Sex. It is important to ascertain whether the excessive prevalence of pellagra among females holds in all ages of the population, and whether the excessive prevalence found in certain age groups, notably those from twenty to forty-five years, is to be found among both males and females. Referring to Table VII it may be seen that the excess among females is not the same among all ages of the population, but is confined largely to those between the ages of twenty and forty-four years. Further, under ten years of age males and females show practically the same prevalence of pellagra. From ten to nineteen years the females show a rate a little over twice that of the males; in the large group of from twenty to forty-four years the females show a rate per 10,000 over nine times greater than the male rate. Among the population of forty-five years and over the distribution between the sexes is again nearly equal.

These cases have been further analyzed by decades, with the result as represented graphically by curves in Chart 3. These curves express actual number of cases.

Table VII.—Distribution by Age and Sex.

Age.	Sex.	Population.	Number of cases.	Rate per 10,000.	Excess per 10,000.
Under 5	M.	7,763	10	12.9	
	F.	7,431	11	14.8	1.9
5 to 9	M.	4,490	12	27.0	
	F.	4,364	12	27.5	0.5
10 to 19	M.	10,906	7	6.4	
	F.	10,954	16	14.6	8.2
20 to 44	M.	12,822	16	12.5	
	F.	13,417	148	110.3	97.8
Over 44	M.	5,652	25	44.2	
	F.	5,509	27	49.0	4.8

The fall in the curve in the second decade of life is present for both sexes, but is more marked for males. Thereafter the male curve continues to fall, whereas the female curve rises to its highest point in the following decade (twenty-one to thirty years), drops slightly among women of thirty-one to forty years, then falls abruptly in the next decade (forty-one to fifty years) to a point somewhat below both males and females under ten years. In the decade of from fifty-one to sixty years the female curve continues to fall, and for the first time descends below the male curve, which shows a slight rise. Thereafter the number of cases is small and the two curves fall together.

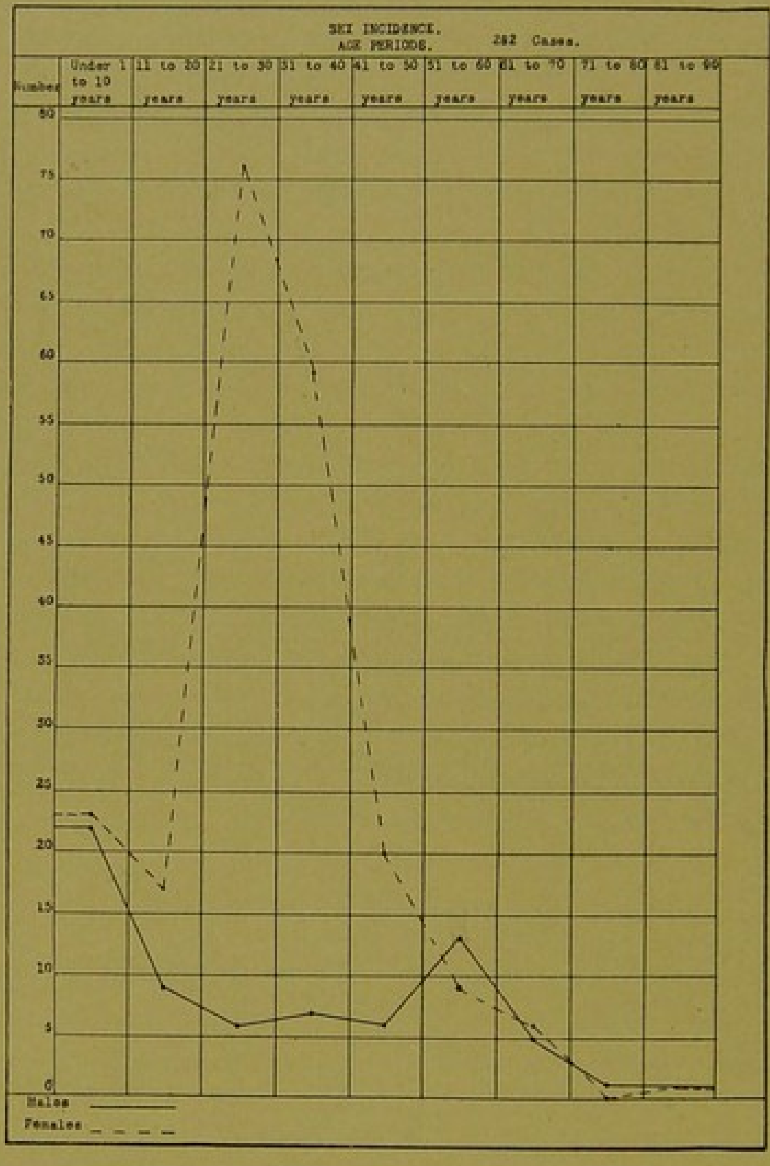


CHART 3.—Distribution by age and sex.

The data expressed in Table VII and Chart 3 may be summarized as follows: Pellagra appears to be about equally prevalent among males and females under ten years of age and over forty-five years. Males alone show the highest prevalence in children under ten years. Females show a strikingly higher prevalence in the two decades of twenty to thirty and thirty to forty years than does either sex in any other decade.

Table VIII indicates in a general way that both whites and negroes separately show practically the same inequalities in the distribution of pellagra between the sexes in the different age groups, as has been shown in considering both races together. Any closer analysis of the figures for the two races is unsatisfactory, owing to the small number of negro cases in each age group.

TABLE VIII.—Race, Age, and Sex Incidence (Two Hundred and Eighty-two Cases).

Age.	Whites, 257 cases.		Negroes, 25 cases.	
	Male.	Female.	Male.	Female.
Under 1 to 5	9	11	1	0
Under 6 to 10	12	11	0	1
Under 11 to 20	9	14	0	3
Under 21 to 30	4	65	2	11
Under 31 to 40	6	56	1	3
Under 41 to 50	6	20	0	0
Under 51 to 60	14	9	0	0
Under 61 to 70	4	5	1	1
Under 71 to 80	1	0	0	0
Under 81 to 90	1	0	0	1
Totals	66	191	5	20

While it is not proposed to enter into any extensive comparative studies in this preliminary report, there are certain data upon the age and sex distribution of pellagra in this country which present an interesting parallel with the figures for Spartanburg County.

Chart 4 represents by curves based on actual number of cases the age and sex distribution of 164 cases of pellagra, 99 of which were reported by Mizell,[8] of Georgia, and 65 by Tucker,[9] of Virginia.

Chart 5 shows mortality rates for the State of Texas. This chart was furnished to us by Dr. H. K. Beall, of Fort Worth, Texas,[10] who first directed attention to the inequalities of distribution by age in males and in females.

Chart 6 is based upon death reports of pellagra in Alabama between June, 1909, and December, 1912. These reports cover a total of 1148 cases during this period. The data were kindly supplied by Dr. W. H. Sanders and Dr. H. G. Perry, of the Alabama State Board of Health.[11]

Chart 7 presents a graphic representation of mortality rates for pellagra in the State of North Carolina for 1911 and 1912. We have to thank the health authorities of North Carolina for the information on which this chart is based.[12]

[8] From paper read at the Second Triennial Meeting of the National Association for the Study of Pellagra, Columbia, S. C., October 3, 1912.

[9] Beverley R. Tucker, M.D., A Discussion of Pellagra, with Remarks on Sixty-six Cases Occurring Outside of Institutions, Old Dominion Jour. Med. and Surg., April, 1911, vol. xii, No. 4.

[10] Personal communication. [11] Ibid. [12] Ibid.

The data from these five sources are all the statistics available to us at the present time which lend themselves to a comparison with our own figures regarding age and sex distribution. It should be noted that the curves in Chart 4, like our own, are based on morbidity statistics, while Charts 5, 6, and 7 are based upon death reports.

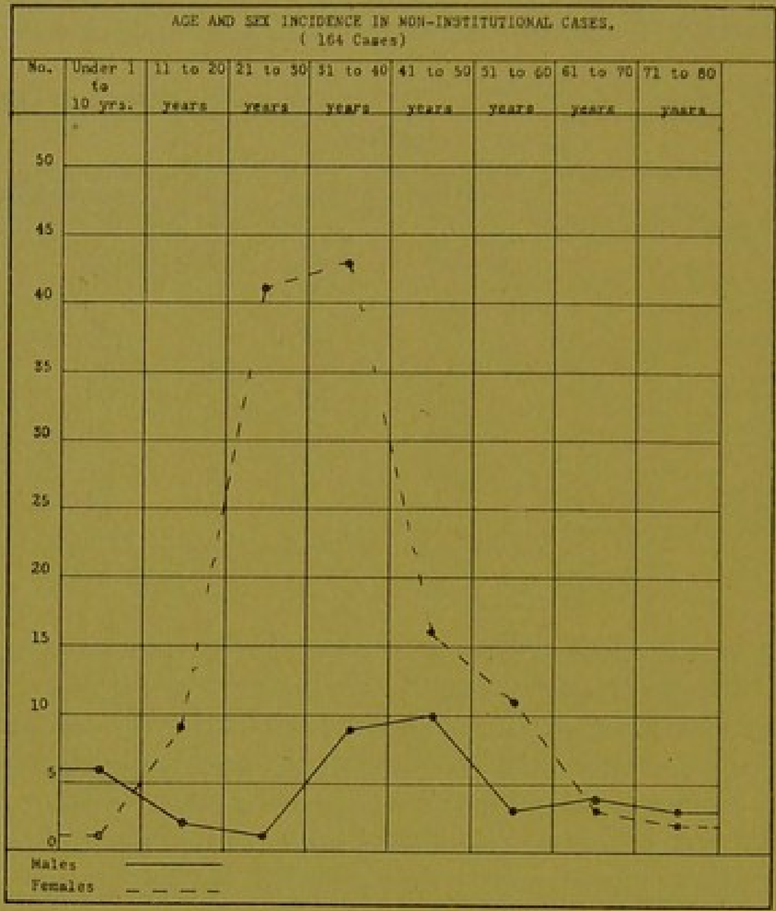


CHART 4.—Age and sex incidence in non-institutional cases.

A comparison of the four charts shows considerable variation in both the male and the female curves in different age groups. They all agree, however, in showing a strikingly excessive prevalence among females of middle age and a comparative equality of distribution between males and females in childhood and among people of advanced age.

X. DISTRIBUTION BY OCCUPATION. The consideration of the relationship between occupation and the incidence of pellagra in Spartanburg County resolves itself almost entirely into a discussion of the relative prevalence of the disease among field laborers, workers in the cotton-mills, and those engaged in housework. Only a few scattered cases gave other employment. The actual data with regard to occupation obtained from 234 cases of pellagra is set forth in Table IX: 110 (47 per cent.) gave housework as their occupation exclusively; 14 others (6 per cent.) gave housework as their chief employment; 16 (6.8 per cent.) were employed in housework part of the time, working the remainder of the

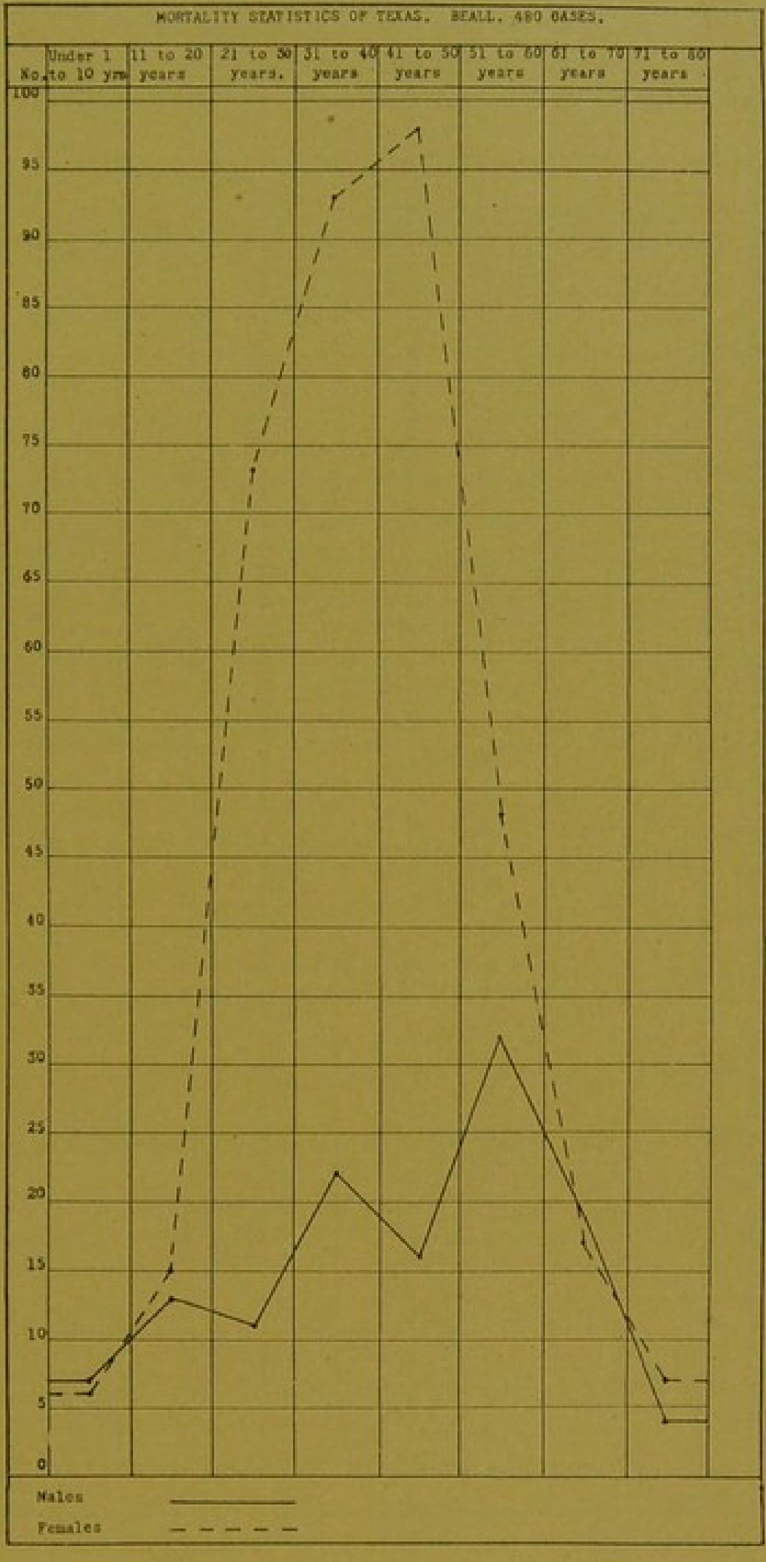


CHART 5.—Mortality statistics of Texas.

time in the mills; 18 (7.7 per cent.) worked alternately about the house and in the fields. Thus a total of 158 (67.5 per cent.) of the 234 cases, were employed in household work within the home for at least a fair portion of their time. These figures mean little

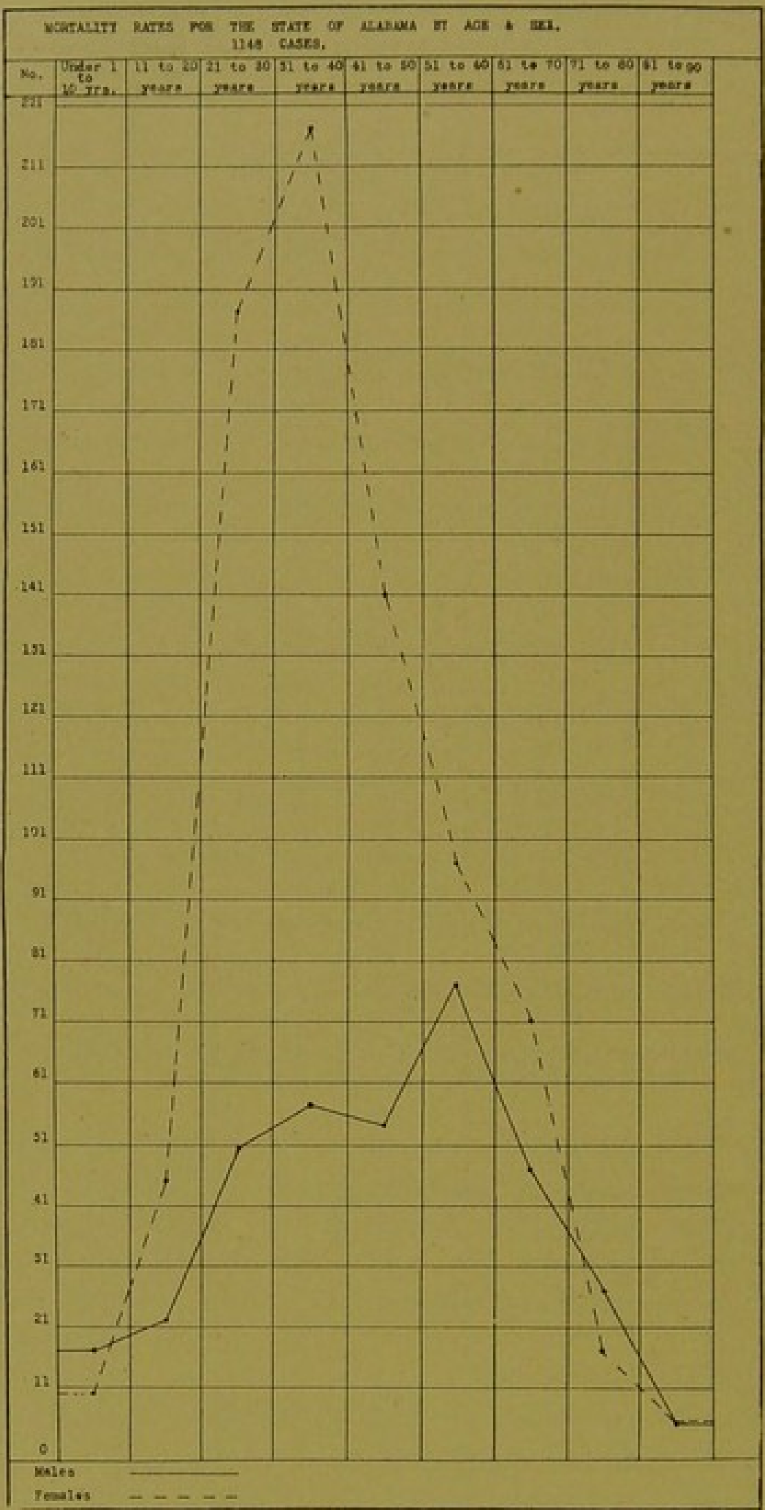


CHART 6.—Mortality rates for the State of Alabama by age and sex.

more than what has already been shown by the age and sex distribution of the disease—namely, that it is excessively prevalent among adult females the great majority of whom are employed in housework. There is one further indication, however, that pellagra has a much higher prevalence among the adult females of the mill-villages who are occupied as housewives than among those who work in the mills, and this point may be more closely examined by considering the occupational distribution of pellagra in the mill population alone.

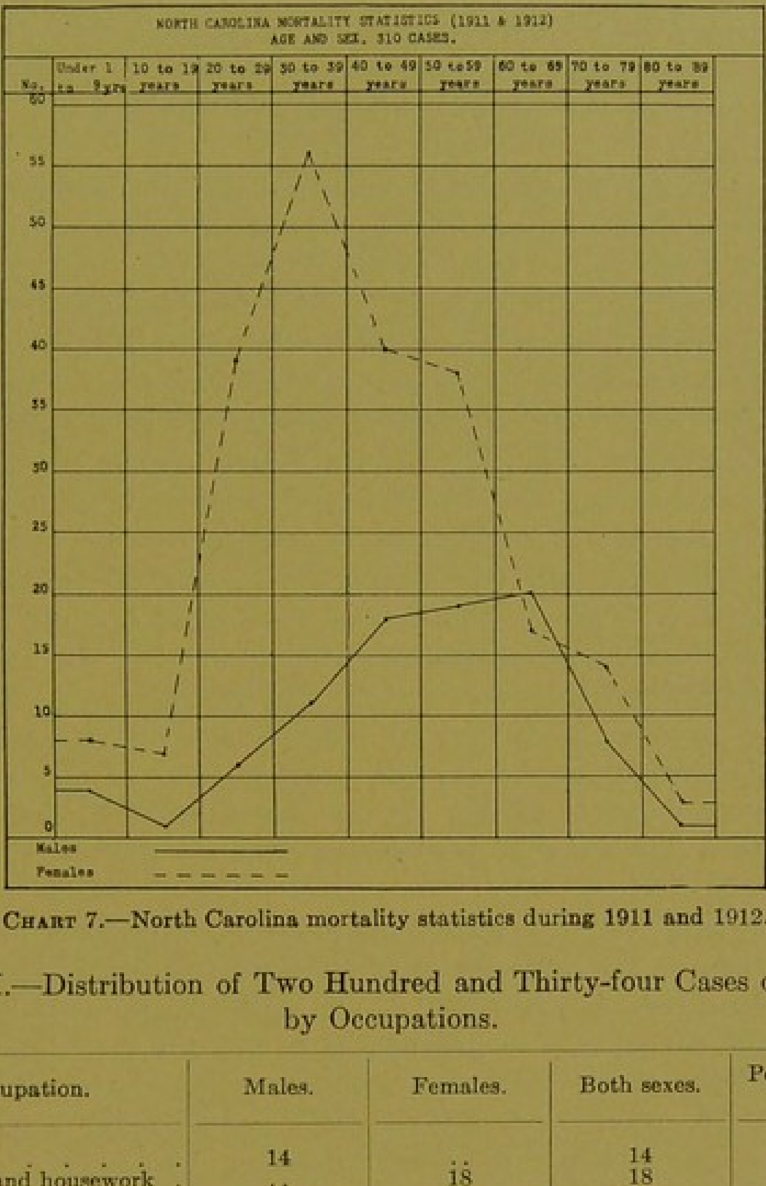


CHART 7.—North Carolina mortality statistics during 1911 and 1912.

TABLE IX.—Distribution of Two Hundred and Thirty-four Cases of Pellagra by Occupations.

Occupation.	Males.	Females.	Both sexes.	Per cent. of total.
Farmers	14	. .	14	6.0
Field work and housework .	. .	18	18	7.7
Mill work exclusively . .	21	20	41	17.5
Mill work, some housework .	. .	16	16	6.8
Housework exclusively . .	. .	110	110	47.0
Housework chiefly, some mill work	. .	14	14	6.0
Scattering[13]	9	3	12	5.1
No occupation	2	7	9	3.8

There are available for this study 121 cases of pellagra of working age residing in mill-villages. Of these, 24 were males and 97

[13] Two patients were merchants, two dressmakers, one was employed in each of the following occupations: insurance, student, carpenter, butcher, clerk, railroad fireman, day laborer, school teacher.

females; 21 (87.5 per cent.) of the 24 males were mill operatives. Of the 97 females, 12 (only 12.37 per cent.) worked in the mills exclusively; 16 additional female cases worked in the mills the greater part of the time, making a total of 28 female mill workers (or 28.86 per cent.) of the 97.

46, or very nearly half (47.42 per cent.) of the 97 women did no mill work, devoting themselves to housework exclusively; while 14 others were chiefly employed in housework, going to the mills only occasionally, making a total of 60 houseworkers, or 68.85 per cent. of the female pellagrins of working age living in the mill-villages.

We have no actual statistics regarding the proportion of males and females among mill operatives. It would seem perfectly safe to say that there are at least as many females as males, the probabilities being that they are in a considerable majority. As a rule, female operatives are preferred by the mill operators. Assuming equality between the sexes among mill workers, as may surely be done with safety, the data above presented has a highly important significance, in that it shows a nearly equal prevalence of pellagra in males and females who are employed in the mills as operatives—namely, 17 males and 12 females—if we include only those women doing mill work exclusively, and 28 females if we include the 16 who gave mill work as their chief but not exclusive occupation. This comparative equality as regards the prevalence of pellagra between the sexes among mill operatives is in striking contrast to the inequality between adult males and females in our sex statistics for the population as a whole, and is very closely in harmony with what is known of sex distribution in institutional cases where a difference in prevalence between the sexes is absent or slight.

In comparing the mill-village population with the rural population as regards the prevalence of pellagra, we found the disease nearly seven times as prevalent in the mill-villages as in the rural districts, the actual rate of prevalence in the mill population being 104 per 10,000. Out of the total mill-village population of approximately 19,000, about one-half, or 9500, are actually employed in the mills. Among these mill operatives we have 57 cases of pellagra, including those patients who gave mill work as their chief but not exclusive occupation. These 57 cases give a rate of 60 per 10,000 among actual mill operatives, against 104 per 10,000 for the total mill-village population. The 41 patients giving a history of mill work exclusively present a rate of only 43.2 per 10,000. These figures seem to indicate that the excessive prevalence of pellagra in the mill-village population is not found among those who actually work in the mills, but among the women engaged in the day about the houses, and the children who are at home with them.

While children under working age do not form a part of an occupational study, it may well be noted in this connection that 30 mill-village children under ten years of age had pellagra. These cases added to the 60 adult females in the mill-villages engaged in house-work exclusively make a total of 90 cases of pellagra in the mill-village population of the county, which by occupation were about the dwellings during the day, against 57 cases among the population engaged in mill work. The 57 operatives give a rate of 60 per 10,000 for the half of the mill-village population which works in the mills. The 90 houseworkers and children give a rate of 94.7 per 10,000.

XI. Distribution of Cases in Families. 316 cases of pellagra are available in our data for a study of family and household relationships, and these cases represent 223 families, an average of 1.42 cases of pellagra per family. An analysis of the family distribution is given in Table X. About half the total number of cases occurred singly in families, and about one-fourth of the total number occurred two to a family. Of the total number of families with pellagra (223) nearly three-fourths (160) had but one case, and nearly one-fifth gave but two cases. Nearly one-tenth of the families gave 3, 4, or 5 cases.

Table X.—Distribution of Pellagra in Families.

	Number of families.	Number of cases.	Percentage of total number of families.	Percentage of total number of cases.
One case to one family	160	160	71.7	50.6
Two cases to one family	42	84	18.8	26.6
Three cases to one family	14	42	6.3	13.3
Four cases to one family	5.	20	2.3	6.
Five cases to one family	2	10	0.9	3.2
Total with more than one case to one family	63	156	28.3	49.4

In view of the inequalities found in the prevalence of pellagra in the two sexes, and at different ages, an attempt has been made to discover whether the sex and age distribution differs among cases which occur singly in families from the distribution among cases occurring two or more to a family—in other words, to determine whether cases developing singly in families are apt to be of any particular age or sex, and to differ in these respects from multiple family cases. For this purpose, 294 cases for which age and sex statistics are available have been charted (Chart 8) by age periods of five years each—cases occurring singly in families being represented by a solid line, and cases occurring two or more to a family by a broken line. The upper two curves represent male cases alone; the middle curves, females alone; and the lower curves, the two sexes combined. The curves represent the percentage of the total 294 cases and not the actual number of cases in each group. Accordingly, the solid line and the broken line would coincide wherever the same condition of distribution exists between single cases and cases occurring two or more to the family.

The Age and Sex Distribution of Pellagra in Families with a single case and in Famillies with two or more cases

Single cases per family ———— Multiple cases per family - - - - - - - - -

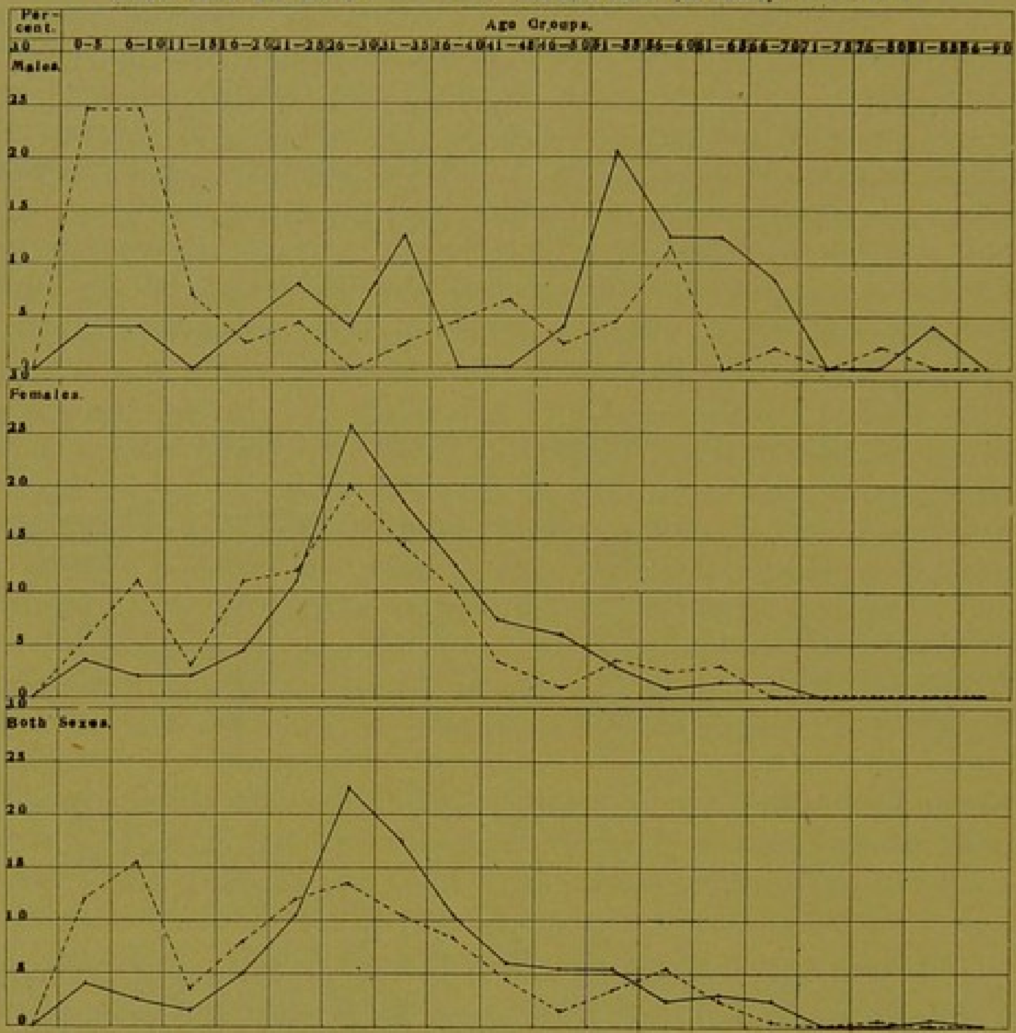


CHART 8.

The most striking inequality between the two curves is present among children under ten years of age. Not only is the curve for multiple family cases higher than the curve for single cases in both males and females, but for males alone and for the combined sexes it goes higher among children under ten years than in any other age group. In this respect it presents a striking contrast to the curve for single family cases and to our general age distribution. It is remarkable, further, that this excessive prevalence in multiple family cases is much greater among males than among females, especially in the younger group of children under six years of age. Among cases occurring singly in families the curve never goes above 5 per cent. in any age group under twenty years among males, females, or the sexes combined. These facts seem to show that where single cases of pellagra occur in families it is rarely children under ten years who are the ones attacked. Among families with more than one case, however, children under ten years form a higher percentage of the cases than does any other decade. Among families with but one case it would appear that the two decades from twenty-one to forty years give the great majority of cases among females, while among males more single cases occur among those over fifty years.

When considering the subject of age and sex distribution, attention was called to the striking fall of prevalence apparent among persons from eleven to twenty years old. Inspection of the curves in Chart 8 shows this fall to be confined almost entirely to cases which occur two or more per family, the indication being that isolated cases in families are as apt to arise among individuals from eleven to twenty years of age as among children under eleven years.

It is not considered advisable to proceed farther at the present time in an analysis of the family relationships of pellagrins. Such further investigation would carry us into a study of each individual family, the actual sequence of cases in each family, and, furthermore, would introduce the whole subject of household association and its significance with regard to the family relationship. As yet our data are not sufficiently complete to make such a study in a satisfactory manner. It may be said, however, that while there is some evidence in our preliminary investigation that family relationship *per se* does seem to have some influence upon the incidence of pellagra, there are stronger indications that household association is a more important factor in the distribution of the disease.

XII. Relative Prevalence, Severity, and Mortality Rates in Recent Years. Pellagra is not a reportable disease in the State of South Carolina, nor do the State laws require notification of deaths from pellagra to the health authorities.

The data to be analyzed were obtained from a number of sources. The 282 cases studied in detail by the Commission afforded one source. In the City of Spartanburg, official records are on file covering deaths from all causes within the city, and thus it was possible to secure accurate mortality statistics for the city. There are some five or six undertaking establishments in the county, as a whole, and the two establishments in the city of Spartanburg sell very nearly all the coffins used throughout the county. These two establishments keep on file the names, causes of death, and other information concerning the deceased for whom coffins are furnished, and they very courteously permitted us to make abstracts from their records. From these records we obtained information of importance. From the members of the medical profession throughout the county we secured much valuable information relating to prevalence and mortality rates for 1912 and previous years. From pellagrins themselves and from others we were able occasionally to obtain information concerning individual cases. Dr. Babcock, of South Carolina, kindly furnished us with information covering the cases admitted to the State Hospital for the Insane from Spartanburg County.

Although we availed ourselves of all these sources of information, we wish to emphasize the fact that this study is still far from complete. We hope, however, to make it more comprehensive and complete during the course of our studies in the same county in the summer of 1913.

The opinion was expressed by many physicians in Spartanburg County, that pellagra was not so prevalent in 1912, as was the case in 1911. We might say, further, that a like impression prevailed in many other parts of South Carolina and in other Southern States.

The statistical data at hand for Spartanburg County are subject to analysis in several ways:

1. From the information available we have determined as nearly as possible the actual number of cases of the disease existing in the county each year, without consideration of the year in which the disease was contracted and without reference to recurrences.

In 1912	there were 376 cases (minimum).
In 1911	there were 285 cases (minimum).
In 1910	there were 115 cases (minimum).
In 1894 to 1910	there were 114 cases (minimum).

It is quite evident that pellagra was not recognized as such, to any extent, until the year 1909.

We have endeavored to secure from the practising physicians in the county accounts of the first and other early cases occurring in their practices. As yet this information is incomplete, but it establishes the fact that the disease has existed in the county sporadically for a number of years. Dr. Fike of Spartanburg, has the record of a patient dying of pellagra in 1894, although not at the time recognized as such. The patient was an adult female, and three other members of her family are said to have died of the disease. One of the first cases which developed in the city of Spartanburg was that of a young woman in a well-to-do family. She contracted the disease and died of it in 1902. Dr. Jefferies, of Spartanburg, has the record of a patient who died of pellagra, in November, 1903, but the disease was unrecognized as such until years afterward.

While there is no doubt that pellagra has existed in this section for a number of years, information obtained from the medical profession throughout the county indicates very clearly that the cases must have been more or less sporadic until within recent years. The general impression is held that sporadic cases occurred until about 1909, at which time there was a marked increase in the number of cases; that during 1910 and 1911 the disease became more prevalent; while in 1912 there was a slight decrease in incidence. The perceptible increase of cases in 1909 may be accounted for in part by the fact that the disease was not until then generally recognized as pellagra. We have consulted with many medical men in Spartanburg County and in other parts of South Carolina, and in other States, and it is our belief that the large number of cases recognized in 1910 and 1911, as compared with the number recognized previous to that time, cannot alone be explained on a basis of general failure to recognize the disease in earlier years. Non-recognition unquestionably explains some of the increase, but we are thoroughly convinced that there has been an actual and quite perceptible increase in the number of cases within the past three or four years.

2. A second analysis of our data shows that the minimum number of cases of pellagra in Spartanburg County from 1894 to October, 1912, was 495. This is obviously a conservative estimate, as prior to 1911 our data are made up largely of cases in which the disease terminated in death.

3. We have endeavored to determine the actual number of new cases of the disease occurring each year. It is possible to determine this with a reasonable degree of accuracy for 1912 and with a fair degree of accuracy for 1911, but prior to that time the incidence rates (annual) are altogether a matter of conjecture. We have seen that there were at least 376 cases of pellagra in Spartanburg County in 1912. Of the cases seen during our study in 1912 (282), 97 contracted pellagra in 1912, and of 94 others not included in our series we have knowledge of the fact that 16 contracted the disease in 1912. The minimum total of new cases for 1912 is thus 113. In 1911 the total number of cases in the county was 285. Among the cases included in our series (282), 100 contracted pellagra in 1911, and we have record of 20 other cases contracting it in 1911, making a total of 120. Of the remaining 165 cases existing in the county in 1911 the information at hand is more or less indefinite, but unquestionably some of this number contracted the disease in 1911.

Prior to 1911 definite statistics are too meagre to warrant analysis.

Our statistics suggest that pellagra, so far as new cases are concerned, was somewhat more prevalent in 1911 than in 1912.

The annual case death-rate among pellagrins was as follows:

Year.	No. of deaths.		No. of cases.	Per cent. of deaths.
Unknown	8			
1894	1			
1898	1			
1899	1			
1901	2			
1902	2	25	114	22
1903	1			
1904	1			
1908	2			
1909	14			
1910	32		115	28
1911	54		285	19
1912	47		376	12

It should be understood that these mortality statistics are of pellagrins who have died from all causes, not deaths from pellagra alone. In a number of these cases the pellagrous symptoms were of but little moment, the actual causes of death being other factors, among which may be mentioned tuberculosis and senility. The morbidity and mortality statistics for 1910 and the years preceding are not sufficiently complete to warrant any deductions. Those for 1911, showing 19 per cent. deaths, and for 1912, showing 12.5 per cent. deaths, represent more nearly the relationship between the morbidity and mortality rates as they exist at present.

Death during the initial attack is not uncommon. In the series of 282 cases studied by this Commission, 97 contracted the disease in 1912, and 5 of these cases died during the initial attack.

Summary. The following general statements concerning relative prevalence and mortality seem to be warranted:

Sporadic cases have been observed in Spartanburg County since 1894. During the past three or four years there has been an alarming increase in the number of cases. The number of new cases developing in 1911 was somewhat greater than in 1912, although the difference was but slight. When the disease first appeared in Spartanburg County the symptoms were frequently severe and the death-rate appears to have been high. The number of cases in the county is increasing while the death-rate appears to be decreasing.

XIII. Clinical Observations on Pellagra. A. *Chronicity and Periodicity, with a Study of the Influence of Climatic Conditions.* 1. *Chronicity.* We have observed no differences in the symptomatology, and more particularly in the chronicity, of the disease as it exists in this country and in Italy, except the fact that the mortality rates in this country two or three years ago were apparently much higher than those obtaining in Italy at the same time.

A few of the cases in the present series died during the initial attack in 1912, while others presented a wide gradation of symptoms ranging from those involving the cutaneous, gastrointestinal, and nervous systems to those in which the cutaneous system alone was involved.

Original Attack and Annual Recurrences.

Early history indefinite; recurrence, 1912	1
1904.	
First attack, 1904; recurrences, 1905, 1906, 1907, 1908, 1909, 1910, 1911, 1912	1
1905.	
Indefinite history, 1905 to 1911 inclusive; recurrence 1912	1
First attack, 1905; recurrences, 1906, 1907, 1908, 1909, 1910, 1911, 1912	1
1906.	
First attack, 1906; recurrences, 1907, 1908, 1909, 1910, 1911, 1912	1
1907.	
First attack, 1907; recurrences, 1908, 1909, 1910, 1911, 1912	1
First attack, 1907; no clear history, 1908, 1909, 1910; recurrences, 1911, 1912	1
1908.	
First attack, 1908; recurrences, 1909, 1910, 1911, 1912	2
First attack, 1908; recurrences, 1909, 1910; no recurrence, 1911; recurrence, 1912	1
First attack, 1908; no recurrences, 1909, 1910; recurrences, 1911, 1912	1
First attack, 1908; recurrence, 1909; no recurrence, 1910, 1911, 1912	1
1909.	
First attack, 1909; recurrences, 1910, 1911, 1912	11
First attack, 1909; indefinite history, 1910, 1911; recurrence, 1912	1
Indefinite history, 1909, 1910, 1911; recurrence, 1912	1
First attack, 1909; no recurrence, 1910; recurrence, 1911; no recurrence, 1912	1
First attack, 1909; no recurrences, 1910, 1911, 1912	1
First attack, 1909; recurrences, 1910, 1911; no recurrence, 1912	1
First attack, 1909; no recurrences, 1910, 1911; recurrence, 1912	1
First attack, 1909; recurrence, 1910; no recurrence, 1911; recurrence, 1912	1
1910.	
First attack, 1910; recurrences, 1911, 1912	30
First attack, 1910; no recurrence, 1911; recurrence, 1912	3
First attack, 1910; recurrence, 1911; no recurrence, 1912	12
Indefinite history, 1910; recurrences, 1911, 1912	1
First attack, 1910; no recurrence, 1912	3
First attack, 1910; no history, 1911, 1912	1
1911.	
First attack, 1911; recurrence, 1912	69
First attack, 1911; no recurrence, 1912	29
Indefinite history, 1911; no recurrence, 1912	1
Indefinite history, 1911; recurrence, 1912	1
1912.	
First attack, 1912	97
Total	277

It will be noted that in some of these cases the disease was contracted originally in 1904; in others, in 1905 and every year thereafter to 1912, inclusive. Occasionally the history of previous attacks was indefinite, and such cases are so classified.

In this series there are 55 cases of pellagra recognized from one to five years ago by the attending physicians in which the annual recurrence has failed to appear in one or more seasons. In some of these cases the disease has reappeared after an intermission of one or two years, while in other instances symptoms have been present for one or more seasons, and have never since recurred. The following cases illustrate this point:

First attack, 1908; recurrence, 1909; no recurrences, 1910, 1911, 1912	1
First attack, 1909; no recurrences, 1910, 1911, 1912	1
First attack, 1910; no recurrences, 1911, 1912	3

In addition to these five cases we have records of a few other cases in Spartanburg County, not included in this series, in which patients have been without symptoms for a period of two, three, or more years and appear to be cases of recovery from the disease.

Our individual case histories show that a number of adult females have borne children since contracting pellagra, but in only 22 cases is the relationship of the pregnancies to the development of symptoms sufficiently definite to warrant analysis. In 16 of these cases (75 per cent.) there were no symptoms of pellagra during pregnancy. These observations cover only a small number of cases, and this subject will be investigated more in detail in this series and in additional ones during the summer of 1913. Pregnancy seems to show a tendency to inhibit the development of pellagrous symptoms.

2. *Periodicity.* A study of the literature of pellagra gives one the impression that there is a definite seasonal periodicity. We are led to believe that the disease appears in the spring; that there is a relative decrease in the number of cases in midsummer; that a fall recrudescence occurs, and that there is a tendency for symptoms to reappear at the same time each year.

Sambon cites the spring and fall periodicity as a strong argument in favor of his hypothesis that the disease is of protozoal origin and transmitted by a blood-sucking insect, a species of Similium.

We have undertaken some studies bearing on this phase of the subject. It is evident that these observations, except for the year 1912, must be based on the statements of patients suffering with pellagra. We have endeavored to control such statements and to add to their reliability by information obtained from other members of the household, and more particularly by that obtained from the attending physician. The cases will first be considered by month of onset of symptoms. Chart 9 represents graphically the month of onset of symptoms arranged by years. It is understood, of course, that this chart represents not only the month of original onset in each case, but includes also the recurrences in each case year by year.

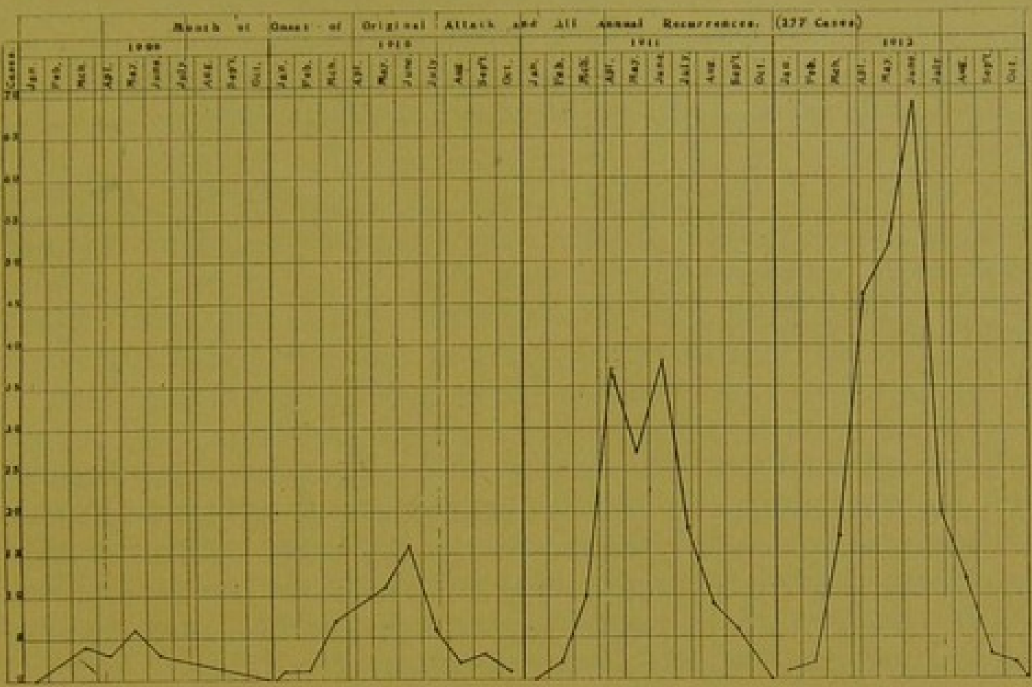


Chart 9.—Month of onset of original attack and all annual recurrences (277 cases).

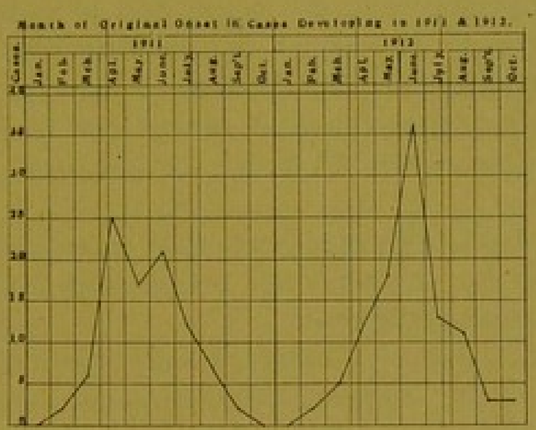


Chart 10.—Month of original onset in cases developing in 1911 and 1912.

In Chart 10 we have analyzed further the 1911 and 1912 cases from the standpoint of original onset of symptoms when the disease was contracted. It is evident from these charts that cases begin to show symptoms in the early spring, that there is a gradual increase in the number showing symptoms until the month of June, when the incidence curve reaches its highest point, and that after the month of June the incidence-rate falls quite rapidly. It is also evident that there are no spring and fall recrudescences of pellagra in Spartanburg County. On the contrary, cases begin to show symptoms in the spring, increase in number until midsummer, and then rapidly decrease.

We have analyzed the recurrent attacks with a view of determining whether or not there was any marked tendency in each individual case for active symptoms to appear during the same month year after year, with the following results:

INTERVAL BETWEEN ONSET OF SUCCESSIVE ATTACKS.

	11½ to 12½ months.	11 to 11½ months or 12½ to 13 months.	Less than 11 or more than 13 months.
Cases contracting pellagra in 1909	4	2	5
Cases contracting pellagra in 1910	12	17	10
Cases contracting pellagra in 1911	21	20	24
	37	39	39

We have analyzed still further the uniformity of recurrences, first by ascertaining the date of appearance of symptoms in individuals who contracted the disease in 1910 and comparing these dates with date of recurrence of symptoms in the same individuals in 1911, and second, by tabulating the same facts for cases developing originally in 1910 and 1911 and recurring in 1912.

Among the cases showing symptoms originally in 1910 the recurrence in 1911 was a month or more earlier in 14 cases, during the corresponding month in 27 cases, and a month or more later in 17 cases. Among the cases contracting the disease in 1910 and 1911 the recurrence in 1912 was at least a month earlier as compared with the appearance of symptoms in 1911 in 36 cases, during the same month in 48 cases, and at least a month later in 33 cases.

It is evident from this analysis that there is no particularly marked tendency for the seasonal recurrences to reappear during the same month year after year.

3. *Influence of Climate.* Climatic conditions are said to influence the periodicity of the disease. If during the spring months the precipitation is high, temperature low, and number of rainy days excessive, there is said to be a delay in the appearance of acute symptoms, more particularly those involving the skin. One of us had occasion to observe this influence in the spring of 1910 while investigating conditions in northern Italy. In March and April of that year the weather conditions in the provinces of Milan and Bergamo were quite unsettled, precipitation was excessive, there were many rainy days, but little sunshine, the temperature was low and the atmosphere was damp and chilly. At this time there were but few cases showing active symptoms of pellagra. The delay in appearance of active symptoms was attributed to unsettled weather conditions. We were informed, further, that it had been observed for many years that unsettled weather conditions in the spring always delayed the appearance of active

symptoms of the disease. We have been able to compare this general impression as regards conditions in Italy with similar conditions in the South. Early in May, 1912, we investigated the prevalence of pellagra in different sections of South Carolina, in North Carolina, and in Georgia. The physicians consulted informed us that there was a delay in appearance of cases showing active symptoms, and that whereas in April, 1911, they had observed many such cases, in April, 1912, they had seen but few. We were informed that spring and settled weather conditions were present much earlier in 1911 than was the case in 1912. This general impression is confirmed by the fact that farmers in the states mentioned were able to get their crops under way quite early in 1911 while in 1912 they were delayed for from three to six weeks. In Spartanburg County it was possible to secure much more detailed information covering weather conditions. The general information given us is in agreement with that outlined above.

In order that these general impressions may be controlled, we have obtained from the United States Weather Bureau its reports on weather conditions in Spartanburg County, South Carolina. The available information from this source, which includes monthly precipitation, monthly mean temperature, and number of rainy days, is presented in Charts 11, 12, and 13.

It is evident from an analysis of the monthly precipitation curves for 1911 and 1912 that in 1912 during the months of January to June inclusive, except for the month of April, the monthly precipitation was greatly in excess of that for the like period in 1911.

Analysis of the monthly mean temperature curve for 1911 and 1912 shows that in 1912 for the months of January to June inclusive the temperature was, in general, appreciably lower than was the case for like months in 1911.

A study of Chart 13 (number of rainy days) shows that for the first six months in 1912, except for the months of March and April, the number of rainy days per month was in excess of the number for the like period in 1911. While there were more rainy days in March and April, 1911, than for the same months in 1912, the amount of precipitation for these two months in 1912 was in excess of that for 1911.

These charts, considered as a whole, indicate quite clearly that settled weather conditions with relatively high temperature and low precipitation existed in Spartanburg County at an earlier date in 1911 than was the case in 1912.

The relationship between climatic conditions existing in 1911 and 1912 and the appearance of acute symptoms of pellagra can be determined by referring to Charts 9 and 10. There was quite a definite tendency for symptoms to appear at an earlier date in 1911 than was the case in 1912. The incidence-rate in both charts was high for the month of April, 1911, while in 1912 the incidence-rate for April was comparatively low, especially in respect to new cases, and the maximum rate was not attained until the month of June.

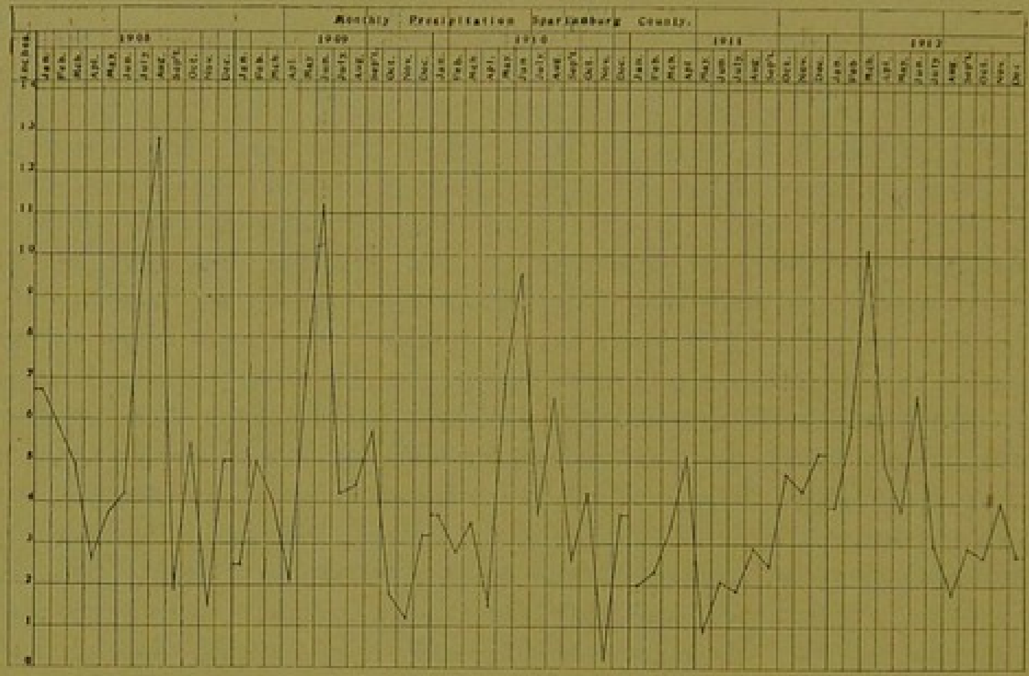


CHART 11.—Monthly precipitation, Spartanburg County.

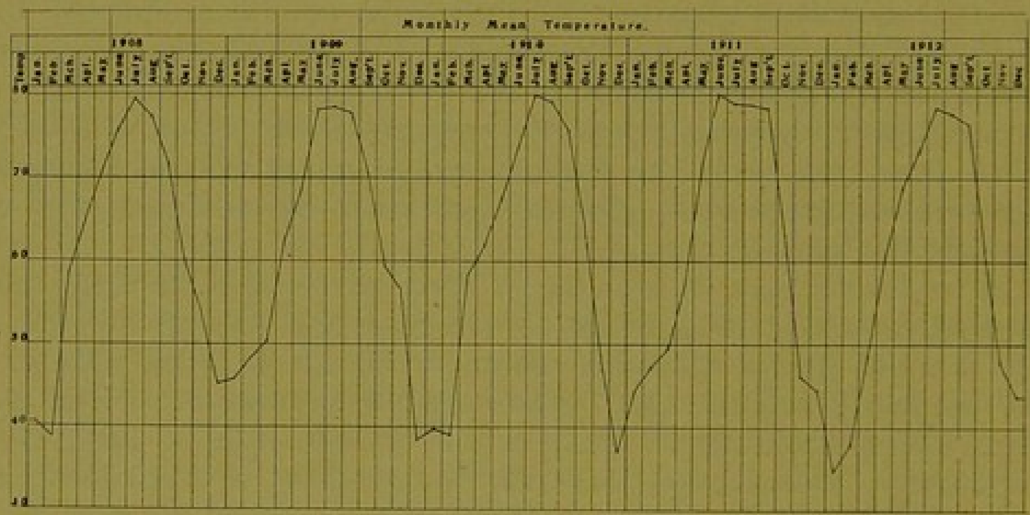


CHART 12.—Monthly mean temperature.

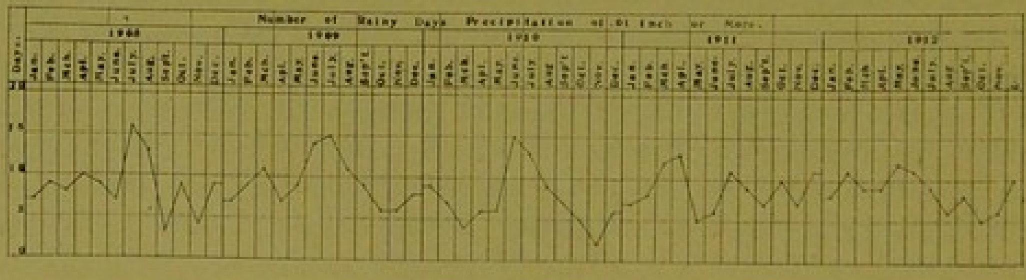


CHART 13.—Number of rainy days, precipitation 0.01 inch or more.

Summary. 1. *Chronicity.* In a large proportion of the cases in this series the disease exhibited marked chronicity. In 20 per cent. the annual recurrences had failed to appear in one or more seasons. Pregnancy seems to show a tendency to inhibit the development of pellagrous symptoms. In 2 per cent. of the cases no symptoms had been present for from two to three years, and these appear to be cases of recovery from pellagra.

2. *Periodicity.* Cases begin to show symptoms in the early spring, increase in number until midsummer, and then rapidly decrease. There was no evidence whatever pointing to any spring and fall recrudescences, so frequently referred to in the literature of pellagra. There is no particularly marked tendency for the seasonal recurrences to appear during the same month, year after year, in the same individual.

3. *Influence of Climate.* Climatic conditions appear to influence the development of symptoms of the disease. If during the spring months precipitation is high, temperature low, and number of rainy days excessive, the appearance of acute symptoms, more particularly those involving the skin, is delayed.

B. *Symptomatology of* 1912 *Attacks.* A considerable amount of information has been collected in reference to symptomatology, but a discussion of this phase of the subject will not be undertaken until we have followed these cases through their 1913 recurrences.

The following general statements are warranted: While three or four years ago it was quite the usual thing to see patients showing a combination of severe skin lesions, severe stomatitis, intractable diarrhea or dysentery, mental derangement, and physical exhaustion, comparatively few patients exhibiting this symptomatology in a marked degree were observed in Spartanburg County during the summer of 1912. In many of the cases observed the symptoms were quite mild, and frequently they were confined almost entirely to the cutaneous system. This apparent indication of a decreasing virulence of the disease is strengthened by certain facts which appear in the study of mortality rates of pellagra in Spartanburg County for 1912 and earlier years.

XIV. Clinical Observations upon Economic Status and Previous Health of Pellagrins. It is believed by many who are brought into contact with pellagra that predisposition plays an important part in its development and that the disease most frequently affects the poorer classes, who live under unfavorable hygienic conditions and who subsist on a diet of low nutritive value and of limited variety. Some detailed studies were undertaken covering these points. The general hygienic conditions and dietary will be discussed elsewhere, and this section will be confined to a consideration of financial circumstances and health conditions as possible predisposing factors.

A. *Economic or Financial Circumstances.* In recording the data relating to the economic conditions under which the patients lived, the following classification was adopted: squalor, poverty, necessities, comfort, affluence. These terms are somewhat arbitrary and necessitate some brief explanation.

Squalor. Cases so classified are confined to those living in wooden huts in poor repair and without out-houses. Their diet was extremely poor and without variety, living rooms squalid, clothing filthy and in rags.

Poverty. Cases of this class lived in cabins usually without out-houses, rather isolated, ordinarily on large plantations. Food consisted largely of bacon, molasses, corn-bread, and biscuit. Negroes of the poorer tenant class form this group very largely.

Necessities. This class included those instances in which the family had a fairly regular cash income sufficient to provide for actual needs. It is made up largely of mill operatives and their families. They live in cottages, with some land about them, but rather closely aggregated to form mill-villages.

Comfort. Cases classified in this group are made up largely of farmers who own their own plantations and stock, have a good diet, and are in comfortable financial circumstances.

Affluence. In this group are included patients who live under the best of hygienic and financial conditions. Their houses are well-constructed, usually screened, and their diet is well balanced.

The cases so classified number 277 and are divided as follows:

Squalor	2
Poverty	28
Necessities	200
Comfort	41
Affluence	6

It will be seen that in 83 per cent. of the cases (squalor, poverty, necessities) the economical conditions were poor; that in 15 per cent. (comfort) the economical conditions were within the average, and in 2 per cent. (affluence) the financial circumstances were well above the average.

In connection with the "affluence" group, it may be said that the members of the Commission have personal knowledge of a number of other instances in which pellagra has developed in persons living under the best of hygienic and economic conditions.

Grouping the cases under two general subdivisions, we find that in 83 per cent. of the cases the economic conditions are poor, while in 17 per cent. they are good.

B. *Diseases of Childhood and General Health in Childhood. Diseases of Childhood.* In considering the diseases of childhood the cases were divided in two groups: (1) those giving a history of one or more of the following diseases: measles, mumps, chickenpox, and whooping cough; (2) those giving a negative history for the diseases of childhood. The data covered 270 cases.

DISEASES OF CHILDHOOD.

Cases giving a history of one or more of the following diseases of childhood: measles, mumps, whooping cough, and chickenpox	252
No history of diseases of childhood	18
Total	270

As permanent injury to the heart and kidneys not infrequently follows attacks of scarlet fever, this disease was considered separately. In 20 cases a history of scarlet fever was elicited.

General Health in Childhood. The classification adopted in the consideration of general health in childhood was the following: Good, fair, and poor. Inquiries covering this point were made in 270 cases. Of this number, 232 (86 per cent.) gave a history of good health during childhood; in 28 cases it was fair, and in 10 cases it was poor.

C. *Diseases of Adult Life and General Health during Adult Life. Diseases of Adult Life.* The total number of cases considered is 198. The diseases peculiar to female adult life will be considered in a separate table. The following summary shows the prevailing diseases in some detail:

	No. of cases
Gastric disturbance	14
Dysentery, acute or chronic	28
Typhoid fever	46
Tuberculosis	7
Other diseases, unclassified	36
No history of ill health	67
Total	198

An analysis of diseases of adult life shows that 34 per cent. (67) of the total number of cases gave no history of ill-health. In 25 per cent. of the cases, those giving history of gastric disturbances, dysentery, and tuberculosis, a chronic disease was present.

General Health in Adult Life. In considering this point the classification adopted was that of good health, fair health, and poor health.

GENERAL HEALTH DURING ADULT LIFE.

Good	134
Fair	66
Poor	18
Total	218

An analysis of the data concerning general health conditions during adult life shows a history of good health in 62 per cent., fair health in 30 per cent., and poor health in 8 per cent.

D. *Obstetrical and Gynecological History.*

Social Status.

Married	150
Widowed	9
Single	25
	184

Obstetrical History.

Married females who have borne children	136
Unmarried females who have borne children	2
Married females who have not borne children	23
Unmarried females who have not borne children	23
	184

Number of females who have borne 1 child	28
Number of females who have borne 2 children	20
Number of females who have borne 3 children	21
Number of females who have borne 4 children	25
Number of females who have borne 5 children	16
Number of females who have borne 6 children	8
Number of females who have borne 7 children	10
Number of females who have borne 8 children	4
Number of females who have borne 9 children	3
Number of females who have borne 10 children	1
Number of females who have borne 11 children	2
	138

Average number of children borne = 3.8.

Menstruation during Period of Acute Pellagrous Symptoms.

Normal	95
Irregular	53
Excessive	6
Suppressed	10
Menopause	11
No information	9
	184

Diseases of Women.

Number of females giving more or less definite history of ovarian, uterine, or other pelvic disease	49

From this summary it will be noted that among the females who had attained the age of puberty, 86 per cent. of the cases occurred in married women, and that 86 per cent. of these married women had borne children. The greatest number of children borne by an individual is 11. The average number borne is 3.8. We have collected some statistical information in reference to the average size of families in mill-villages in Spartanburg County, from the standpoint of children borne by each woman, and it is not significantly different from the average number shown among pellagrous women.

The amount of time at our disposal and the relative importance of the subject did not warrant examinations of sufficient thoroughness to classify in detail the diseases of women. Of the 49 cases giving history of such diseases the following were noted: tubal and ovarian inflammation, pus-tubes, cystic ovary, endometritis, uterine fibroid, carcinoma of the uterus, displacement of the uterus, and pelvic inflammation. In a number of cases, symptoms referable to the genital tract were quite indefinite.

The feature of most interest and relative importance in the consideration of predisposing factors is the chronologic relationship of previous illness to the development of pellagrous symptoms. The following summary gives in some deatil the information secured:

Recent Illness Possibly Predisposing to Pellagra.

Gastric disturbance (including chronic gastric indigestion)	15
Dysentery (chronic during summer)	23
Diarrhea	6
Hookworm disease (moderate infection)	1
Ovarian cyst (large)	1
Uterine disease	4
General poor health (usually following childbirth)	30
Nephritis	3
Ascites (probably due to nephritis)	1
Valvular disease of the heart	1
Asthma	1
Pulmonary tuberculosis	7
Malarial fever	1
Alcoholism	1
Morphine habit	1
Infantile paralysis	1
Whooping cough	2
Measles	12
Chickenpox	1
No history of recent illness, 156; Health better than usual, 2	158
	270

In 15 of the cases a history of chronic indigestion was obtained. In explanation of these cases it may be said that symptoms of gastric disturbance preceded the active cutaneous symptoms of pellagra by a period of several months to several years. In 11 per cent. (30) of the cases no history of illness immediately preceding the development of pellagra could be obtained other than the fact that the general health was poor. Quite frequently this history of poor health followed confinement. One history of hookworm disease is included. This case showed objective clinical evidence of hookworm infection, which was uncommon for Spartanburg County. Malarial fever does not appear to be endemic in this county, and the one case included in this table was contracted in one of the "low country" counties. We were impressed with the fact that children not infrequently contracted pellagra during convalescence from acute infectious diseases, or very soon thereafter. It will be noted that 15 such observations were made: whooping cough, 2; measles, 12; chickenpox, 1. Of the 43 cases in children under ten years of age, 11 (approximately 23 per cent.) gave a history of measles. In most of these the attack of pellagra occurred soon after recovery from measles.

SUMMARY. In the large majority of these cases (83 per cent.) economic conditions were poor, and the disease is most prevalent among people of insufficient means. We would, however, invite attention to the fact that 17 per cent. of these cases occurred in patients living in comfortable circumstances. This is not in agreement with Italian conceptions of the disease, where it presumably is confined altogether to the poorer element of the general population.

An analysis of general health conditions during childhood shows that in 86 per cent. of the cases the history was that of good health. So-called congenital diseases and inherited constitutional defects were of no apparent significance.

An analysis of diseases of adult life shows that in 25 per cent. of the cases, those giving a history of gastric disturbances, dysentery, and tuberculosis, a chronic disease was present, and it might be inferred that there is evidence of existing predisposition. During adult life the general health conditions were good in more than half the cases (62 per cent.).

An analysis of the obstetrical and gynecological data shows that among females who had reached the age of puberty, those most affected were married women (86 per cent.). As 86 per cent. of the married women had borne children and the average number of children borne was 3.8, it might be inferred that childbearing is an important predisposing factor. We know, however, that the average number of children borne by married women in the general population of the South is equal to or even greater than this.

Recent illnesses do appear to be worthy of serious consideration as predisposing factors, and it is our opinion that they frequently do influence not only the development of pellagra but also the severity of the attacks. It will be noted, however, that 59 per cent. of the cases in this series gave no history of illness immediately preceding the development of pellagra.

XV. STUDIES UPON HYGIENIC AND SANITARY CONDITIONS OF HOUSES AND PREMISES. A. *Houses.* The prevailing type of home in this county is a frame dwelling. The site usually is well drained, and there is always more than sufficient space between houses to afford free circulation of air.

In this study the dwelling houses are considered in three groups: brick, frame, and cabin.

Brick Dwellings. Dwellings of brick construction are relatively few in number. The mercantile houses in the larger centres are usually of brick construction, one or more stories in height, and the upper stories occasionally are used for living quarters. One of the cases included in this series was occupyiug such quarters.

Frame Dwellings. The mill-village dwellings are of the same general type, usually one story, sometimes two (Figs. 1, 2, 3, and 4).

The houses are almost always double. The single-story houses consist of a combination sitting and bed room, dining room, and

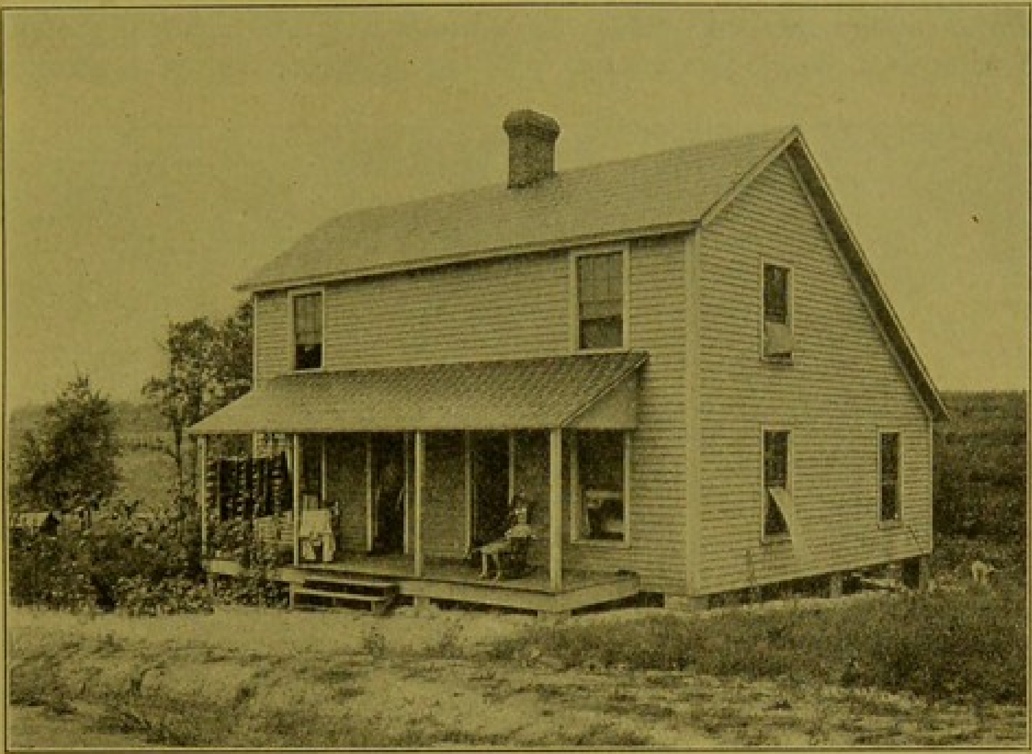


Fig. 1.—Typical mill-village house.

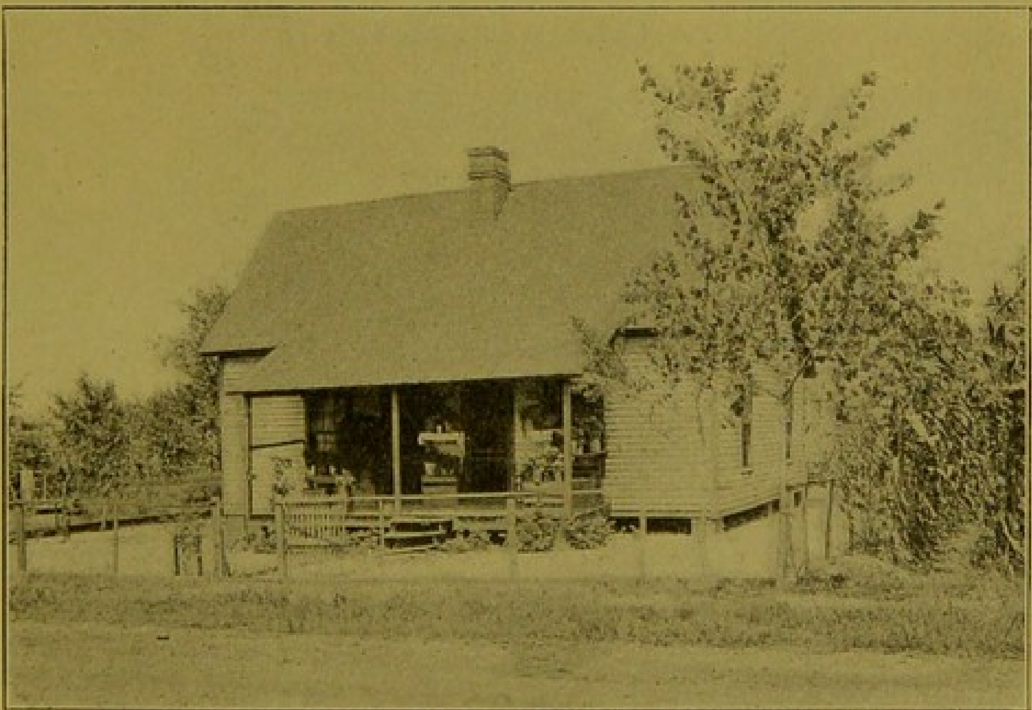


Fig. 2—Typical mill-village house

kitchen (Fig. 5). In the two-story houses there is in addition a bed room on the second floor. Small families occupy one-half of a double single-story house, and large families live in either a two-story house or both sides of a double one-story house. There are two or three windows in each room and a small porch in front. These houses have no cellar, the foundation is brick, the ground floor is well above the ground, and the space between the ground

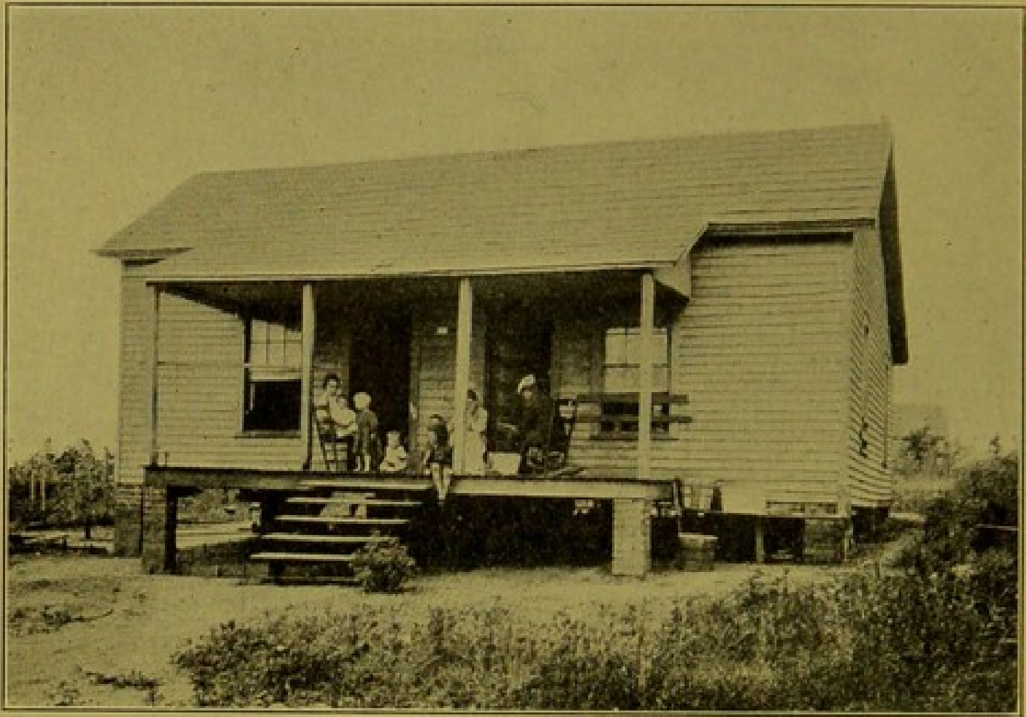


Fig. 3.—Typical mill-village house

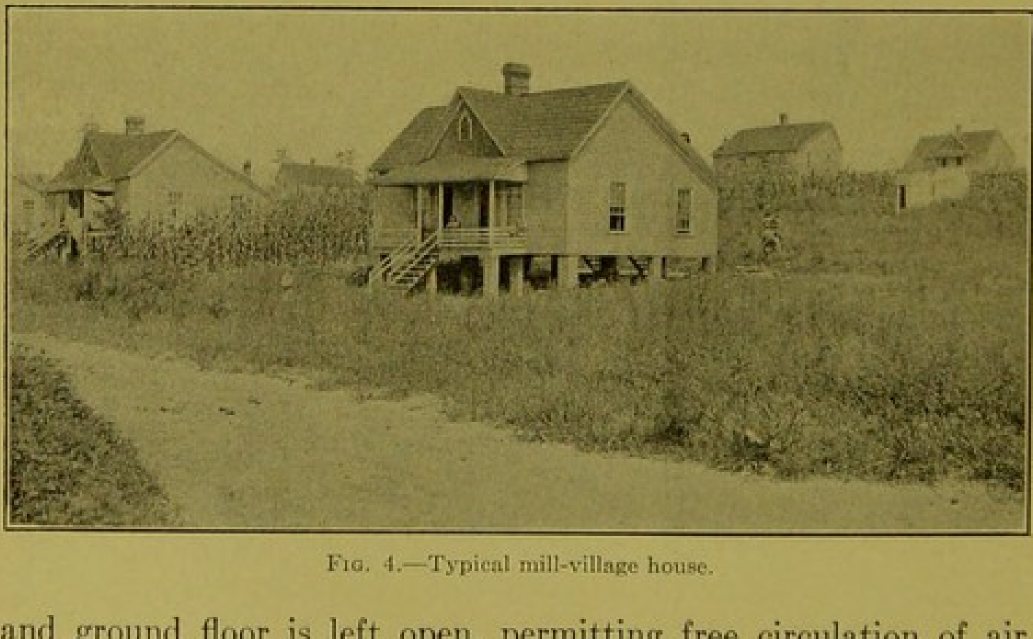


Fig. 4.—Typical mill-village house.

and ground floor is left open, permitting free circulation of air. Doors are placed directly in line from front to rear of the house, permitting free and unobstructed passage of fresh air. Rooms are sealed, both walls and ceiling. The timber used for this purpose is sometimes matched, sometimes not. The roof has a good pitch with a large attic, permitting circulation of air, and the bed rooms have open fireplaces which further improve ventilation.

These houses are practically all infested with *Cimex,* and the grooves between the boards used in sealing the rooms afford an ideal place for the hatching out of broods of these insects.

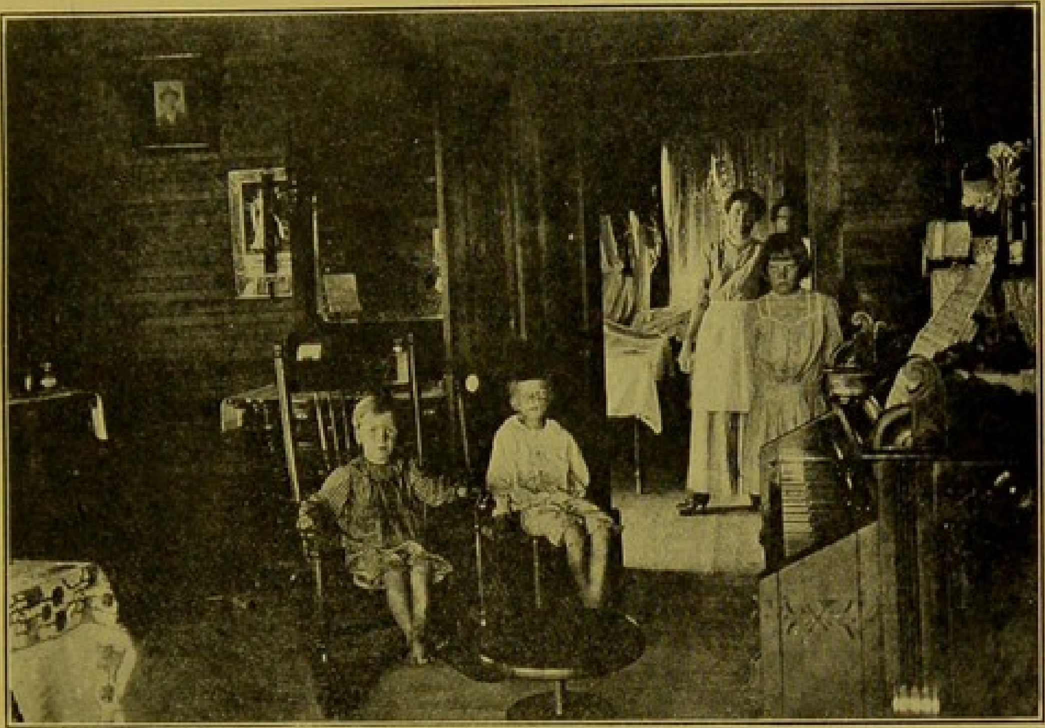


Fig. 5.—Interior view, mill-village house.

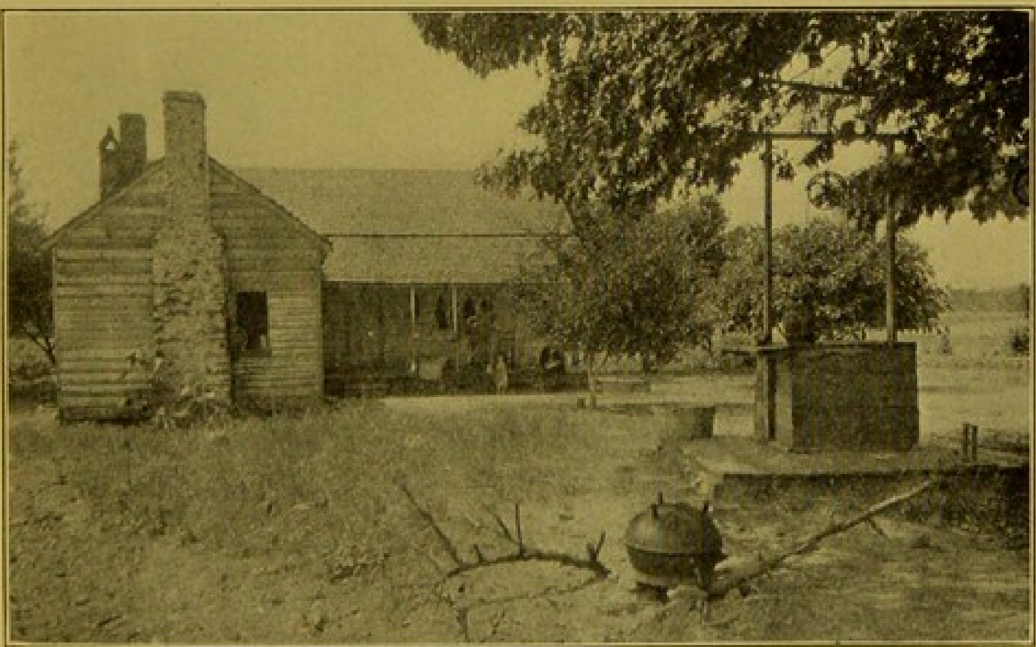


Fig. 6.—Type of farm-house and well.

The dwelling houses in the farming section are practically always frame houses (Fig. 6). Many of the farm-houses, more particularly those occupied by owners, are well-constructed, roomy, and superior to the mill-village dwelling-house. On the other hand the usual tenant-house is inferior in many respects to that found in mill-villages.

Cabins. In this group are included the small frame or log dwellings, poorly constructed and ill-ventilated (Fig. 7). The negroes of the farming class usually occupy such houses.

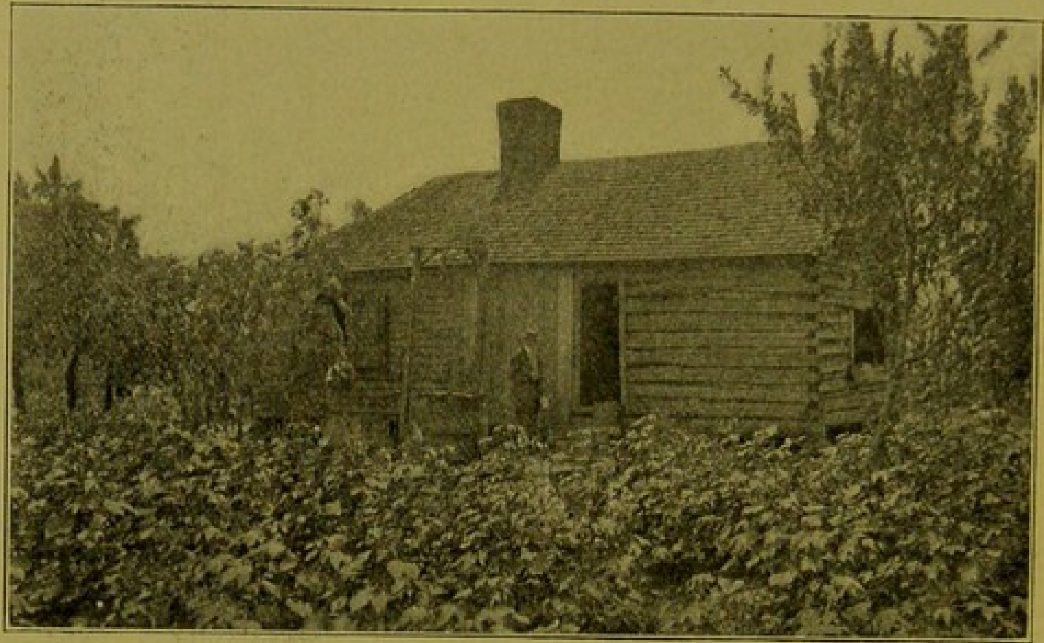


Fig. 7.—Type of cabin occupied by negro tenants on farms.

HYGIENIC AND SANITARY CONDITION OF HOUSES.

Brick		2
Frame		236
Cabin		19
		257
Repair:	Good	212
	Poor	38
		250
Screened:	Yes	21
	No	229
		250
Ventilation:	Good	155
	Fair	86
	Poor	8
		249
General cleanliness:	Good	142
	Fair	92
	Poor	12
		246

SUMMARY. 92 per cent. of the cases lived in frame houses of fairly good size, and 85 per cent. of the houses investigated were in fairly good repair. Nine per cent. of the houses were screened, but in many instances the screening was more or less unsatisfactory. In only a small proportion of the screened houses did the screening afford satisfactory protection against the ingress of insects. *Musca domestica* was present in all, and *Stomoxys calcitrans* was present in many unprotected houses.

Ventilation. In 62 per cent. of the houses investigated, ventilation of the bed rooms was good, in 36 per cent. only fair, and in 3 per cent. poor. The number of persons occupying each bedroom averaged about three, and the available allowance of air space did not, in general, suggest overcrowding. Poor ventilation and overcrowded conditions were more in evidence in the negro population.

SUMMARY. We have failed to find anything of significance in connection with the houses from the standpoint of overcrowding and ventilation. It was observed that *Mucosa domestica* was always more or less abundant, and that of the blood-sucking insects, *Stomoxys calcitrans* and *Cimex lectularius* were of common occurrence. A detailed study of the observations on insects will be considered in the entomological section of this report.

B. *Water Supply.* The sources of water supply for drinking purposes among the general population of Spartanburg County are similar to those considered in this study. For analytical purposes the sources of supply are divided into three groups, wells, springs, and city water.

SOURCE OF WATER SUPPLY.

Wells: Dug well, with bucket	162		
Artesian well, with pump	30	192	
Springs	13	13	
City water, hydrant	36	36	241

PROTECTION OF WATER-SUPPLY WITH REFERENCE TO CONTAMINATION BY SURFACE WATER OR BY SEEPAGE AT POINT FROM WHICH SUPPLY IS DRAWN.

Protection satisfactory (water-supply drawn from hydrants, from artesian wells with concrete base, or from deep wells with concrete base)	65
Partly protected (water-supply drawn from wells with wooden base, either covered or uncovered, or from isolated springs)	176
	241

Wells. The wells are of several types. The type most common in rural districts and in some of the mill-villages is the ordinary dug well, about five feet in diameter (sometimes round and sometimes square), from thirty to sixty or more feet in depth, and protected at the top by a wooden frame. Though a few wells could be classified as "shallow wells," it was quite the usual thing to

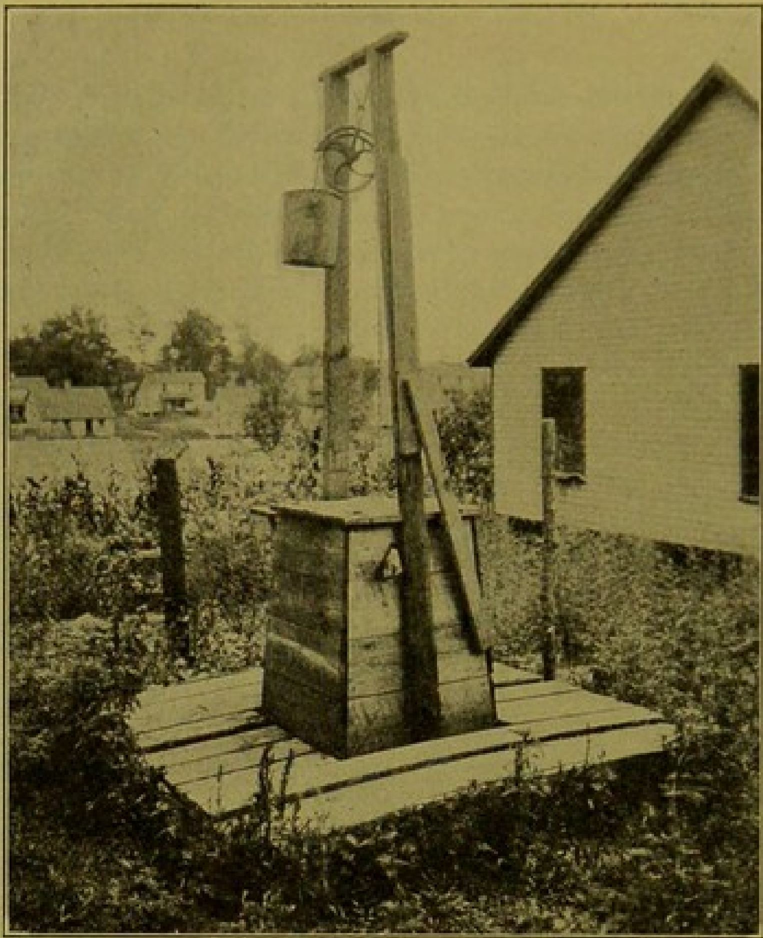


Fig. 8.—Typical dug well with bucket. Wooden base.

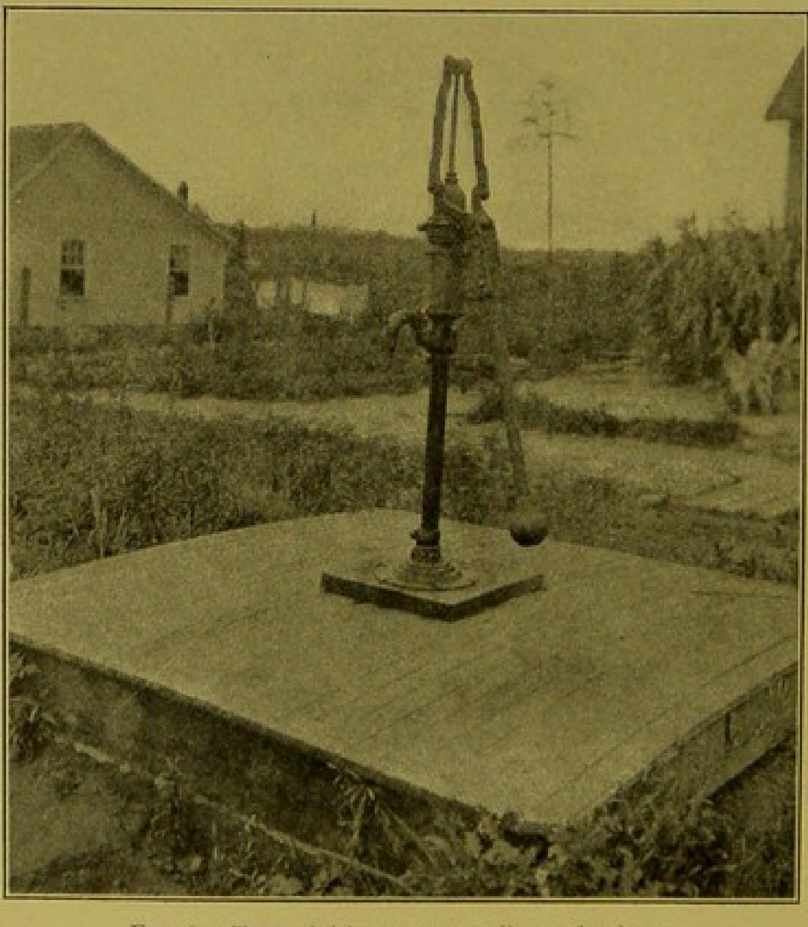


Fig. 9.—Type of driven pump well, wooden base.

find that the supply was obtained from a sufficient depth to insure that an impermeable stratum supervened, preventing contamination by surface water.

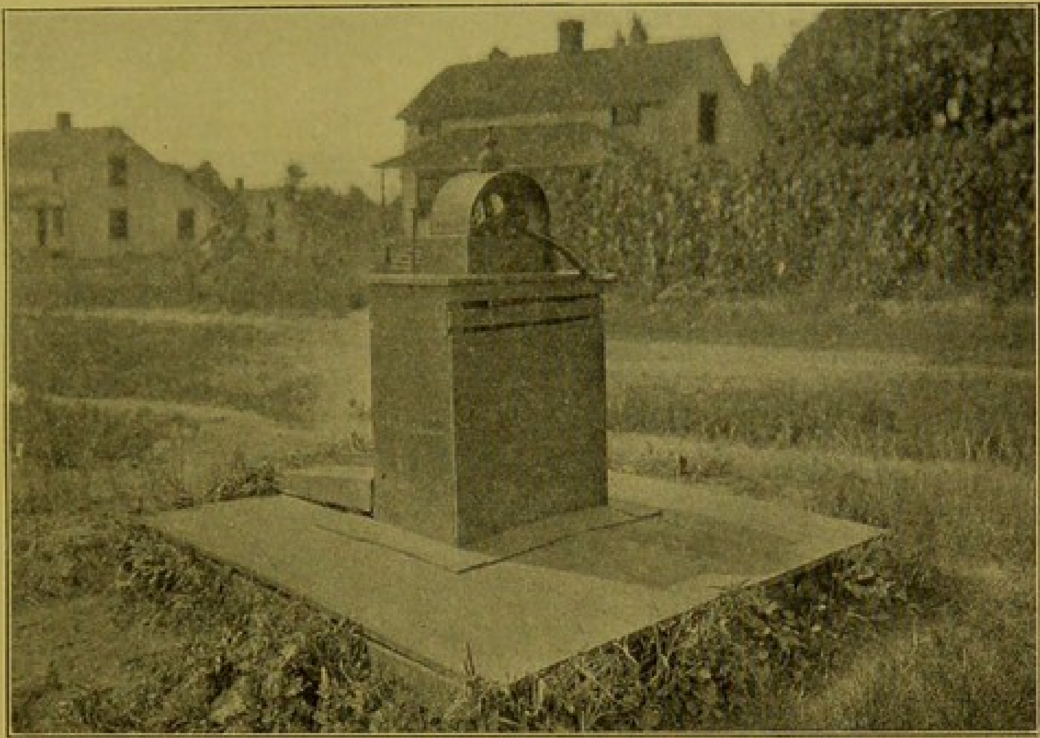


Fig. 10.—Type of bucket well, wooden base

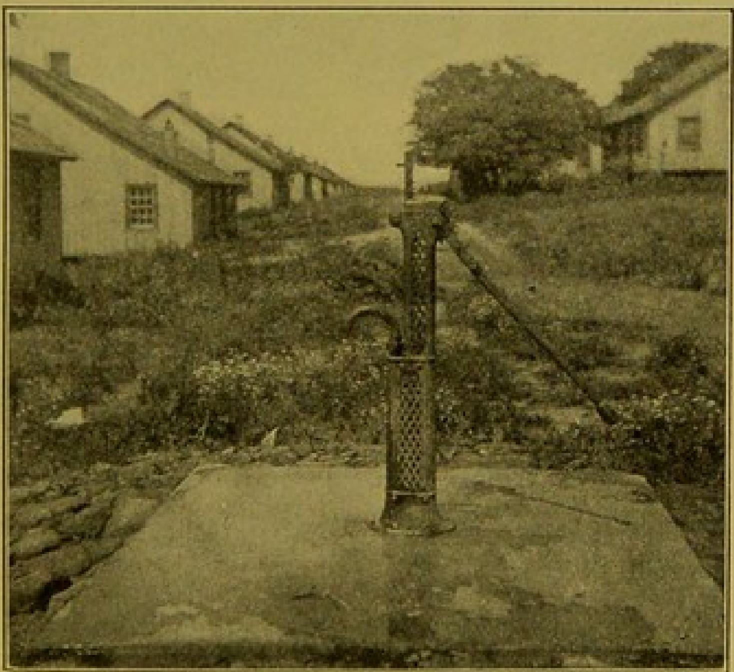


Fig. 11.—Type of driven well with pump. Sloping concrete base

The water was usually drawn by means of the well-known bucket and windlass arrangement, but in a number of instances pumps were in use. In the farming districts, ordinarily, no effort was made to guard against contamination at the immediate source of supply, but in some of the mill-villages these wells have concrete bases, sloping outward. The various types of wells can be better understood by reference to Figs. 8, 9, 10, 11, and 12.

In some of the mill-villages, artesian wells are in use. These artesian wells are usually quite deep, and the water is drawn by pump.

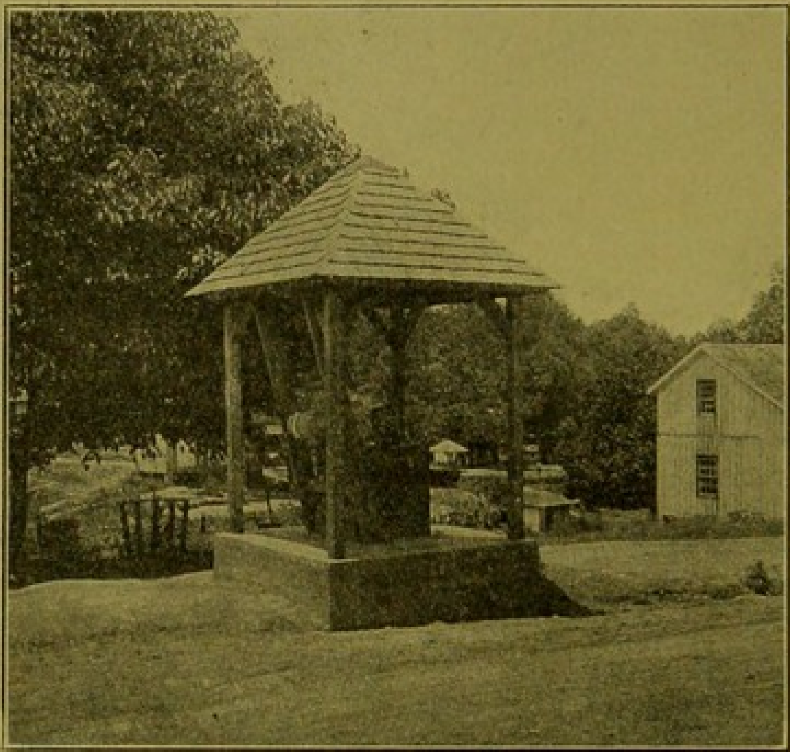


Fig. 12.—Dug well with bucket. Concrete base.

Springs. The use of spring water was, with one or two exceptions, confined strictly to the farming population living in comparative isolation. Usually drainage from the house was not in the direction of the spring, and the possibility of contamination was not a factor of importance.

City Water. This source of supply was confined to the city of Spartanburg. Bacteriological and chemical examinations are made from time to time, with no evidence of contamination.

Summary. It will be noted that 80 per cent. of the cases used well water; 15 per cent. used city water; and 5 per cent. used spring water.

In 27 per cent. of the total observations (241) the water supply was perfectly protected from contamination. The remaining 73 per cent. are classified as partly protected, but this group requires some further explanation, as otherwise an erroneous inference might be drawn. We have included in this group all springs, all shallow wells, and all wells without a concrete base. As a matter of fact, there were few shallow wells, and the probability of contamination in this group, considered as a whole, was but slight.

We realize that the water-supply is not considered to be of any importance as a factor in the etiology of pellagra. In this study, however, we have endeavored to investigate, as far as was possible, all probable factors concerned in the epidemiology of the disease, and for this reason have considered the water-supply. We have found nothing of any apparent significance in this connection.

C. *Disposal of Excreta.* In making a general survey of sanitary conditions, a study of the disposal of excreta was included. In classifying privy types we have adopted, for the sake of convenience, the classification used by the Rockefeller Sanitary Commission in its hookworm investigations in the Southern States.

Index of Privy Types Adopted by the Rockefeller Sanitary Commission.

		Per cent.
Class A.	Water carriage or Marine Hospital Barrel (L. R. S.)	100
Class B.	Water-tight and rigidly fly-proof privy	75
Class C.	Water-tight, closed-in back	50
Class D.	Closed-in back, surface privy	25
Class E.	Ordinary open-in-back surface privy	10
Class F.	No privy	00

We encountered in this study one type of privy not falling strictly in any of these groups. The type in question (Fig. 14) was found in three or four of the mill-villages, and consisted of an out-house open in front and behind. The excreta were collected in square metal pails, supposedly water-tight. These pails were emptied at intervals. No attempt was made to keep out flies, the pails were frequently battered, and not water-tight, and usually were extremely filthy. It was not possible to include these privies in Class C, nor was it fair to put them in Class E. We have therefore placed them in Class D.

The following tables will show the facts observed:

Privy Types.

Class A	11
Class B	0
Class C	0
Class D	51
Class E	152
Class F	29
Total	243

Sanitary Index for all Privies.

Class A.	11 at 100 per cent.	1100
Class B.	00 at 75 per cent.	00
Class C.	00 at 50 per cent.	00
Class D.	51 at 25 per cent.	1275
Class E.	152 at 10 per cent.	1520
Class F.	29 at 0 per cent.	00
Total		3895

Sanitary index = 16.

Distance of Privy from House.

10 yards	4
15 yards	9
20 yards	35
25 yards	25
30 yards	75
35 yards	4
40 yards	9
45 yards	1
50 yards	31
60 yards	2
70 yards	1
75 yards	1
100 yards	2
200 yards	1
Water-carriage system (Class A)	11
No privy (Class F)	29
Total	240

Distance of Privy from Well.

10 yards	5
15 yards	5
20 yards	13
25 yards	7
30 yards	27
35 yards	7
40 yards	12
50 yards	45
60 yards	5
70 yards	6
75 yards	9
80 yards	1
85 yards	1
100 yards	5
110 yards	1
250 yards	1
Water-carriage system (Class A)	11
No privy (Class F)	29
Total	190

The cases in which the disposal of excreta was by water carriage (5 per cent.) were confined to the city of Spartanburg. No privy of the Marine Hospital type (L. R. S.) was observed. Between 30 and 40 cases of pellagra developed in the city of Spartanburg in other than mill-village sections. Only 8 of these cases used a water-carriage system of disposal of excreta. There were no privies of Class B or C. In 21 per cent. the privies were arbitrarily included in Class D. In 63 per cent. of the cases the method of disposal was that of the unhygienic and insanitary open surface privy, and in 12 per cent. of the cases no privy was used.

The method of disposal of excreta in the mill-villages, located in Spartanburg County falls under two classes, D and E (Figs. 13, 14, 15, 16, and 17): In some villages the pail system is in use, but beneficial results are negatived by the fact that no effort is made to screen the closets properly either in front or behind. In other villages the unhygienic open surface privy is in use, and flies have free access to large collections of excreta in close proximity to the dwelling-houses. In some mills the privies are cleaned weekly;

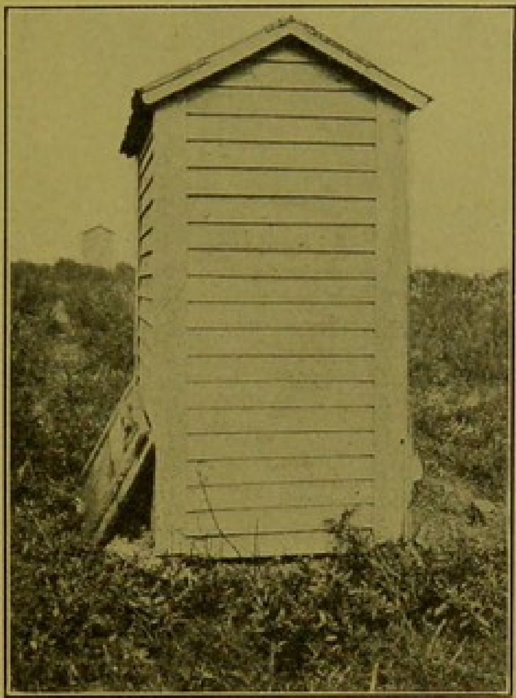


Fig. 13.—Privy, Type E. Surface, unscreened.

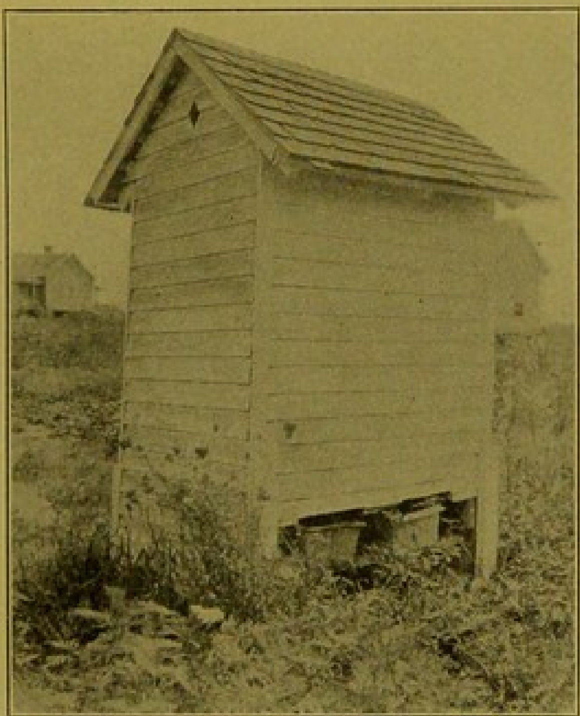


Fig. 14.—Privy, Type D. Pail system, unscreened.

in others, at greater and more irregular intervals. In some villages the sanitary condition around the privies is extremely poor, while in others some attempt is made to keep things relatively clean.

In the farming districts the methods of disposal fall in Classes E and F (Fig. 18). The open-surface privies on farms usually are

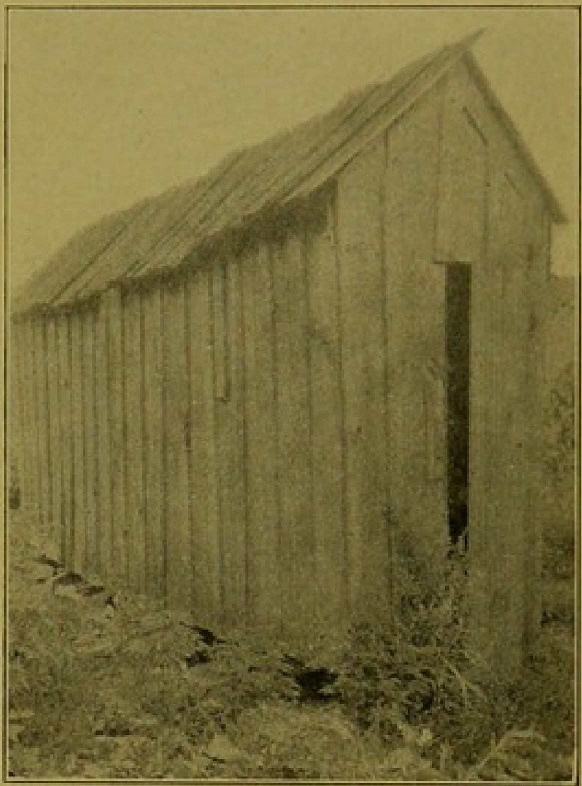


Fig. 15.—Privy, Type E. Surface, unscreened.

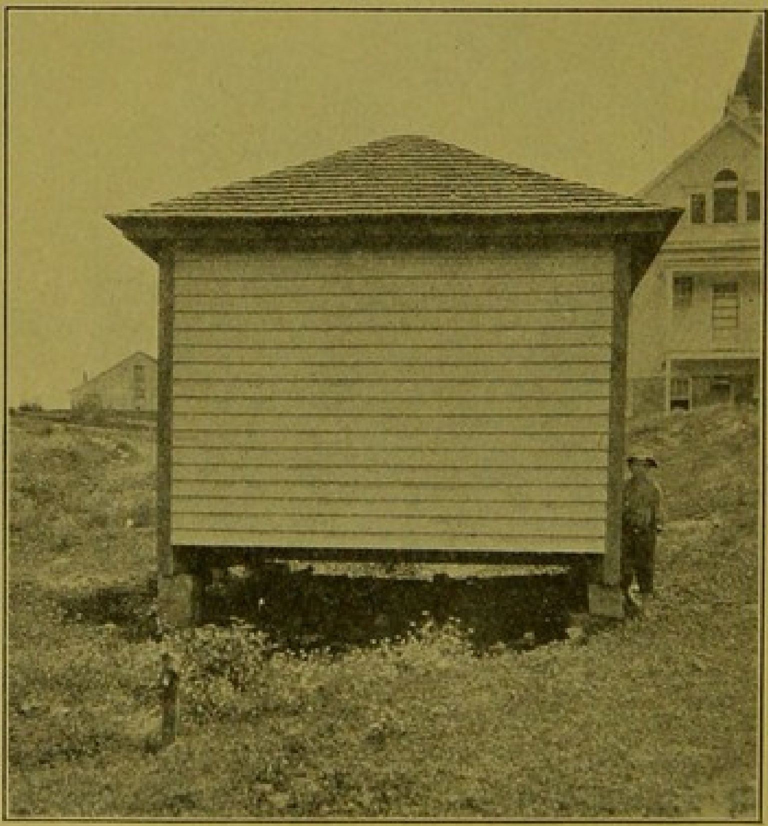


Fig. 16 —Privy, Type E. Surface, unscreened

poorly constructed and filthy, and the excreta are seldom removed, poultry being relied upon as scavengers. Negroes in the farming

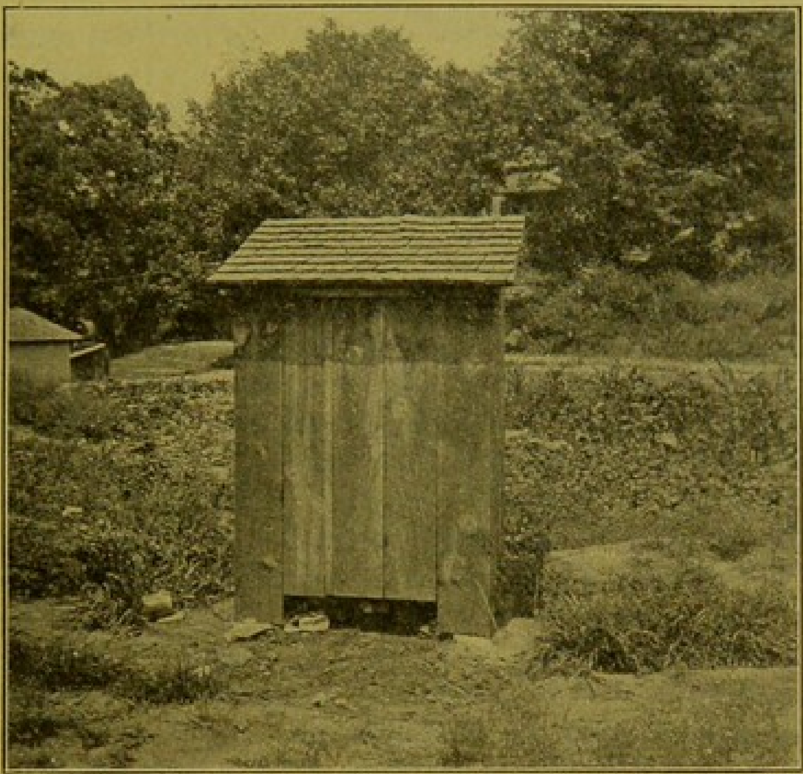


Fig. 17.—Privy, Type E. Surface, unscreened.

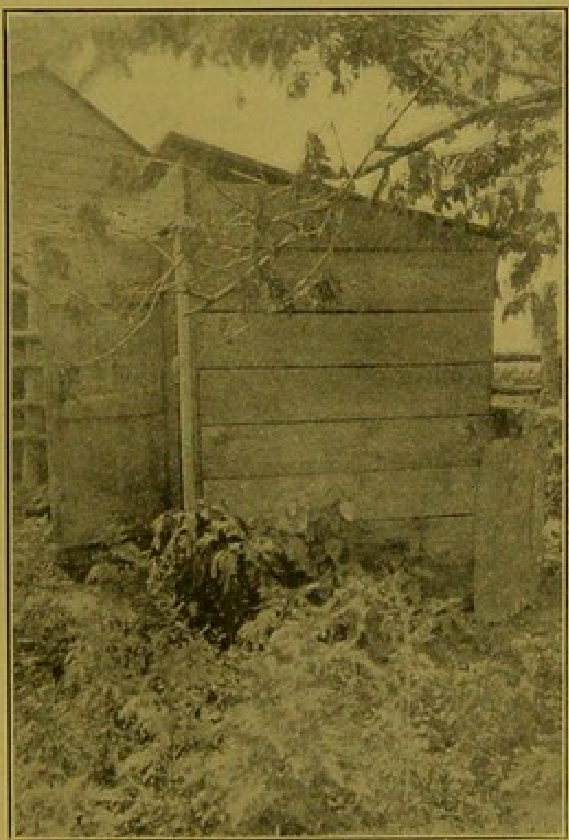


Fig. 18.—Privy, Type E. Surface, unscreened, on farm.

districts seldom have privies, and we were greatly surprised to find that farmers of the better classes sometimes had no privies.

The methods of disposal of excreta observed by us among the families of pellagrins in the different groups of the population are similar to the methods of disposal adopted by the general population in these groups.

Many of the mill authorities are well aware of the importance of good sanitation, and it is their constant endeavor to improve conditions. Even now plans are under way for the installation of a water-carriage system of disposal in one or two of the larger and better mills.

SUMMARY. The average general sanitary index for all the privies studied is only 16, on a basis of 100 for perfect disposal. So far as population groups are concerned the methods of disposal in use by the general population are not different from those observed among pellagrous families. Between 30 and 40 cases of pellagra developed in the city of Spartanburg more or less away from mill districts, and only 8 of these cases used a water-carriage system of sewage disposal. In general the methods of disposal of excreta observed in this series are insanitary, and many of the diseases of the intestinal canal transferred by mechanical means, flies, etc., would find conditions most favorable for such transfer.

D. *Premises.* The following table covers the observations made relative to the sanitary conditions of the premises of pellagrins:

LOCATION OF HOUSE RELATIVE TO MOISTURE AND DAMPNESS.

Air and soil: Dry	242	
Damp	6	248
Drainage: Good	242	
Poor	6	248
General cleanliness of premises: Good	146	
Fair	90	
Poor	12	248
Stagnant water: Yes	7	
No	239	246
Shade: None	145	
Little	62	
Much	38	245
Undergrowth or shrubbery: None	207	
Little	36	
Much	2	245
Barns: Number of houses having barns	90	
Number of houses having no barns	145	235
Animal:[14] Dogs	76	
Cats	79	
Horses or mules	54	
Cows	93	
Goats	6	
Fowl	158	
Rats	88	
Mice	124	

[14] Number of observations, 237.

SUMMARY. In 98 per cent. of the cases the dwelling-houses were well located and the drainage was good. Stagnant water was noted on the premises in only 3 per cent. of the houses investigated (246). But few mosquitoes were observed. The entomological section of this report will deal with permanent streams and collections of water, with the blood-sucking insects breeding therein, and with other biting insects found in the houses, on the premises, and in the neighborhood.

XVI. GENERAL OBSERVATIONS UPON THE DIETARY. The data analyzed in this study are necessarily of a general nature, based on information obtained from statements of patients, physicians, storekeepers, millers, and others.

In order to determine the relative frequency with which the more important foodstuffs were used, patients and their families were closely questioned as to how often certain articles of food would appear upon the family table, and with regard to the patient's particular fondness for any particular dish. Replies to these questions were recorded under the following heads: Daily, one or more times a day; habitually, one or more times a week, but not daily; rarely, at irregular intervals of more than a week; never.

With a view to discovering any significant differences in the habitual dietary of the three groups in the population which show the greatest disparity in the prevalence of pellagra, the results of this inquiry are summarized for the rural population, urban population, and the mill-village population, separately. These results are set forth in the following tables, which represent the actual number of pellagrins and the percentage of the total number of pellagrins from whom the particular information in question was obtained.

TABLE XI.

FRESH MEATS:			Daily.	Habitually.	Rarely.	Never.
Fresh beef in season	Mill population	Number	1	51	84	11
		Per cent.	1	35	57	7
	Urban population	Number	3	27	16	0
		Per cent.	7	59	34	0
	Rural population	Number	2	20	40	12
		Per cent.	3	27	54	16
Fresh pork in season	Mill population	Number	9	68	60	10
		Per cent.	6	46	41	7
	Urban population	Number	1	33	12	0
		Per cent.	2	72	26	0
	Rural population	Number	4	45	18	5
		Per cent.	5	63	25	7
Fresh fish in season	Mill population	Number	0	32	79	34
		Per cent.	0	22	55	23
	Urban population	Number	0	14	29	2
		Per cent.	0	31	64	5
	Rural population	Number	0	7	44	21
		Per cent.	0	10	61	29

TABLE XI.—Continued.

			Daily.	Habitually.	Rarely.	Never.
FRESH MEATS:						
Fresh fowl in season	Mill population	Number	1	59	81	6
		Per cent.	1	40	55	4
	Urban population	Number	1	30	14	2
		Per cent.	2	64	30	4
	Rural population	Number	2	45	23	2
		Per cent.	3	62	32	3
CURED MEATS:						
Cured beef	Mill population	Number	1	0	25	94
		Per cent.	1	0	21	78
	Urban population	Number	0	1	10	26
		Per cent.	0	3	27	70
	Rural population	Number	0	1	3	66
		Per cent.	0	1	4	95
Cured pork	Mill population	Number	92	40	10	2
		Per cent.	64	28	7	1
	Urban population	Number	25	9	9	2
		Per cent.	56	20	20	4
	Rural population	Number	49	12	8	1
		Per cent.	70	17	12	1
Cured fish	Mill population	Number	1	6	45	95
		Per cent.	1	4	31	64
	Urban population	Number	1	5	15	22
		Per cent.	2	12	35	51
	Rural population	Number	1	3	14	53
		Per cent.	1	4	20	75
Canned beef	Mill population	Number	0	14	80	51
		Per cent.	0	10	55	35
	Urban population	Number	0	3	20	20
		Per cent.	0	7	47	46
	Rural population	Number	0	2	25	46
		Per cent.	0	3	34	63
Canned pork	Mill population	Number	0	7	39	88
		Per cent.	0	5	29	66
	Urban population	Number	0	2	14	24
		Per cent.	0	5	35	60
	Rural population	Number	0	1	7	58
		Per cent.	0	2	11	87
Canned fish	Mill population	Number	0	20	90	30
		Per cent.	0	14	64	22
	Urban population	Number	1	7	28	8
		Per cent.	2	16	64	18
	Rural population	Number	0	5	38	29
		Per cent.	0	7	53	40
EGGS, BUTTER, AND MILK:						
Eggs	Mill population	Number	10	36	13	2
		Per cent.	16	59	22	3
	Urban population	Number	7	8	0	0
		Per cent.	47	53	0	0
	Rural population	Number	11	12	17	3
		Per cent.	25	28	40	7
Butter	Mill population	Number	114	16	12	4
		Per cent.	78	11	8	3
	Urban population	Number	33	6	8	0
		Per cent.	70	13	17	0
	Rural population	Number	51	8	9	6
		Per cent.	69	11	12	8
Milk	Mill population	Number	83	21	29	12
		Per cent.	57	15	20	8
	Urban population	Number	16	14	16	9
		Per cent.	29	25	29	17
	Rural population	Number	41	15	18	9
		Per cent.	49	18	22	11

TABLE XI.—Continued.

VEGETABLES, FLOUR, LARD:			Daily.	Habit-ually.	Rarely.	Never
Fresh vegetables in season	Mill population	Number	120	21	3	3
		Per cent.	82	14	2	2
	Urban population	Number	36	6	4	0
		Per cent.	78	13	9	0
	Rural population	Number	61	11	1	0
		Per cent.	84	15	1	0
Canned vegetables	Mill population	Number	4	41	70	29
		Per cent.	3	28	49	20
	Urban population	Number	2	17	25	2
		Per cent.	4	37	54	5
	Rural population	Number	3	8	25	37
		Per cent.	4	11	34	51
Wheat flour	Mill population	Number	142	1	0	0
		Per cent.	99	1	0	0
	Urban population	Number	45	0	0	0
		Per cent.	10	0	0	0
	Rural population	Number	71	1	0	0
		Per cent.	99	1	0	0
Leaf lard (pork)	Mill population	Number	30	16	2	0
		Per cent.	62	34	4	0
	Urban population	Number	10	2	0	0
		Per cent.	83	17	0	0
	Rural population	Number	28	4	0	0
		Per cent.	87	13	0	0
Compound lard	Mill population	Number	101	2	23	5
		Per cent.	77	2	18	3
	Urban population	Number	37	5	2	1
		Per cent.	82	11	5	2
	Rural population	Number	62	1	7	1
		Per cent.	87	1	10	2

TABLE XII.

CORN PRODUCTS. CORN MEAL USED.

		Daily.	Habitually.	Rarely.	Never.
Mill population	Number	85	21	40	0
	Per cent.	58	14	28	0
Urban population	Number	23	12	10	2
	Per cent.	49	26	21	4
Rural population	Number	47	13	11	0
	Per cent.	66	18	16	0

SOURCE OF SUPPLY OF MEAL. SHIPPED MEAL GROUND IN NEARBY STATE

		Exclusively.	Mostly.	Rarely.	Never.
Mill population	Number	84	8	22	4
	Per cent.	71	7	19	3
Urban population	Number	29	2	5	1
	Per cent.	78	5	14	3
Rural population	Number	16	9	13	4
	Per cent.	38	21	31	10

LOCAL CORN GROUND LOCALLY.

		Exclusively.	Mostly.	Rarely.	Never.
Mill population	Number	30	22	2	0
	Per cent.	56	40	4	0
Urban population	Number	7	7	0	0
	Per cent.	50	50	0	0
Rural population	Number	32	19	4	0
	Per cent.	58	35	7	0

TABLE XII.—Continued.

QUALITY OF MEAL.

		Good.	Musty.
Mill population	Number	41	49
Urban population	Number	13	12
Rural population	Number	34	18

USE OF HOMINY OR GRITS.

		Daily.	Habitually.	Rarely.	Never.
Mill population	Number	9	47	53	19
	Per cent.	7	37	41	15
Urban population	Number	9	16	7	5
	Per cent.	24	43	19	14
Rural population	Number	5	14	23	11
	Per cent.	10	26	43	21

		Syrup.	Corn-starch.	Whisky.
Mill population	Number	47	5	19
	Per cent.			
Urban population	Number	23	5	9
	Per cent.			
Rural population	Number	27	3	6
	Per cent.			

Meats. The following meats were used to a greater or less extent in these three subdivisions of the population: fresh meat, fresh pork in season, fresh fish in season, fresh fowl, dried or chipped beef, bacon, cured fish, canned beef, canned sausages, and canned salmon. Fresh beef is not a staple article of diet of any of these population groups during the summer months. By far the greater number of individuals among the mill-village and rural population groups used it but rarely, and some never, while the urban group used it more extensively. The actual percentages of those eating fresh meat, either rarely or never, are as follows: Rural cases, 70 per cent.; mill-village cases, 64 per cent.; urban cases, 34 per cent. Fresh pork in season was used approximately equally in the three groups, but rather more generally in the rural group, the actual percentages of those using it daily or habitually being as follows:

Urban cases, 74 per cent.; rural cases, 68 per cent.; mill-village cases, 52 per cent.

Fresh fish is not a common article of diet in Spartanburg County, and was but rarely used in any of the three groups. This statement applies more particularly to the mill-village and rural population. The percentages of those using fresh fish either rarely or never are as follows: urban cases, 59 per cent.; rural cases, 90 per cent.; mill-village cases, 78 per cent.

Fresh fowl was used quite extensively in all three groups particularly during the summer months; most extensively by the rural cases; less so by the urban group, and least extensively by the mill-village group. The actual percentages of those using fowl, either daily or habitually, are as follows: urban cases, 66 per cent.; rural cases, 65 per cent.; mill-village cases, 41 per cent.

Cured beef is used but rarely in any of the three groups. In 95 per cent. of the rural group, 78 per cent. of the mill-village group, and in 70 per cent. of the urban group it was never used.

Bacon (cured pork) is a common article of diet in all groups, being used either daily or habitually by 92 per cent. of the mill-village group, 87 per cent. of the rural group, and 76 per cent. of the urban group.

Cured fish is little used in any of the three groups, though somewhat more frequently in the city population than by the the other two classes.

Canned beef is not used extensively. In 63 per cent. of the rural cases, 46 per cent. of the urban cases, and 35 per cent. of the mill-village cases it is never used. When used it appears to be eaten neither daily nor habitually.

Canned sausages (pork) are quite extensively used although seldom with any great frequency or regularity. The farming population uses them least.

Canned Fish. Canned salmon, while quite generally used, is not a staple article of diet in any of the groups. In 93 per cent. of the rural cases, 86 per cent. of the mill-village cases, and 82 per cent. of the urban cases it is rarely or never used.

Eggs, Butter, and Milk. These farm and dairy products are used with great frequency and regularity in all three groups of the population. Eggs were used either daily or habitually by 100 per cent. of the urban cases, 75 per cent. of the mill-village cases, and 53 per cent. of the rural cases. Butter was used daily or habitually by 89 per cent. of the mill-village cases, 83 per cent. of the urban cases, and 80 per cent. of the rural cases. Milk was used either daily or habitually by 72 per cent. of the mill-village cases, 67 per cent. of the rural cases, and 54 per cent. of the urban cases. The use of eggs and butter is not so common in the rural group as in the other two. It must be remembered, however, that a greater number of negroes are included in this group, and their diet is probably below that of the whites, more particularly from the standpoint of variety. For example, Table XI shows that in 3 cases among the rural population, eggs were never used; 2 of these cases were negroes. Of 6 cases that never used milk, 3 were negroes. Our data are not sufficiently extensive to draw a careful comparison between the average dietary of whites and negroes at the present time. Further information on this subject will be sought, the coming season.

Vegetables. Fresh vegetables were used in season, to a very large extent, by all the groups. They were used either daily or habitually by 99 per cent. of the rural cases, by 96 per cent. of the mill-village cases, and by 91 per cent. of the urban cases. Among the vegetables most commonly used may be mentioned cabbages, green corn, beans, potatoes (Irish and sweet), peas, tomatoes, and squash. During the winter months the available vegetables were confined largely to Irish potatoes, cabbage, peas, and beans. Canned vegetables were seldom used habitually. In 85 per cent. of the rural cases, 69 per cent. of the mill-village cases, and 59 per cent. of the urban cases they were either rarely or never used.

The lards used consisted of pure leaf lard, the compound lards, and pure vegetable (cotton-seed) lards. In 7 cases pure leaf (hog) lard was used exclusively. In many instances, particularly so in the rural cases, sufficient lard was rendered from the pork killed at home to supply all needs for from two to eight months of the year or longer. Others used compound or pure vegetable lards exclusively. Inquiry among 50 non-pellagrous families in one mill-village showed the use of compound lards to be quite as extensive as among pellagrins.

Some of the grocers catering to the well-to-do classes of the population in Spartanburg informed us that some customers preferred the pure leaf lard, while others preferred and used constantly the pure vegetable lards.

Wheat Flour. Bread made of wheat flour was used daily by 99 per cent. of the cases in each group, and was used habitually by the remaining 1 per cent.

Corn Products. Among the corn products used are included corn meal, hominy, grits, syrup, corn-starch, and whisky. Corn-meal is a staple article of diet in all classes of the population in the area studied. In this series, 84 per cent. of the rural cases, 75 per cent. of the urban cases, and 72 per cent. of the mill-village cases used corn-meal either daily or habitually. Two cases had not used corn-meal for a period of two years prior to the development of pellagra. These cases were two children whose mother had contracted pellagra in 1910, at which time she was advised by her physician to discontinue the use of corn products absolutely. She states that she had done so and that there had been no corn products in the house for the past two years. The children, aged six and thirteen years respectively, developed the disease in 1912.

The meal was obtained from different sources. Many of the families used no meal other than that grown locally and ground at a local mill; others used such meal the greater part of the time; others used, exclusively, meal shipped in from a near-by state; and still other used such meal the greater part of the time, but used more or less meal made from local corn, locally ground. The cases in which both local and shipped meal was used are included in both tables, which accounts for the apparent excess in numbers.

Some families raised sufficient corn to supply them with meal, locally ground, for from six to eleven months of the year, the remainder being purchased from a grocer. The quality of the meal varied. When meal was made from the home-raised corn it was the usual custom to grind it up in small amounts at frequent intervals, and such meal was said to be fresh and sweet. The meal purchased from grocers was sometimes musty, but such meal usually was fed to the chickens. The use of hominy and grits was not so common in these groups as had been expected. Among the rural cases 64 per cent., the mill-village cases 56 per cent., and the urban cases 33 per cent. rarely or never used either.

Comparative dietary studies on the normal non-pellagrous population under like conditions are desirable in any attempt to determine the possible influence of the dietary on the development of pellagra. We have made some comparative studies with this object in view, but our data are not sufficiently complete at this time to warrant any definite conclusions.

The diet to which most of these cases were accustomed is of fairly good variety, but it is probable that in many instances the methods of preparation and cooking of the food are subject to criticism. This matter likewise is to be made a subject of further investigation. We are quite certain, from personal observation, that the average dietary of the poorer classes of the population in the county studied is much superior both in its variety and actual nutritive value to the dietary of the peasants in the North of Italy. Another striking difference may be mentioned, namely, that corn-meal in the form of polenta constitutes the chief bread component of the diet of the peasant of Northern Italy, whereas in Spartanburg County, among all classes of the population, wheat flour, in the form of bread or biscuit, is the principal bread-stuff, and corn-meal, while extensively used, is not nearly so staple an element of the dietary as wheat flour.

XVII. Synopsis. The epidemiological study of pellagra as it exists in Spartanburg County, South Carolina, is still in progress and will be continued during the spring and summer of 1913. The work done in 1912 constituted a more or less general preliminary survey of the field, and the results of that work as set forth in this report are tentative and will be further tested by continued observations and study.

The results of the work in 1912 tend to strengthen the belief that a satisfactory knowledge of the epidemiology of pellagra is best to be gained by intensive studies, of the behavior of the disease in selected communities, and of the prevailing conditions which influence its local prevalence and distribution. It is hoped that a study conducted with sufficient care and thoroughness along these lines will yield valuable evidence either for or against the possible infectious nature of the disease and its possible communicability.

The epidemiological data presented in the present report are summarized below:

Part I. 1. Pellagra shows a striking inequality of distribution in the ten townships within the county, the township rate of prevalence per 10,000 of population varying from 0 to 71. The city of Spartanburg, with a population of 17,517 gave a rate of 49 per 10,000 against 34 per 10,000 for the remainder of the county.

2. Density of population while showing a tendency to conform to the relative prevalence of the disease does not alone offer an explanation of the geographical inequalities of its distribution within the county.

3. The cotton-mill-village population gives a rate of prevalence of 104 per 10,000 against 19 per 10,000 for the remainder of the county, and against 16 per 10,000 for the rural sections alone.

4. The variations in the rates of prevalence in the ten townships are in a measure proportional to the presence or absence of a large mill-village population. Excluding the mill-village population, there is still a marked discrepancy between the townships in the rural population alone, ranging from 0 to 29 cases per 10,000 of population. The excessive prevalence among the farming classes is found in the townships which have a relatively large mill-village population.

5. The white population of the county gives a prevalence of 45 cases per 10,000; the negro population a prevalence of 9.5 per 10,000. Excluding the mill-village population which is practically all white, the remaining white population still gives a rate of prevalence (25.2 per 10,000) over two and one-half times that among the negroes.

6. The rate of prevalence per 10,000 for males in the county is 17; for females, 50.5. White males give a rate of 22.95 per 10,000; white females, 87.5 per 10,000, negro males, 3.9 per 10,000; negro females, 14.9 per 10,000.

7. The rate of prevalence among children under ten years of age and among adults aged forty-five years and older is practically equal in the two sexes.

8. The rate of prevalence drops among males between the ages of nineteen and forty-five years, whereas for females there is a remarkable excess of prevalence between these ages.

9. In both males and females there is a striking fall in prevalence between the ages of ten and twenty years.

10. The most significant fact with regard to occupation is the excessive prevalence of pellagra among women employed in housework.

11. The excessive prevalence of pellagra in the mill-village population is found largely among women and children at home during the day. Among actual mill-workers the rate of prevalence between the two sexes appears to be about equal.

12. One-half of the cases occurred singly in one family; about one-fourth occurred two in one family; the remaining fourth occurred in groups of three, four, or five in one family. The question of the possible relative importance of family relationship and household association is still under investigation.

13. Among cases occurring singly in families, the proportion of children of both sexes under ten years of age is low and that of adult females excessively high. Among cases occurring two or more in one family the proportion of young children is proportionately high, especially among males.

PART II. 14. While apparently authentic sporadic cases of pellagra within the county can be traced back to as early as 1894, the disease does not appear to have occurred in any great number of cases in any year until 1908. Since 1908 the incidence-rate appears to have rapidly increased each year to 1911. The number of new cases developing in 1911 appears to have been slightly greater than in 1912.

15. There was no evidence pointing to any spring and fall recrudescence of the disease in the population so frequently referred to in the literature of pellagra. There is no particularly marked tendency for the seasonal recurrence to appear in an individual during the same month, year after year.

16. *Influence of Climate.* Climatic conditions appear to influence the development of symptoms of the disease. If during the spring months precipitation is high, temperature low, and number of rainy days excessive, the appearance of acute symptoms, more particularly those involving the skin, is delayed.

17. *Symptomatology.* It would appear that three or four years ago a large proportion of the cases observed in the county presented intestinal and nervous symptoms of great severity. In 1912, in many instances, symptoms were quite mild, and sometimes were confined almost exclusively to the cutaneous system, the disease appearing to be of a less virulent type in 1912 than in previous years.

18. *Economic Status.* In the majortiy of cases (83 per cent.) economic conditions are poor and the disease is most prevalent among people of insufficient means.

19. *Predisposing Diseases.* General health conditions in childhood do not appear to warrant consideration as etiological factors when the disease develops in adult life. In a number of cases the development of pellagrous symptoms in children was preceded by one of the acute exanthematous diseases of childhood. About one-fourth of the cases gave a history of a preceding chronic disease in adult life. In more than one-half of the cases (62 per cent.) the history was that of good health. Among adult females, those most affected were married women (86 per cent.), and 86 per cent. of the married women had borne children.

A history of illness immediately preceding the development of pellagra was elicited in 59 per cent. of the cases.

20. *Hygiene and Sanitation of Houses and Premises.* The most unsanitary condition found in the county is the absence of properly constructed privies. Outside of a part of the city of Spartanburg which is supplied by a water-carriage sewage system, there is no effective provision in the county for the proper disposal of human excreta. A second striking unsanitary condition is the almost complete absence of effective screening of dwellings.

These two conditions present a situation highly favorable to the transmission of disease organisms eliminated in the excreta, both by direct contamination of food and person and by insects. This situation is naturally aggravated in the mill-villages and small towns by the greater congestion of houses. The absence of effective screening for dwellings gives rise to conditions conducive to the possible transfer of diseases transmitted by biting insects.

21. *Dietary.* Observations upon the habitual use of the more common foodstuffs failed to discover any points of difference between pellagrins and non-pellagrins in the county or any facts which would seem to explain the strikingly greater prevalence of pellagra among certain classes of the population.

The most striking defect in the general dietary of the working classes, appears to be the limited use of fresh meats, the animal proteid being supplied largely in the form of cured meats, of which salt pork (especially bacon) is the most important.

Unhygienic preparation of food appears to be a probable important factor in the general health of the population.

Investigation of the kind, quantity, and qualtiy of corn and corn products used in the county failed to bring to light any epidemiological evidence pointing to the agency of corn as an etiological factor in the disease. The presence of two cases in our series giving a definite history of no corn consumption within two years prior to the onset of symptoms, together with several other cases in which corn products were eaten, if at all, only in small quantity and at extremely rare intervals, would seem to argue strongly against any hypothesis that corn products alone are the causative agent of the disease.

III.

AN INTENSIVE STUDY OF INSECTS AS A POSSIBLE ETIOLOGIC FACTOR IN PELLAGRA.[1]

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and

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In 1911, Dr. J. W. Babcock, Superintendent of the State Hospital for the Insane at Columbia, South Carolina, brought to the attention of the State authorities, the desirability of an investigation into the prevalence and etiology of pellagra.

Following this action, through the initiative of Dr. J. A. Hayne, Secretary of the State Board of Health and Representatives A. F. Lever and Joseph T. Johnson of South Carolina, the writers were, early in 1912, assigned by Dr. L. O. Howard, Chief of the Bureau of Entomology, United States Department of Agriculture, under the direction of Mr. W. D. Hunter, of the Bureau, to investigate the possible relation of insects to pellagra and to gather such data as might serve to indicate whether there was ground for the assumption that blood-sucking or other arthropods were involved in the transmission of pellagra in South Carolina.

After several months' work in various parts of the State, we were afforded opportunity to coöperate with the Thompson-McFadden Pellagra Commission of the Department of Tropical Medicine of the New York Post-Graduate School upon its arrival in Spartanburg County. From June 15 until the middle of October, our own studies were carried on in Spartanburg County in collaboration with this Commission, and it is with this portion of our field work that the present preliminary report has to deal.

These studies included the investigation of the premises of pellagrins and of the neighborhoods in which they resided, with special reference to the presence, distribution, and biologies of such insect groups and species as appeared worthy of consideration, after careful study of the conditions.

To this end, we visited the houses of as many as possible of the cases studied by the Commission, and made minute observations

[1] Reprinted from the American Journal of the Medical Sciences, September, 1913, No. 3, vol. cxlvi, p. 411.

of the insect fauna. The patients and their families were questioned in order to obtain such histories as they could give of the attacks or presence of insects and their general experience in regard to the pests with which they were familiar. In many instances the houses were visited more than once, and comparative observations were made under varying conditions. In some instances, the studies were extended to the homes of the non-pellagrous inhabitants of mill villages and elsewhere and the data thus gathered were used to confirm and extend the information obtained from the patients themselves. Sanitary and other conditions which might have a bearing upon the presence or abundance of insects were noted, and the more remote surroundings were inspected and studied in connection with such forms of insect life, occurring in such situations, as might influence the pellagra focus under investigation. When this focus was of considerable importance, with marked incidence of the disease, the neighborhood, as a whole, was investigated comprehensively and all possible facts bearing upon the situation were noted.

As a rule, the persons interviewed were ready to give such information as they possessed regarding the insect pests with which they came in contact. It was fully realized that popular observations of this nature are liable to be highly inaccurate. Great care was therefore exercised in making the inquiries and in sifting the information obtained. Only such reports were recorded as gave evidence of reliability and clearly referred to the insect which was the subject of the inquiry.

The breeding of certain insects was attempted, but owing to the character of the available facilities and the exactions of the active field work, but meagre results were obtained. This phase of the investigation was therefore unavoidably subordinated to that of the entomological side of the general epidemiological study.

Character and Economic Condition of Spartanburg County. The following description of Spartanburg County and its climate is quoted from the preliminary report of the Thompson-McFadden Pellagra Commission:[2]

"Spartanburg County is situated in the northern or Piedmont section of South Carolina. It is forty miles long in a north-south direction, thirty miles from east to west, and contains 762 square miles. Its surface is hilly and broken by a network of small streams and by four rivers which, with their tributaries, flow across the country in a southeasterly direction, one of these rivers forming the county line of the south. The elevation above sea level at Spartanburg, the county seat, is 875 feet. To the northwest, the slope is upward, the northwest corner of the county being situated at the foot of the Blue Mountain range, while to the south and east

[2] Epidemiological Studies, Part I., Amer. Jour. Med. Sci., July, 1913, pp 44–45.

the elevation becomes somewhat lower than at Spartanburg, but with no precipitate fall, the whole county thus resting upon a plateau over 700 feet above sea level."

There are no considerable swamps or marshes, and small areas of boggy ground in the neighborhood of streams, while not uncommon, were generally found to be negligible in connection with the breeding of insects of economic importance.

"The annual mean temperature, as recorded at Spartanburg, is 60° F. While the winters are mild, killing frosts are apt to occur from November to March inclusive, and the normal mean temperature for the months of December, January, and February is about 42° F.

"The total population of the county is 83,465. Spartanburg, with a population of 17,517, is the only city in the county, the remaining population (65,948) being distributed on farms, in cotton-mill villages, and among eleven small towns, only two of which have over 1000 inhabitants. The density of population, as a whole, is 109 per square mile; for the rural population (*i. e.*, outside of Spartanburg City), it is 86.5. While in South Carolina, as a whole, the negroes form 55 per cent. of the total population, in Spartanburg County the whites predominate numerically in the proportion of somewhat over two whites to one negro, there being a white population of 57,055, and 26,410 negroes, the percentage being 68.4 per cent. whites, and 31.6 per cent. negroes."

"The chief industry, and almost the only industry conducted upon a large scale, is that connected with the cotton mills. There are twenty-eight cotton mills in the county, each mill supporting its own village. These mills give employment to approximately 10,000 operatives, representing about 4000 families, and a total mill-village population of about 20,000."

Epidemiology. The epidemiology of pellagra in Spartanburg County presents certain features which have a distinct bearing upon the subject of insect transmission, and may be briefly summarized.

The cases considered in this report are distributed among the population as follows: Mill, 151 cases; rural, 77 cases; and urban, 51 cases.

Divided according to sex, there are: Male cases 71, or 25 per cent., female cases 211, or 75 per cent., or three females to one male.

These are distributed as follows: Mill cases, males, 38; females, 113. Rural, males, 19; females, 58. Urban, males, 11; females, 40.

The racial distribution shows 257 cases among the whites to 25 among the negroes, a ratio of 10 to 1.

The economic condition of the cases may be thus summarized: 85 per cent. were in poor circumstances; 15 per cent. were comfortable; and 2 per cent. were affluent.

The age of the males and females affected is shown as follows: Under five years, 21; five to nine years, 22; ten to nineteen years, 28; twenty to forty-four years, 158; and over forty-four years, 53.

By sex and age, cases appear as follows: Under five years, males, 10; females, 11. Five to nine years, males, 12; females, 12. Ten to nineteen years, males, 7; females, 16. Twenty to forty-four years, males, 16; females, 148. Over forty-four years, males, 25; females, 27.

Sex Incidence. The sex incidence presents striking features. As shown above, the proportion of female to male cases is 3 to 1; and statistics for the entire endemic area in the United States show that this is the approximate ratio throughout.[3] So pronounced an inequality must be based upon some fundamental difference either in environment or physiologic organization of the sexes. It is difficult to account for the inequality upon the ground of great female susceptibility, as such susceptibility is contrary to medical experience and to the well recognized natural law that the female in general is more resistant to adverse influences than the male. Cases of pellagra originating in institutions for the insane have also shown an approximately equal distribution among males and females.[4]

Beall[5] has sought to explain the inequality in sex incidence by associating the immediate cause of pellagra with the dwelling, calling attention to the high rate among females whose time is largely spent about the home, and to the fact that a large proportion of the male cases occurs during the ages when the association with the home is closest, that is, among children and the aged; men during their active years escaping to a great degree.

Of the 282 cases studied, 211, or 75 per cent. were females, of whom 173 were adults; and of these adults, 142, or 82 per cent. were engaged in housework most or all of the time. The adult female population of the mill villages, divided between mill operatives and those who devote themselves mainly or exclusively to household occupations, afforded an opportunity to compare two classes living under seemingly identical conditions with the exception of those of occupation. Of this class, there were 88 female cases, of whom 60 cases, or 68 per cent., gave all or most of their time to housework; the remaining 28 women, or 32 per cent., were engaged in mill work for a portion or all of their time. This disparity, marked as it is, becomes more striking when only those engaged exclusively in house or mill work are compared. Here we find but 12 cases among those who work in the mills, while 46 women, who were occupied exclusively with housework, were

[3] S. A. Roberts, Pellagra, St. Louis, 1912. K. H. Beall, Bull. Texas State Board Health, 1911, v, No. 9. Tennessee State Board Health, Report on 316 Cases of Pellagra, 1911. C. H. Lavinder, Reprint from P. H. Rep. 65, 1911. R. M. Grimm, P. H Rep., 1911, xxvi, No. 38.

[4] H. Douglas Singer, Report Pellagra Commission, State of Illinois, 1911.

[5] K H. Beall, Loc. cit.

affected, the percentages of these groups being 13.6 and 52 respectively. Thus it is seen that a close correlation appears to exist between pellagrous incidence and the amount of time spent in or about the home, and that this holds, not only when the sexes are compared, but within the sexes, themselves.

A marked characteristic of pellagra in all countries is its rural nature. Although the disease sometimes appears to originate in cities of considerable size, an analysis of conditions in such cities will usually, if not always, show that in certain important aspects, the rural element governing the presence and abundance of insects is predominant.

Isolated sporadic cases of a disease are highly suggestive of an insect carrier, under certain circumstances, especially when exposure of the individual to infection by association with other cases may be excluded. The suggestiveness is strengthened, in the case of pellagra, by the existing evidence against direct contagion and also by the low degree of infectiousness which the disease appears to exhibit.

Another fact which may point to the agency of an insect in pellagra transmission, is the occurrence of several cases in a single family, and this frequently happens. It is obvious that the close association of persons constituting the household would increase the opportunity for transmission by predatory insects. This feature is emphasized by what appears to be a definite chronological connection between such cases.

At the same time, the large number of instances in which but a single member of a household is affected, does not preclude the same possibility. It is conceivable that by reason of habits or constitution, the unaffected members, might, for a time, altogether escape infection. Or, scarcity of the insect carriers, especially if conditions favor their free entrance into and departure from the house, may lessen the chances of transmission within the home.

Attention may be directed to some features of the epidemiology of pellagra which suggest a certain analogy to those of two other diseases, viz., malaria, an insect-borne protozoal disease often of chronic character; and acute anterior poliomyelitis, which, as apparently shown by certain recent experiments, may be transmitted by biting flies, thus strongly indicating at least one of the channels for the communication of that disease.

The seasonal recurrence of pellagra and its period of greatest development during the summer months, the period of greatest insect activity, finds an approximately similar condition in malaria and probably a greater similarity in the case of poliomyelitis. Both of these diseases are largely of rural origin, as is pellagra. Poliomyelitis, moreover, is marked by the occurrence of sporadic cases, not to be explained by contact infection and there is a lack of evidence of direct contagion, two facts which are true of pellagra.

THE INSECTS STUDIED. While the object of our investigation was the study of all insects which may have any part in the transmission of pellagra, it was realized that a careful consideration of conditions and of the insect fauna would inevitably narrow the field to a few genera and species. It became clear that efforts might safely be concentrated upon a few groups of insects, mostly of blood-sucking habits. Keeping in view the conditions which are imposed by the facts of disease transmission by insects, the following groups were given careful attention: Diptera, or two-winged flies; Hemiptera, including the lice and bed-bugs; Siphonaptera, or fleas, and Acarina, or ticks. Some attention was also paid to the roaches, Blattidæ.

ACARINA. The ticks of the family Ixodidæ must be mentioned, although their importance in this connection is negatived by their habits, life history and the infrequency with which the persons who suffer most from pellagra appear to come in contact with these arthropods in Spartanburg County.

It will be remembered that most ticks of the family Ixodidæ (no members of the family Argasidæ occur in Spartanburg County) require three hosts during their period of development, dropping to the ground on the completion of each stage and reattaching themselves to another host, sometimes of a totally different species, when they have advanced to the next stage of their existence. The chances of any tick of this group attaching to successive *human* hosts are remote. It is unusual for these parasites to remain undiscovered on man long enough to complete the stage during which attachment was effected. Almost certainly they are removed and killed and transmission of infection from the first host thereby prevented. The presence of animal reservoirs of infection would therefore seem to offer the only means by which this disease could be transmitted by the group of ticks mentioned and there is no indication that such reservoirs exist. Reports from pellagrins and non-pellagrins of attacks by ticks were rare and in the course of the work only two lots of ticks were collected, one lot from dog and one on the clothing of man. Many dogs and other animals were examined and the indication is that the tick infestation of the country is light. *Amblyomma americanum* and *Dermacentor variabilis* probably occur in the county. The usual hosts of these species are dogs but they are known to attach to man.

It is impossible to explain the sex incidence of pellagra by the incrimination of ticks, men being obviously more exposed to their attack than women. In view of this fact and the lack of evidence that animals are subject to and can serve as reservoirs of pellagrous infection, the almost certain death of all ixodid ticks which bite human beings, together with the equal certainty that not all pellagra sufferers in the region can have been exposed to the bites of ticks, these arthropods can safely be excluded from among the possible factors of pellagra transmission.

Pediculus Vestimenti and Capitis. Head lice (*Pediculus capitis*) were locally said to be far from rare among certain classes of the population, but this statement is not borne out by our observations or by reports received. Only one or two reports of previous experience with the parasite could be obtained, and the writers saw but one case of actual infestation. As reports regarding such insects as bed-bugs and fleas were usually frankly given, it seems hardly probable that reticence could account for the many negative reports in regard to *Pediculus*. We are forced to believe that whatever may be its prevalence, it is far from universal and entirely inadequate as a possible agent in the transmission of the disease. That a wingless insect with the habits and associations of the head louse can be the cause of infection in any but a very limited class of cases, is scarcely to be credited, and such an inference leaves the question of female preponderance and sporadic cases unsatisfactorily answered.

It is well known that head lice will, upon occasion, be transferred from infested to clean persons, but observations indicate that unless the infestation is gross or the association of persons is intimate such transfer of the parasite is not particularly common, and this is borne out by the experience of persons of ordinarily careful habits. We are unable to see that the head louse can be incriminated when we consider its rare occurrence upon persons of fastidious habits, who yet furnish an appreciable number of cases of pellagra.

No reports of *Pediculus vestimenti* were received and no observations of the species were made. The evident rarity of the species as well as its habits exclude it from consideration as definitely as the foregoing.

Cimex Lectularius. The bed-bug (*Cimex lectularius*) was found to be of practically universal occurrence in the houses of the largest class of pellagrins of the region. Of 256 reports received from pellagrins, the actual presence or recent attacks of bed-bugs were admitted in 241 instances. Only 15 persons denied that they had been exposed to this pest, and from their known prevalence in the mill villages and elsewhere some doubt may be entertained as to the accuracy of at least some of the negative reports.

Concerning the incrimination of *Cimex* in pellagra transmission, there is one fact which alone is sufficient to indicate its innocence. This is the sex incidence of the disease. It has never been shown that *Cimex* attacks females more frequently than males, certainly not in the proportion of 3 to 1, or if adults in the prime of life are considered, of 9 to 1. If this is not the case, the explanation of transmission by the insect is unsatisfactory. In the often crowded, badly infested, and none too cleanly homes of a considerable class of pellagra sufferers, indiscriminate attacks of the insect are greatly facilitated and must certainly be made upon the inmates without regard to age or sex.

It is well known that the bed-bug has the power to endure starvation for extended periods, and nothing is more difficult than eradiction of the pest when it has once taken possession of a building. If it were capable of conveying pellagrous infection, these qualities might account for what has been termed the "place infection" of pellagra. At this time, proof is lacking of such a source of infection, but should it be shown to exist, the facts of sex incidence just cited together with the occurrence of but one case in a family in many instances must stand opposed to incrimination of the insect.

While but 2 per cent. of the pellagra cases studied were in affluent circumstances, others of this class have come to our notice in other localities, and it may be asserted that such cases are by no means rare. It cannot be questioned that the habits of life and general associations of such persons greatly minimize the possibility of their infection having been brought about through the agency of the bed-bug.

Specimens of this species were collected in connection with some cases, but no special effort was made to do so in the majority of instances. No systematic search for a causative organism was being prosecuted nor transmission experiments carried on in the field. It was therefore considered that the value of actual collections of bed-bugs, systematically made, hardly justified the time required and the interruption caused to the routine pursued in securing case histories of pellagrins. In addition, the positive reports generally received, supported by occasional collections seemed amply sufficient to establish the almost universal presence of the pest.

BLATTIDÆ. Of roaches, only the common cockroach, *Periplaneta orientalis* and the smaller *Blattella germanica* were encountered. These disagreeable household pests were found to be abundant and generally distributed, but nothing remarkable was noted in their relations to the homes of pellagra cases or of the population in general.

Though armed with strong, biting jaws which enable the insects to commit serious injury to leather and other substances there are few accounts in the literature of attacks upon human beings, and these seem to be confined to nibbling of toenails, eyelashes, etc. Even such as they are, attacks upon man must be considered exceedingly rare, and they cannot be considered a factor in transmission.

The well known habit of roaches of frequenting kitchens and larders, their omnivorous habits, and the inefficient protection of food too frequently practised by the classes who suffer most from pellagra suggest the possibility of its transmission by food contamination. If such means is possible the part played by the insects must be far less important than that of house flies, for the exposure of food to the latter is unquestionably greater and the carriage of fecal matter far more regular and constant than can be the case with roaches. Certain experiments conducted by one of us (A. H. J.) indicate that roaches will not readily feed upon such material and under normal conditions their opportunities for the contamination of foodstuffs with human excreta are far less than those afforded house flies.

Roaches can, therefore, not be considered an important element in pellagra causation and must be considered in the same category with, but far inferior to, the house fly.

TABANIDÆ. Flies of the family Tabanidæ, which includes the well-known horse-flies, were rare in Spartanburg County during the season of 1912. One or two specimens of *Tabanus atratus* (?) were seen flying about our automobile while in motion, but none were captured. Only two specimens of Tabanidæ were collected in Spartanburg County and these were unfortunately lost before exact determinations were made. The flies of this group are primarily a pest of the larger domestic and also of wild animals in localities where the latter are found, and their habits are such as to exclude them from the possibility of an active role in pellagra transmission. In localities where Tabanidæ are numerous the biting of human beings is by no means uncommon, yet even in such regions bites are scarcely received with the frequency and regularity which are essential to the transmission of human disease in the absence of an animal reservoir of infection.

The comparative scarcity of these flies in Spartanburg County where pellagra is prevalent is the reverse of the conditions of the country near the Atlantic coast where tabanids are exceedingly numerous and pellagra comparatively rare.

SIPHONAPTERA. In our studies, fleas were given particular attention on account of their known role as carriers of certain diseases and the fact that in certain localities they are very abundant and annoying pests.

It must be understood that, except where otherwise stated observations and conclusions regarding fleas refer strictly to conditions in Spartanburg County.

Somewhat to our surprise we found that, in the region studied, fleas, so far as attack on human beings is concerned, seemed to be almost of negligible importance. Reports were obtained from 154 pellagra patients or their families and of these but 10 gave positive accounts of attacks by these insects. Assuming that the reports were reliable, this may seem a remarkable condition, and allowing for a certain percentage of inaccuracy it is still practically certain that these insects are not a universal or constant pest of human beings in the locality.

While persistent attacks of fleas upon man are comparatively infrequent in Spartanburg County, they are much more common in the low sandy country lying between the Piedmont region and the coast. In the latter section the prevalence of pellagra is slight when compared with the region of which Spartanburg County is a part.

The human flea, *Pulex irritans*, is uncommon even if it exists in Spartanburg County. We failed to find this species upon any of the numerous animals examined, nor did we succeed in collecting it from human beings.

Ctenocephalus canis and *Ctenocephalus felis* were taken on numerous dogs and cats. *Echidnophaga gallinacea,* the chicken flea, is a not uncommon pest of fowls, occurs with some frequency upon cats, dogs, and domestic rabbits, and in one instance, a report of its attack upon human beings was obtained.

In view of the fact that cats and dogs are very commonly kept, and that these animals were found to be practically always heavily infested with their respective fleas, it might be assumed that attacks upon human beings would be of common occurrence. Several reasons for doubting this assumption may be advanced. While the cat and dog fleas are less fastidious in their choice of host and more tolerant of abnormal host species than many other fleas, it is nevertheless quite certain that these species are less frequently a human pest than is usually supposed. Attacks by them upon man are not uncommon, but under ordinary conditions, even in the presence of infested animals, it by no means follows that persons associating with the animals will be infested.

It has been personally noted by one of us, in another locality, that in a house in which cats heavily infested by *Ctenocephalus felis* were kept, the fleas which were a frequent source of annoyance to the human inhabitants were all found to be *Pulex irritans*. Eggs from the flea-infested, long-haired cats must have been freely dropped about the floors, which offered excellent conditions for the development of the insects. It is equally certain that adult fleas were lost from their feline hosts, yet during a period of more than a year, every flea which annoyed the members of the household was carefully sought for and collected. They were all *Pulex irritans* and it is noteworthy that their attacks were usually made at night.

This extreme instance is cited to indicate that except at times of unusual abundance the fleas of domestic animals are not likely to attack human beings freely. It is true that individual fleas of cats and dogs ordinarily remain on human hosts but a short time, frequently leave him without biting and are probably but rarely transferred directly from man to man, factors which would tend to lessen the probability of their acting as carriers of a purely human disease.

The number of domestic animals kept by pellagrins or their families is of interest in this connection. Of 227 instances in which notes were made regarding the keeping of the smaller flea-bearing domestic animals, cats or dogs were kept in 120 cases, or 53 per cent., while none were kept in 107, or 47 per cent., of cases. This is significant in connection with the host habits of fleas which have just been discussed. If human beings in Spartanburg County are freely and regularly attacked by fleas derived from cats or dogs, which are usually heavily infested, it seems remarkable that in so few instances were the keepers of these animals able to report their noticeable presence.

Of the 10 cases reporting attacks of fleas, dogs or cats were kept in 9 instances and none were kept by but one family. This is too small a number upon which to base conclusions. There were 149 cases in which data were secured on both the keeping of cats or dogs and the attacks of fleas. Animals were present in the houses of 78 of these cases and absent in 71. Of the former, 9 reported attacks of fleas, while, of those who kept no animals, but 1 gave such a history. The ratio of the number of reported attacks, by families in which cats or dogs were kept, to those by families with none of these animals is therefore 9 to 1 and seems to indicate that when fleas are troublesome, domestic animals are the usual source. In connection with the figures relative to the number of animals kept, it is also indicated that these animals by no means always cause the infestation of their human associates.

Sixty families who kept domestic animals and 70 who kept none, reported no attacks of fleas.

The presence of rats was reported in 38 cases, and of mice in 124. In spite of efforts to secure specimens of rat fleas, it was possible to do so in only one instance so that the degree of infestation of the rats of the region and the species occurring upon them could not be learned. The single rat secured has been determined as a cross between *Mus rattus* and *Mus alexandrinus*. The fleas with which this rat was infested proved to be *Xenopsylla cheopis*, the Indian rat flea. The occurrence of this flea at a point so far inland is interesting as is the species of its host, an animal with which it is intimately associated in the East and in many parts of its littoral range.

The facts opposed to the incrimination of fleas in pellagra transmission are: those of the sex incidence of the disease, its association with the home, the host habits of fleas, the comparative infrequency of their attacks upon human beings in the districts suffering most heavily from the disease and the inverse ratio of their abundance to the occurrence of pellagra.

In consideration of these facts it is impossible to base any satisfactory theory of transmission upon the agency of these insects.

CULICIDÆ. The abundance of mosquitoes, both of species and individuals, their agency in the transmission of important human diseases, their persistence in seeking blood and, in certain instances, their close association with man cause these troublesome pests to assume a position of the highest economic importance.

Although present to a greater or less degree in most parts of Spartanburg County, they are few in number in comparison with those present in many less favored localities. The topographical features of the district have much to do with this condition, and owing to the conformation of the land and the character of its drainage, extensive breeding areas do not exist.

When this group is considered in connection with the possibility of pellagra transmission, certain salient facts are to be noted.

The longevity with which some mosquitoes are known to be endowed, their great abundance and the predilection displayed by certain species for man's vicintiy, appear to fully qualify these insects for the role of transmitters of human disease. This is amply shown to be true by the number of diseases which are transmitted by them.

Furthermore, mosquitoes are readily transported in various ways other than by their own flight to places far distant from their original habitat, with the attendent possibility of spreading infection.

Their power of flight renders the carriage of infection from house to house an easy matter, although the distance travelled is probably not great in the case of house mosquitoes and ordinarily the radius of infection conveyed by them would be correspondingly short.

It is unquestionably an argument, though not necessarily a conclusive one, against the incrimination of mosquitoes in pellagra transmission that no one species, occurring in endemic regions, has a range as wide as the geographical distribution of the disease and different species would necessarily (if the group be incriminated) assume the role of transmitters in different parts of the endemic area.

It is possible, were pellagra transmissible by mosquitoes, that several species might have the power to transmit the disease, yet there is often a high degree of specialization in insect vectors. In view of the nice physiologic adjustment between the insect host and its parasite, which is evidently necessary to the function of transmission, the foregoing assumption is not necessarily valid.

The most important fact which is opposed to the agency of these insects is the preponderance of cases among females and especially among home-keeping females. If, as indicated, the disparity is due to the greater exposure of women to infection, a cause must be sought which affects this class only and excludes those classes which show a low pellagrous incidence. In other words, the cause must be active in the day time when housewives, children, and old men are largely at home and which does not operate at night when all ages and sexes of the household are within the home influence. It is illogical to seek the cause in an insect whose activities are confined to the night hours, however well it may otherwise conform to the epidemiological and other facts of the disease.

It is to be noted, as we have said, that while mosquitoes are, comparatively speaking, not abundant in the Piedmont region where pellagra abounds, they are a more serious pest and infinitely more numerous in the low-lying country near the coast where pellagra, though not absent, is by no means abundant.

While a very considerable number of our cases reported attacks of mosquitoes, more than an appreciable percentage of these referred to localities beyond the bounds of our terrritoy, largely to places in the low country below the Piedmont.

The scarcity of mosquitoes was noted by all members of the party and it is highly probable that their number falls short of that required for effective disease transmission. It is admitted that diseases fail of transmission and cease to exist even in the presence of their known carriers when the number of the carriers falls below a definite point.

Certainly, it will hardly be asserted that a group of insects, represented so sparingly as are mosquitoes in this locality, can be the agent of causation of a disease having the activity displayed by pellagra in this region at the present time.

Culex quinquefasciatus and *Culex restuans* are the principal species recorded by us. *C. quinquefasciatus* was taken at a number of points and is, as might be expected, widely distributed in the county. Some water barrels were heavily infested and were producing enough mosquitoes to infest the entire immediate neighborhood. *C. restuans* is rather widely distributed and probably ranks with *C. quinquefasciatus*, as a general nuisance. *Aedes calopus*, the yellow fever mosquito was not taken within the county although quite ample facilities for its propagation exist. It is undoubtedly introduced, probably every year, but appears not to be a constant resident, the winters being usually too severe to admit of its survival. It can have no importance in the present connection in spite of its day biting proclivities and house haunting habits. Its geographical range is not as wide as the distribution of pellagra and it thrives as well in large cities as in small.

Spartanburg County bears the reputation of being almost entirely free from malaria, a reputation sustained by the small number and especially the character of the anopheline mosquitoes recorded by us. *Anopheles crucians*, a host of the estivo-autumnal parasite was encountered but once. The only other species observed was *Anopheles punctipennis* whose incrimination in malaria transmission remains somewhat doubtful. This species was met with chiefly in the vicinity of Spartanburg, a place whose physicians unanimously declare to be free from endemic malaria. Of 240 pellagra patients questioned as to the biting of mosquitoes, 160 gave positive reports while 40 only were negative.

SIMULIIDÆ. Although but recently incriminated in disease transmission, the flies of the genus *Simulium* have long been known in both Europe and America as a serious pest of man and animals, their visitations assuming in certain regions the proportions of a scourge. Much has been written regarding their blood-thirstiness and the intolerable nature of their onslaughts, the heavy loss occasioned among all kinds of domestic animals and even the death of human beings. Some of the accounts of their depredations seem to bear the stamp of a vivid imagination, but the more conservative and scientific statements, especially those of later years, are sufficient warrant for classing them among the more important and blood-thirsty of predaceous insects.

The attractive theory propounded and defended by Sambon, that these gnats are the active agents in the causation of pellagra has brought them into prominence from a new point of view.

He bases his belief in the agency of the Simuliidæ upon the following: *Simulium* affects the same topographical conditions as pellagra; in its adult state, it seems to present the same seasonal incidence; it is found only in rural districts and, as a rule, does not enter towns, villages, and houses; these flies cause severe epizoötics in Europe and America. The disease, he finds, is limited to agricultural laborers (to be explained satisfactorily only by the incrimination of the gnats); the range of the group seems to cover that of pellagra, although indeed it exceeds it.[6]

Knab has pointed out that close association with man is one of the essential factors in disease transmission by insects, when, as premised by Sambon in the case of pellagra, the disease is of parasitic origin and the organism is present in the blood stream.

Simulium inhabits regions in which pellagra is endemic and in many well-watered localities presents a picture of distribution which completely covers every part of large areas. Its numbers are often great enough to cause annoyance and even injury to all warm-blooded inhabitants, yet in spite of these phenomena it can not be said to show the association with man to which we have referred. The species of *Simulium* are essentially "wild" and there is no evidence, in what is known of their life history and habits, that repeated attacks on human beings with intervening periods of, at least, several days can take place with sufficient frequency to confer upon the insect the character of an effective disease tranmitter. As Knab cogently insists: "It is not sufficient that occasional specimens bite man, as for example, is the case with forest mosquitoes. Although a person may be bitten by a large number of such mosquitoes, the chances that any of these mosquitoes will survive to develop the parasites in question (assuming such development to be possible) and then find opportunity to bite and infect another person are altogether too remote."[7]

[6] L. W. Sambon, Progress Report Investigation Pellagra, Jour. Trop. Med. and Hyg., October 1, 1910, xiii, No. 19.

[7] Frederick Knab, Unconsidered Factors in Disease Transmission by Blood-Sucking Insects, Jour. Econ. Ent., 1912, v, No. 2.

Although Knab cites, as an example, the forest mosquitoes, the principle is of wide application and includes within its scope the species of *Simulium*, which, indeed, he excludes upon this very ground, from consideration as potential transmitters of disease.

It must be borne in mind that the essential factor here, is not the possibility that an occasional individual might sometimes be able to fulfil these conditions, but rather that the group lacks the habits (of close association with man) necessary to the establishment of the biologic relations between the vertebrate host, the invertebrate host, and the parasite of the disease.

Our observations of the group in Spartanburg County are strongly corroborative of the foregoing. We found *Simulium* breeding near or even within the limits of mill villages as well as of towns, but we failed to detect the slightest disposition on their part to seek out and attack man, to come about his dwellings, or to come in contact with him in any but the most casual and incidental manner.

Fig. 1.—Stream at edge of mill village. A breeding place of *Simulium venustum*.

The assertion that these flies cause severe epizoötics is certainly not supported as regards America, at least. The heavy loss of domestic animals which occurs during severe visitations of the gnats can not be attributed to any specific disease which is communicated by them. All the evidence indicates that death is caused by the venom injected and by the worry and irritation occasioned by the myriad bites.[8]

Individuals are carried to or through mill villages as well as other communities, upon animals (in the ears of horses and to a less extent on cattle). This might be a limited source of supply for localities removed from the vicinity of the breeding grounds of the fly. However, it is not even known that, after a full engorgement, the female will seek a second blood meal. The extreme degree with which the flies distend themselves with blood, when undisturbed during biting, coupled with the probably short life of the adult insect, suggest that they do not ordinarily bite again.[9]

Species of *Simulium* are unquestionably found in numbers in large areas of country in which pellagra is rampant, but there is evidence to show that, contrary to Sambon's assumption, the disease is found where *Simulium* is not. We have information that pellagra occurs endemically in Barbados and as yet not only has no species of *Simulium* been found in the island, but its physical characteristics entirely preclude the existence there of the fly.[10] There are arid regions in the United States in which the same situation exists but under different conditions and there are still other localities where these gnats are far too rare to satisfactorily account for the cases of pellagra originating in them.

That the extension of the range of *Simulium* beyond the limits of pellagrous endemicity is certainly, as Sambon says, no argument against its incrimination for there are many localities inhabited by insects with known powers of disease transmission, yet which are entirely free from the diseases which these insects may confer. In the absence of the human carrier of infection and the proper conditions, the insect vectors are innocuous.

The seasonal appearance of *Simulium*, which is supposed to correspond with that of pellagra, is probably of less significance than has been assumed. The studies of the Commission have shown that the spring-fall recrudescences of the disease do not occur, with the intensity ascribed, at least in the area under consideration,[11] although the period of greatest abundance and activity of *Simulium* appears to be here, as in Italy, the early spring. Until more light is thrown upon the length of the incubation period of the disease, which seems to be variable, assumptions as to the exact time at which infection is incurred, must be received with reserve.

The disease is of essentially rural distribution but in South Carolina, it occurs in towns of considerable size. As has been

[8] C. V. Riley, The Southern Buffalo Gnat, Report of Comm. Agric., United States Dept. Agric., 1886.

[9] C. V. Riley ibid.

[10] Personal letter from Dr. H. A. Ballou, Imperial Entomologist, Barbados.

[11] J. F. Siler and P. E. Garrison, An Intensive Study of the Epidemiology of Pellagra, loc. cit.

pointed out, in these places the rural element, as regards insect life, is predominant and the conditions do not necessarily preclude the occurrence of rural diseases.

In the classes of the population affected by pellagra, a very marked contrast appears to exist between European and American conditions, if European reports are accurate. The practical confinement of the disease in Italy to agricultural laborers, a class living under conditions of abject poverty, finds no economic or occupational parallel in America. Although, in Spartanburg County, the farming class furnishes a considerable percentage of all cases, the highest incidence of the disease is found among inhabitants of mill villages, whose conditions and habits of life are radically different in most essential features from those of the Italian peasant.

The fact that more than one species of *Simulium* would have to be involved to cover the entire range of pellagra is not a convincing argument against incrimination of the group but it lessens, to a certain degree, the probability of their agency. (See page 92 on mosquitoes.)

It seems to have been assumed that because the many streams of a well-watered country are infested with the larvæ of *Simulium*, the inhabitants of that country, especially those living in close proximity to streams, must be exposed to and incur the bites of the gnats.

Knowledge of the biting habits of the American species is incomplete, but it is clear that some of these species show great irregularity in their practice of seeking blood. The variation in the exercise of this habit seems to have in it a large geographic, or possibly, topographic element, for a species may be a serious pest of man in one part of its range, yet seem to ignore him entirely in another. Thus, *Simulium venustum*, one of the so-called "black flies" while proverbial for its onslaughts in the Maine woods, is only moderately troublesome in the Adirondack Mountains. In the mountains of Henderson County, North Carolina, these flies were found by one of us to be exceedingly abundant but offering no attack to man though this was courted. Sitting or standing quietly with small swarms of the flies "dancing" about the head, no attempt was made to bite. This occurred both in the presence and absence of animals which in the former case were being actively attacked. Persons of intelligence who were questioned, denied that the flies bite people and in only one instance was such a report elicited. In this case the identity of the fly was open to question, although probably a *Simulium*.

Similarly, *Simulium vittatum* is known to bite man in some parts of its habitat, but on excellent authority it is stated that in Idaho it "does not bite people."[12]

[12] Personal Letter from Prof. J. M. Aldrich.

Such variation in biting habits is not without parallel among blood-sucking flies, as *Glossina palpalis* is reported by Steudel to bite man on Victoria Lake but not on Lake Tanganyika.[13]

This variability is of special significance, for it points to the fallibility of deductions based upon the mere presence of *Simulium* larvæ in a given locality without regard to the species represented and the *local* biting habits of that species.

Simulium pictipes, a widely distributed and often abundant species, does not bite man at all.

So numerous are the streams in the county that the homes of 275 pellagrins stood within an average distance of 210 yards from running water, and 215 of these streams were found to be infested with *Simulium*.

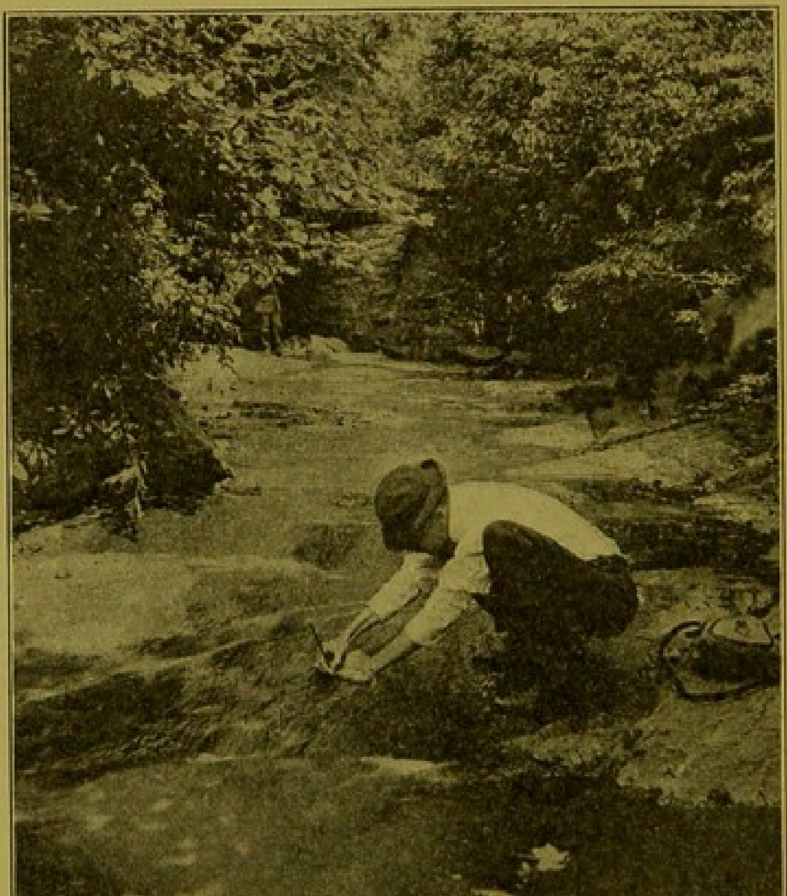

Fig. 2.—A typical breeding place of *Simulium pictipes*.

In spite of this fact, but 16 cases reported attacks of flies, the description of which could with any probability of truth, be interpreted as referring to *Simulium*. Great patience was exercised in eliciting these reports and they were carefully weighed before recording.

[13] Steudel, Deutch. Kolonialblatt, 1912, 15 Mai, xxiii, No. 10, and Beihefte zum Archiv f. Schiffs und Tropenhygiene, 1912, Mai, Beiheft 4.

The distance of *Simulium*-infested streams from the homes of 11 cases reporting bites of the fly averaged 236 yards, no data as to infestation of streams being available in 5 cases reporting bites.

The distance of *Simulium*-infested streams from the homes of 125 cases reporting *no* bites of the fly averaged 221 yards.

This difference in average distance is not actually great but it is interesting nevertheless. It is a striking fact that so large a number of persons living a shorter average distance, many within a few yards, from infested streams should not have been bitten and points forcibly, not only to the uncertain biting habits of *Simulium*, but to the lack of significance in the proximity of streams, even when *Simulium*-infested.

We may add that adult *Simulium* were collected in the immediate neighborhood of 46 cases who reported no bites.

The tenor of these reports is amply corroborated by those of many persons, including a considerable number who were especially well qualified through intelligence and experience with the flies in other localities or who had observed their attacks upon animals in this.

It cannot be questioned that as a pest of man in Spartanburg County, the species of *Simulium* are of small importance and that at most their attacks are delivered locally and are few in number. When comparison is made between this condition and that existing in places (including Spartanburg County) infested by stable flies, sand flies, mosquitoes, etc., the contrast is striking. These insects are always well known, even when not abundant, as we have shown in regard to mosquitoes in this locality. It is practically impossible that *Simulium* could be present and bite man in sufficient numbers and with enough persistence to satisfactorily explain the occurrence and spread of pellagra without being a well recognized and familiar pest.

Three species of the genus were encountered by us within the limits of our territory, namely: *Simulium venustum, S. vittatum,* and *S. pictipes.*

The former is by far the most numerous and generally distributed of the three. It was taken in its four stages, adults being collected about twelve times, either in the act of attacking animals or of ovipositing.

Simulium vittatum was taken in the larval, pupal, and adult stages, and also probably in the egg. Adults were twice collected while attacking horses or mules.

Simulium pictipes occurs quite locally in large colonies where suitable conditions exist. These consist of a rapid flow of clear water over boulders and sheets of rock in the larger streams. Such conditions are not very frequently met with in this vicinity owing to the turbidity of most of the creeks and rivers of the locality.

There are no records of this species attacking man and it need not be considered in the present connection.

The facts as set forth above do not support the incrimination of *Simulium* in the transmission of pellagra.

House and Blow Flies. So abundant is the current literature regarding the nature, habits, and pernicious activity of the house fly, that a general discussion of this well known and troublesome species seems superfluous. Its familiar role as an active mechanical carrier of bacterial disease, however, renders it of the highest economic importance and necessitates its consideration in the present study. The possibility of the transmission of pellagra by house flies through the contamination of food to which they have access, or by direct mechanical transmission of the virus (if it exists) from man to man, is evident.

Musca domestica was present everywhere and was usually extremely numerous. Sanitary conditions were only too frequently such as to attract, if not actually to breed, the filth-loving species of flies, but in the more or less congested village and town communities there was no strict correlation between the sanitary condition of the individual premises and the number of flies present. Even well-kept homes offered sufficient attraction to insure their infestation by the flies which in every neighborhood were present in large numbers.

In mill villages the principal source of house flies appeared to be the accumulations of manure of horses and cattle at the stables and sheds in which the draught animals of the mill companies and the cows of the operatives were sheltered. In those villages in which milch cows are allowed to be pastured and stabled indiscriminately through the village, breeding occurred almost everywhere in the haunts of the animals.

The type and condition of privies in mill villages are conducive to the presence and breeding of this species as well as to the carrion flies, *Calliphora, Lucilia,* and the *Sarcophagidæ*. Upon otherwise cleanly premises, the privy was often a source from which flies emanated and was a standing menace of infection.

Musca domestica was found in and about the homes of practically all of the cases studied as well as those of non-pellagrins. In a very few instances case histories make no mention of the species, but this is unquestionably due to inadvertence.

Until the transmissibility of pellagra is disproved or the nature of its virus and the manner of its communication are known, the house fly must be regarded with suspicion.

Stomoxys Calcitrans Linn. The biting stable fly is an insect of cosmopolitan distribution and great economic importance. In most localities within its habitat it is very abundant, and though it feeds by preference upon domestic animals, man is very frequently attacked. Attacks upon human beings are more common when the animals upon which it normally feeds are not available and its onslaughts are often severe and persistent.

The injury inflicted upon live stock is often very serious and many deaths are caused during the occasional outbreaks of this fly, which sometimes occur under unusual conditions favoring its inordinate propagation. At all times it is a serious pest of animals and has been incriminated in the transmission of trypanosomal diseases of animals, anthrax in animals and man, and of anterior poliomyelitis in man.

While *Stomoxys* is, as a rule, more abundant in country districts, owing to the greater facilities for propagation which it finds in the rural environment, it is usually common in towns and cities of even the largest size. In the very heart of the great cities and in such neighborhoods as practically preclude the possibility of its breeding, it may be seen in considerable numbers along the main thoroughfares. The vicinity of markets and wharves is especially likely to be heavily infested and this is the case even when scrupulous scavenger work renders its propagation at the spot impossible. The source of supply under such circumstances may be far removed and the fly population maintained by the constant arrival of individuals which accompany animals on their journeyings or which are guided by their sense of smell in independent flights from more or less distant localities.

The stable fly will breed in unmixed manure of horses and cattle, in such materials mingled with particles of straw and in rotting straw alone. While we have repeatedly bred the stable fly in large numbers from naturally infested, unmixed dung of horses and even a few individuals from that of cattle, the observations of Bishopp during a recent severe outbreak of the fly in north Texas, indicate that decaying straw is the material most favorable to its propagation. His careful work shows conclusively that in the order of preference, the substances in which *Stomoxys* will breed are oat, rice, barley, and wheat straw, horse manure, lot manure, and cow manure; that pure horse and cow manure are less attractive to the fly than when mixed with a considerable quantity of straw and that under a combination of conditions of plentiful moisture and abundance of rotting straw, breeding will occur at its maximum intensity.[14]

Similar observations have been made by Lucien Iches in Argentina.[15]

There is a direct relation between the presence and numbers of domestic animals and the abundance and distribution of this fly, which wanders far from its breeding places in search of food and will follow animals for long distances. This, however, is not its

[14] F. C. Bishopp, The Stable-Fly (*Stomoxys calcitrans L.*). Jour. Econ. Ent., 1913, vi, No. 1.

[15] Lucien Iches, *Stomoxys calcitrans L.* et le betail Argentin., Bull. Soc. nation Acclimat., France Ann., 1909.

only means of dispersion, as steamships, passenger trains, and those carrying live stock upon railroads are a common aid to its migration. We have encountered the species under all these conditions and have seen it carried for hours on the under side of an automobile top, in spite of wind and jolting over rough roads. In the latter case, the fly appeared to be full fed and, resting in this way after engorgement, it would be more likely to remain in such a situation and to be carried to a new locality. This is of special significance in connection with disease transmission. It is evident that flies carried in the ways mentioned, if infected or acquiring infection en route would have the power to carry the disease to a new locality remote from endemic foci. Particularly would this be the case if opportunity for feeding during the journey was lacking, as the hungry fly would upon arrival immediately seek a meal of blood, human or animal, and thus transmit the infection. An instance of the persistence of *Stomoxys calcitrans* in seeking blood was observed by us on the coast of South Carolina. The six occupants of a fishing boat were attacked, more than a mile from land, by numerous flies which suddenly appeared and which had evidently not been carried in the boat. It must be borne in mind that the stable fly is not attracted to offensive substances, and the odors from the fish-scented boat can hardly have played a part in drawing the flies so far from land. All the persons in the boat were bitten one or more times and the bare-legged boatmen greatly annoyed. They stated that such an occurrence was very common and that they were frequently attacked when at sea. *Stomoxys calcitrans* is very abundant along this line of seacoast and in the adjacent country. The day was clear and hot with a gentle off-shore breeze.

Although primarily a pest of live-stock, infesting and breeding in situations frequented by domestic animals, this fly often invades dwellings. While indoors it attacks the human inhabitants and we have even seen it more numerous in living rooms of mill dwellings than the ever-present house fly. It must be understood that in such cases the latter species was somewhat less numerous than usual.

Stomoxys has the habit of utilizing several hosts in order to secure a single meal, either from choice or because when dislodged by one host it flies to another.[16] This habit is important in connection with disease transmission. Especially is this the case in the interior of dwellings where all the members of the household would be exposed to the infection, if transmissible, which might be carried by one of its members.

It is, moreover, within the possibilities that a puncture of the

[16] C. T. Brues and P. A. E. Sheppard, The Possible Etiological Relation of Certain Biting Insects to the Spread of Infantile Paralysis, Jour. Econ. Ent., 1912, v, No. 4; Herbert Osborn, Insects Affecting Domestic Animals, Bull. 5, N. S. Bu. Ent. United States Dept. Agric., 1896; H. Maxwell-Lefroy, Biting Flies of India, 1907

skin by an infected fly's proboscis might introduce the infection although no blood is drawn. This has been shown to be experimentally possible in the non-mechanical transmission of trypanosomiasis by *Glossina palpalis*.[17]

As has been pointed out, the members of the household who suffer most from pellagra are those who pass the most time in the home or its vicinity in the day time and it is these members, the females, who are most exposed during daylight hours to the attacks of *Stomoxys*.

As we have stated, *Stomoxys calcitrans* is not attracted by the odors of putrefaction. Hog-pens and privies are not inviting to it, nor is it apparently drawn to the nasal secretions of animals nor presumably to those of man as is the house fly, this discrimination being of importance in connection with the carriage of certain diseases.

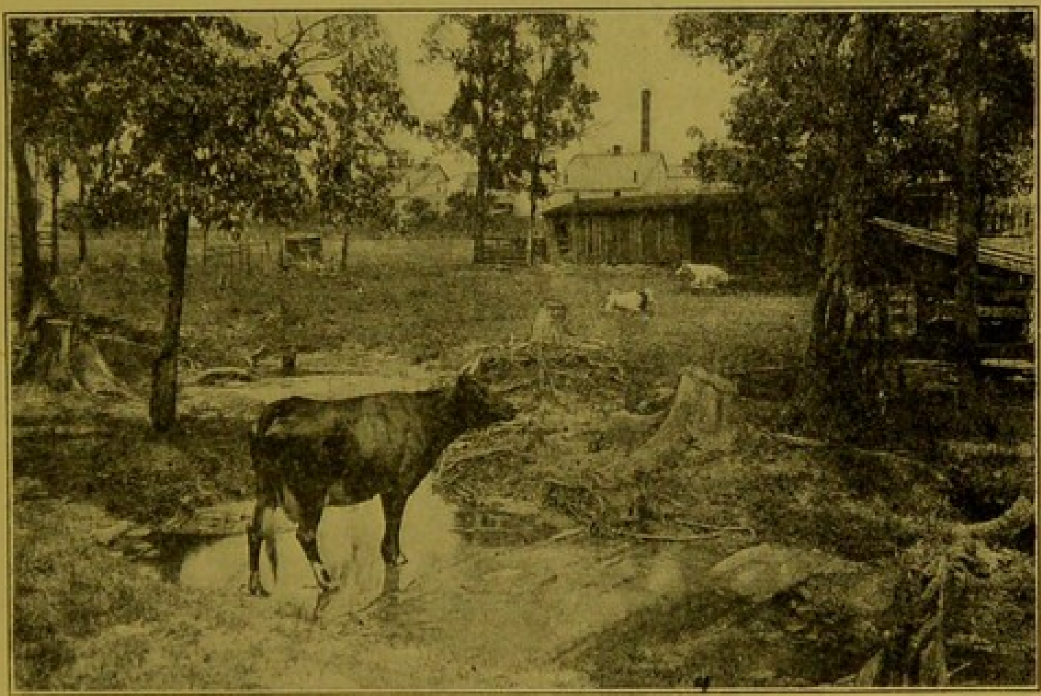

Fig. 3.—A pasture provided by mill authorities for cows, etc. of operatives. Note cow-sheds, hog-pens, and proximity of dwellings. The stream in foreground breeds *Simulium*.

The stable fly is exceedingly abundant and generally distributed in Spartanburg County. In most of its geographical range the species is of importance in its relation to live stock and, our studies indicate, that it is also a pest of man with which it is necessary to reckon. No part of the region is free from this fly and it may be seen in numbers upon the streets of towns and villages, about barnyards, modest dwellings, and pretentious residences. Every

[17] A. D. Fraser and H. L. Duke, Proc. Roy. Soc., August 24, 1912, Ser. B, lxxxv, No. B, 581 Abs. Sleep. Sick. Bull, 1912, 4, No. 40

team upon the roads is followed, and every cow in pasture or barnyard is constantly exposed to its attack during the daylight hours

As a part of the study devoted to this species, statements regarding its biting were obtained from as many persons as it was possible to interview, the questions being put to pellagrins and their families as well as to non-pellagrins. In obtaining reports on the biting habits of the fly, great care was exercised not only to be sure of the identity of the fly of which the individual was speaking, but to suggest nothing which might influence the tenor of the report. All reports were rejected which after careful consideration seemed doubtful, either as to the identity of the insect or the details of the statement.

Reports relative to the biting of *Stomoxys* were obtained from 227 pellagra patients and of these 115, or 50.7 per cent., gave positive histories of attacks and to these should be added 10 from members of families of pellagrins who could not themselves recall having been bitten. In 112 cases, or 49.3 per cent., the patient could remember no bites or was positive that none had been inflicted.

In addition to the above reports, many persons not included among our pellagra sufferers recounted experiences with the persistence of attack and voracity of the fly.

Close attention was given to the presence of the fly in such situations as would facilitate its attack upon the inmates of dwellings of all descriptions, that is, its presence or absence about the yards and premises, especially upon the outside of houses near open, unscreened windows, upon porches, and the interiors of dwellings. The distribution of the fly in the latter situation has some significance, and observations were made to determine its preference for different kinds of rooms.

Stomoxys was present about premises, yards, sides of house, or porch of the homes of 136 pellagrins, being abundant in 94 instances.

An illustration of the universal distribution of the fly was seen in a mill village which was studied with special care. This village contained 113 inhabitated buildings, including the company's store and office. Stable flies were found about 103 of these buildings and inside of several of them. It was found that the distribution varied somewhat, houses seemingly free from the flies at the time of our first visit would be infested at a later time, the reverse also being true. Nevertheless, there were few dwellings about which individuals could not be found at any time and it is to be assumed that they were present at all buildings more or less frequently.

For various reasons, it was quite often impossible to make a careful search of the interiors of pellagrous dwellings and conditions of weather, light, etc., were sometimes unfavorable to the presence of the flies at the time of inspection and made their discovery difficult. Enough observations of its presence were made to show that invasion of human habitations is of common if not regular occurrence.

Its presence was noted in more than 30 dwellings of pellagrins, in fully half of which it was abundant, and in one instance a partial count showed 30 individuals.

The character of the rooms frequented by the fly has a bearing, not only upon the opportunity for attack, but upon its general habits. Strong preference was shown for the living rooms and in more than half of the houses studied these were the only rooms infested. In about one-fourth, flies were found in both living rooms and kitchen, while in only one instance was the kitchen alone infested and then by only one or two flies. In the houses of mill workers the living room is usually also a bed room. It will be seen that in case of illness or during moments of relaxation, the occupant of a bed in a *Stomoxys*-infested room invites the attack of the fly. It was evident that in addition to the odors of putrefaction, those of cooking are not attractive to this species, which is in strong contrast to habits of the house fly. The difference in domestic habitat of the two species is very striking, kitchens frequently swarming with house flies where living rooms were only moderately infested, the same houses showing infestation of *Stomoxys* in living rooms only.

Management of Live-Stock in Mill Villages, Etc. The relation of domestic animals, especially horses and cattle to the presence and abundance of *Stomoxys* is so important, that a knowledge of the number and management of these animals is essential to a study of the bionomics and distribution of house and stable flies.

Cattle, horses, mules, and hogs are very commonly kept in Spartanburg County especially upon farms, while in the cities, towns, and hamlets, many of the non-farming residents maintain milch cows and driving or draft animals. The inhabitants of the mill villages also keep many cows, one cow to about three families being a fair average.

Upon farms, the stables and sheds in which animals are housed are usually placed about the barnyard at no great distance from the dwelling. Manure is often allowed to accumulate, and the floors of the outbuildings are frequently covered by a deep layer of droppings, the fresher portions heavily infested with fly larvæ. These conditions are by no means invariable and in many instances manure is not allowed to accumulate about the stable or barnyard, but is disposed of more or less promptly.

The definite allotment of land for purposes of pasturage is not invariable and, especially when but a few head of stock are maintained, they are pastured in a more or less indiscriminate fashion upon waste land, in lanes, woods, and such situations as prevent danger to growing crops. As a rule the milch cows are brought to the barn to be milked, and draught-stock is invariably stabled and fed. Hogs are sometimes pastured but are frequently confined to small yards or pens which, too often, are unsanitary in the extreme and highly attractive to house and blow flies.

In cities and small towns, with the exception of the poorer dwellings, many, if not most, residences are provided with a stable in which a horse or cow, sometimes both, are sheltered. Depending somewhat upon density of population, these animals may be pastured upon vacant lots, road sides, and door yards or they may be confined to small yards adjacent to the stable. The care given the animals and their quarters varies greatly, but ample opportunity for fly propagation occurs. Hogs are usually excluded from the corporate limits of the larger communities.

In most of the mill villages there are no regulations regarding the keeping of domestic animals, including hogs. Cows are pastured indiscriminately about streets and village lots. They are stabled in small shacks upon the house lots of their owners or even under the houses when these stand upon sloping ground and sufficient room for this purpose is afforded. The cows are milked and fed grain, etc., on the premises, and their droppings are a source, sometimes a prolific one, of fly breeding.

In a few of the mill villages a common pasture is provided in which the cows of the mill operatives must be kept. They are not permitted upon the streets or house lots, and rough shed stables are usually provided in which the animals are fed, milked, and sheltered in inclement weather. These sheds are roughly constructed and although the droppings are removed from the stalls at intervals, piles of manure are left for varying periods in the immediate vicinity providing breeding places for great numbers of flies.

The plan of exclusion is an excellent one, but, unfortunately, the benefit is minimized by certain details of its application. Pastures are usually contiguous to the village, the nearest houses often standing within 100 feet of the pasture boundary and cow sheds. In one instance the pasture is almost at the centre of the village and is closely approached on three sides by the dwellings. In another village there are two pastures at opposite sides of the village and a large part of the community is thus exposed to the flies frequenting or produced within them. The rule of exclusion is not always rigorously enforced and exceptions are sometimes permitted; calves are occasionally, either openly or surrepticiously, kept about the owner's house and in one instance which came under our notice a cow was regularly brought for milking to the owner's house in spite of the regulation and an examination of the surroundings showed a large number of stable flies about the house adjoining that of her owner, whose premises were comparatively free from them.

A fact bearing upon the importance of domestic animals in connection with *Stomoxys* in its relation to human beings is that of

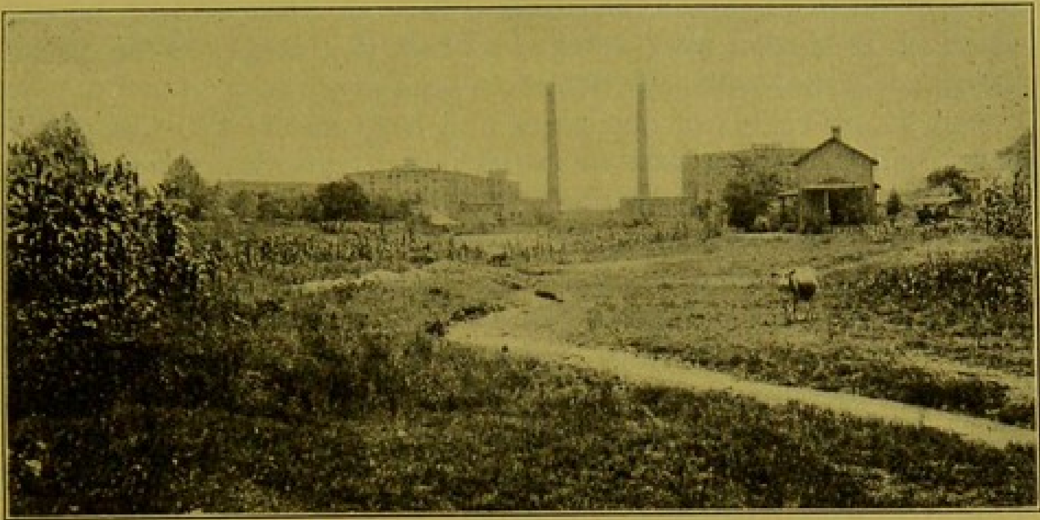

Fig. 4.—Open commons used as cow pasture by mill operatives. The stream in foreground is an active *Simulium* breeding place. Houses of operatives in middle distance.

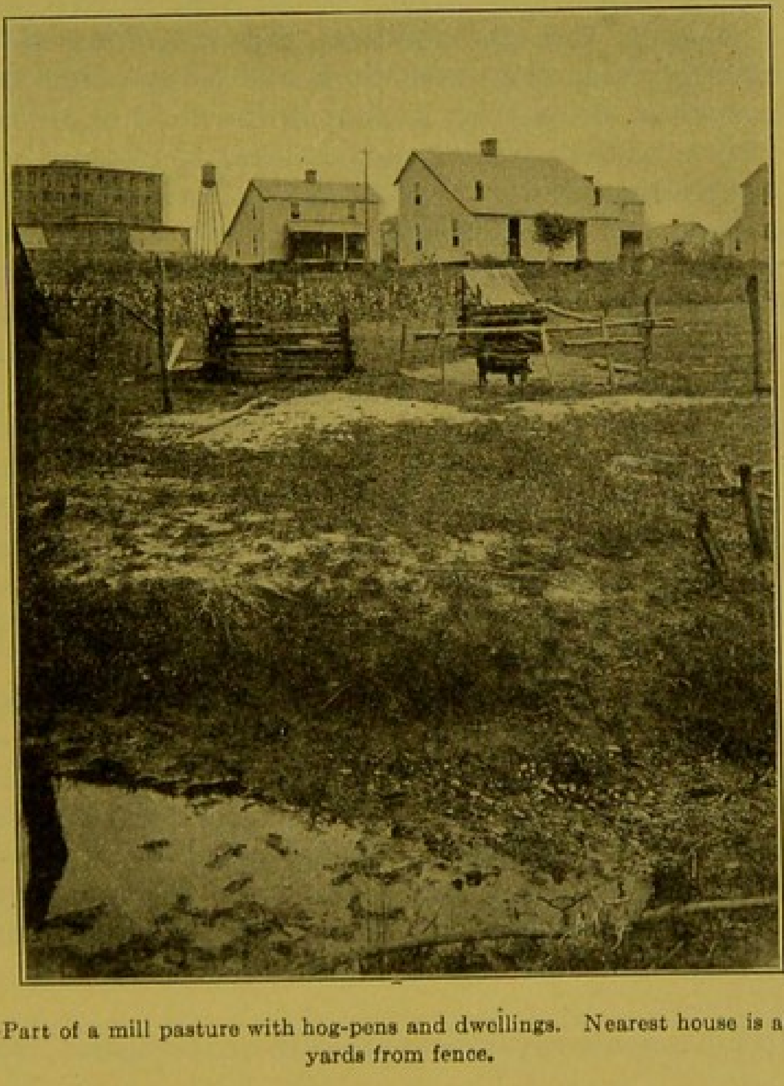

Fig. 5.—Part of a mill pasture with hog-pens and dwellings. Nearest house is about sixty yards from fence.

attack upon milkers. Although in the presence of animals which the fly normally prefers to man, the comparative quiescence of the persons so engaged, renders them peculiarly liable to attack, while those attending to and associating with cattle while actively engaged upon their duties may escape. That the milker is frequently attacked is shown by the reports we received.

But 21 pellagrins of our series had been in the habit of milking cows, and 2 of these were not questioned regarding the fly in this connection. Of the remaining 19, 14 or about 74 per cent., stated that they had been bitten while milking, and a considerable number of non-pellagrins made similar statements.

The comparative distribution of *Stomoxys* in urban, rural, and mill districts is interesting. Infestation of premises—the presence of *Stomoxys* upon the outside of houses, upon porches and in the immediate vicinity—in places from which entrance to the house or attack upon its inmates would be easy, occurred most frequently in mill villages. In these villages 97 per cent. of the homes visited were infested in the way described while of rural and farm homes 67 per cent., and of urban, 50 per cent. were similarly frequented.

The explanation of this seems to be that in the presence of domestic animals, the stable flies in the immediate vicinity will be concentrated upon and about them and many follow them when driven to work or to pasture, so that in the absence of the animals the infestation of the premises may be greatly lessened or the flies be so few as to escape notice. In the mill villages, the flies, separated from passing teams or cattle become generally distributed, seeking shelter and food among the dwellings, and it is significant of the truth of this explanation that in mill villages whose rules do not exclude cows from the village precincts, the number of stable flies present about the houses is more variable although apparently larger in the aggregate than in those villages which practice exclusion.

In comparing the reports of biting by *Stomoxys* received from pellagrins of the three classes, it is interesting to note that 55 per cent. of the reports received from mill cases were positive; 54 per cent. from rural cases were also positive; while but 13.4 per cent. of the urban cases could recall attacks by the fly.

It will be seen that the highest percentage of reports of bites by *Stomoxys* was received from the mill villages which also furnish the greatest number of pellagra cases. The rural districts follow closely in their percentage of positive reports though there is a greater discrepancy between pellagra incidence in the mill villages and that of these districts than is indicated in the reports. This fact might be accounted for by the lack of congestion of population in the rural sections with a lower percentage of possibly infected flies.

These reports evidently indicate that there is a definite correlation between the abundance of *Stomoxys*, the character of its distribution and its biting of man.[18]

SUMMARY. Our investigation was entered upon with no bias in favor of the infectiousness of pellagra or its transmissibility by insects. In the nature of the case, however, and as a basis for our work, it was necessary to assume that both were among the possibilities.

No preconceptions as to the involvement of any particular insect were indulged, and our conclusions regarding individual species of insects are based upon the epidemiological picture of pellagra, mainly as presented in Spartanburg County, and upon the habits and distribution of the insects as observed by us and as elsewhere recorded.

Ticks, lice, bed bugs, cock roaches, horse flies, fleas, mosquitoes, buffalo gnats (*Simulium*), house flies, and stable flies (*Stomoxys*) were under consideration. Of these, horse flies have nothing and cock roaches little to support them.

Ticks and fleas are excluded on occount of their scarcity and the nature of their biting habits. In view of these characteristics, it is doubtful if even the existence of an animal reservoir of infection would bring the groups into prominence.

Lice and bed bugs do not account for the sex or age incidence or the rural nature of the disease; the scarcity of the former is an additional reason for its exclusion.

The rarity of mosquitoes here and the lack of coincidence between their distribution and that of pellagra for the State in general, together with the night-biting habits of the local species, which fail to account for the sex incidence, seem sufficient cause for their elimination.

House flies (*Musca domestica*) should be active if the malady is an intestinal infection in which the germ is passed with the feces, with contaminated food acting as the vehicle of infection.

The buffalo gnats (*Simulium*) should be eliminated, principally by the facts of their biting habits and lack of those of intimate association with man, also possibly by their comparatively moderate abundance (in our territory). We find that in Spartanburg County they are hardly known as a pest of man and when they do attack him, it is very locally and largely confined to field workers. Had Sambon's theory not been advanced, these flies could hardly have attracted suspicion of any connection with pellagra in this country.

The stable fly (*Stomoxys calcitrans*) displays certain salient characteristics which seem to qualify it for the role of a transmitter of pellagra.

The range of this one species covers and exceeds that of pellagra;

[18] Allan H. Jennings and W. V. King, One of the Possible Factors in the Causation of Pellagra. Jour. Amer. Med. Assoc., January 25, 1913, lx.

its seasonal activity, likewise, is coincident with that of the disease and, although its period of greatest abundance is somwehat later than the maximum intensity of pellagra, its appearance in spring precedes that of most of the spring recurrences and new cases, at which time it is already abundant; it is an abundant species, its abundance being most manifest in rural districts thus corresponding with the rural nature of pellagra, its numbers amply fulfilling our conception of those necessary to effective disease transmission; it bites by day only, thereby offering an explanation of the phenomenon of sex incidence and the related one of age distribution; it is intimately associated with man and habitually infests his vicinity and enters his dwellings; it bites man frequently and persistently; its longivity seems sufficient for the development of a hypothetical causative organism; it is readily and frequently carried long distances and might thus account for the occurrence of sporadic cases of the disease.

IV.

METABOLISM IN PELLAGRA.[1]

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Introduction. A study of the metabolism in pellagra would appear to be of interest from a number of different viewpoints—namely, as an aid to the interpretation of the gastro-intestinal symptoms generally observed; in connection with the maize theory of the etiology of the disease; and, further, because of the resemblance in certain particulars to beriberi,[2] in which the etiologic factor appears to be an inadequate dietary. Despite the reasons which would seem to make a knowledge of the metabolism in this disease desirable no extended study has been carried out in this connection, with the exception of the work of Camurri,[3] in Italy. However, certain points of interest have been noted—namely, the frequent occurrence of gastric anacidity by Johnson,[4] by Cecconi,[5] and by Niles,[6] and the presence of indicanuria by a number of observers, most recently by Ormsby and Singer.[7]

The experiments conducted by Camurri were fairly comprehensive, though directed in particular toward the study of the mineral metabolism. His work included a general study of the

[1] Reprinted from the American Journal of the Medical Sciences, May, 1913, No. 5, vol. cxlv, p. 705.

This paper forms a part of the preliminary report of work performed under the auspices of the Thompson-McFadden Pellagra Commission of the Division of Tropical Medicine, Department of Laboratories, New York Post-Graduate Medical School and Hospital. The results of this work were reported at the Second Triennial Meeting of the National Association for the Study of Pellagra, Columbia, S. C., October 3, 1912, and at a meeting of the Section on Medicine of the New York Academy of Medicine, February 18, 1913. The analytical work was carried out with the assistance of Messrs. G. O. Volovic, W. I. Sivitz, Dr. E. Kister, and Mr. A. Bernhard; and the ward work with the assistance of Mrs. J. H. Brinkerhoff and the Misses H. A. Macarow and H. F. McDowell.

[2] For discussion of literature on beriberi, see Strong and Crowell, Philippine Jour. Sci., 1912, B, vii, 271.

[3] Atti del Quarto Congresso Pellagrologico Italiano, Udine, 1910, p. 67.

[4] South. Med. Jour., 1911, iv, 478.

[5] Gazzetta Degli Ospedali e delle Cliniche, 1911, xxxii, 77.

[6] Pellagra, 1912, p. 77.

[7] Report of the Pellagra Commission of the State of Illinois, 1911, p. 23; also Arch. Int. Med., 1912, x, 123 and 219.

composition of the diet, urine, and feces of pellagrins subsisting upon mixed diets and upon diets composed largely of corn. Balances were given for nitrogen, fat, and salt in comparison with those of normal individuals upon similar diets. The points of interest will be discussed in connection with our own work.

Johnson found the free hydrochloric acid of the gastric juice to be absent in 14 out of 20 cases, while rennin was absent in 7 cases. Diarrhea was observed in the 14 cases with absence of free hydrochloric acid, but only in one of the other 6 cases, and here attributed to another cause. Cecconi found free hydrochloric acid absent in all of his 12 cases, while Niles in an examination of 64 cases of undoubted pellagra found free hydrochloric acid absent in 18, deficient in 31, excessive in 12, and normal in 3. He noted that the gastric secretions were diminished or absent in most cases of long standing, while in the few instances where those juices were increased the cases were acute.

In a study of 55 cases of pellagra, Tucker[8] reported an increase in indican in 3 cases. In the report of the Illinois Pellagra Commission, however, Ormsby and Singer noted a marked reaction for indican in all the cases examined.

The experiments here reported were made upon the patients sent to the Post-Graduate Hospital by the Thompson-McFadden Pellagra Commission. We have endeavored to make a fairly extensive study of the metabolism in pellagra, because a thorough knowledge of the fundamental processes of metabolism appeared particularly desirable in this disease; and, further, because it was believed that points of attack might be disclosed which would offer opportunities for more intensive study.

Methods Employed. The general procedures employed in this metabolism study were to secure gastric contents (after the Ewald-Boas meal) as soon as practical after the admission of the patient to the hospital. Subsequently the patient was placed upon a weighed diet, and the urine and feces collected daily for a period varying usually from seven to ten days. Following this period, gastric contents were again secured in certain of the cases, while in two instances a second metabolism experiment was conducted.

The examination of the gastric contents has been directed particularly to determining the acidities and ascertaining the peptic activity. The customary titration methods were employed for the acidities and Rose's method for pepsin, as conducted in this laboratory.[9]

During the period of the metabolism study a lacto-vegetarian and practically purin-free diet was employed for experimental reasons. The general type of the diet may best be illustrated by a sample day (August 8) taken from Case 8 (M. T.).

[8] Jour. Amer. Med Assoc., 1911, lvi, 246.

[9] Post-Graduate, 1912, xxvii, 506.

	Grams or c.c.
Breakfast:	
Corn-flakes	25
Banana	89
Bread	63
Egg	48
10.30 A.M.	
Water	150
Apple	105
Dinner:	
Apples	125
Water	50
Bread	127
Egg	43
Potato	140
3.00 P.M.	
Graham crackers	26
Supper:	
Cream of wheat	25
Water	300
Bread	101
Egg	46
Orange	148
Water	200
10.00 P.M.	
Banana	97
Distributed between the various meals as desired:	
Cane sugar	63
Milk	800
Butter (salt free)	23
Salt (pure NaCl)	6

This would furnish 91 grams protein (14.6 N $\times$ 6.25), 71 grams fat, 460 grams carbohydrate and would yield approximately 2800 calories, which is not far from the average found for the period in this case.

As insufficient time prevented our making a complete analysis of the food intake, the figures for protein, carbohydrate, and fat were for the most part calculated from the data given by Atwater and Bryant[10] for American food materials, while the figures for the mineral constituents were taken from results compiled by Sherman.[11] Many of the figures for nitrogen, however, were from our own analyses, and we believe that the results which we have given for the nitrogen intake are reliable. The protein intake has been calculated from the nitrogen figures by employing the factor 6.25, and the calorific intake obtained by multiplying the grams of protein and carbohydrate by 4 and the grams of fat by 9 and adding these results.

[10] United States Dept. Agri., Office of Exper. Sta., Bulletin 28, Revised, 1906.

[11] Chemistry of Food and Nutrition, 1911, p. 332.

Previous to beginning the metabolism study the patients were placed for several days upon the diet they were to receive during the period of actual examination. The end of the twenty-four-hour urine period was taken as 7.30 A.M. After the excretion of the last sample of urine for the day the patients were weighed and then given their breakfast. The urine specimens were collected in three-liter glass-stoppered bottles and preserved with a liberal supply of toluene. The urines were taken to the laboratory at 9 A.M., made up to some definite volume (1000 c.c. where possible), and the nitrogenous constituents, the ammonia in particular, determined in most cases the same day. At this time the qualitative and microscopic examinations were made. The urines were then refrigerated at 0° C. for future use. The feces were collected in weighed tin pails, the weight of the feces ascertained by difference, and then kept in a common receptacle in the refrigerator at —4° C. until the end of the period. In most of the experiments the feces of the experimental period were marked off with charcoal, though in some of the later experiments carmin was employed. When the feces for the whole period had been assembled, they were thoroughly mixed and a weighed portion, generally one-half, dried over the water-bath with the addition of alcohol acidified with dilute sulphuric acid, and subsequently ground to a fine powder. All determinations with the exception of the indol and skatol were made upon the air-dried feces.

The examination of the urine included the usual qualitative tests—namely, tests for albumin, sugar, acetone, diacetic acid, and a microscopic examination of the centrifugalized sediment, and, in addition, quantitative estimations of the total nitrogen, urea, ammonia, uric acid, creatinin, creatin, chlorides, phosphates, inorganic and ethereal sulphates, neutral sulphur, total acidity, and indican on the individual specimens, and determinations of sodium, potassium, calcium, and magnesium on composite samples. The methods employed were: For total nitrogen, Kjeldahl; for urea, the Benedict (S. R.) method;[12] for ammonia, uric acid and creatinin, the Folin methods;[13] for creatin, the Benedict (F. G.)-Myers' modification of the Folin method;[14] for chlorides, the Volhard-Arnold method; for phosphates, uranium nitrate; for inorganic and ethereal sulphates, the Folin methods;[15] for neutral (total) sulphur, Benedict's (S. R.) method;[16] for total acidity, Folin's method; indican as described by Myers and Fine;[17] the sodium and potassium in part as directed by Folin,[18] the potassium

[12] Jour. Biol. Chem., 1910, viii, 405.
[13] Amer. Jour. Phys., 1905, xiii, 45.
[14] Ibid., 1907, xviii, 397.
[15] Jour. Biol. Chem., 1905-6, i, 131.
[16] Ibid., 1909, vi, 363.
[17] Post-Graduate, 1912, xxvii, 1144.
[18] Handbuch der Biochemichen Arbeitsmethoden, 1911, v, Pt. I, 292.

being estimated by the Drushel cobaltinitrite[19] method, and calcium and magnesium as described by McCrudden,[20] the calcium being estimated volumetrically.

The examination of the feces included certain of the simple routine tests and, in addition, estimation of moisture, nitrogen, fat, carbohydrate, mineral constituents, and the putrefactive products, indol and skatol. The moisture was obtained from the difference in the weight of the moist and air-dried feces. The nitrogen in the air-dried feces was estimated by the Kjeldahl method, the fat on the thoroughly dried feces by the Soxhlet method with anhydrous ether, and the carbohydrate with the Allihn method after hydrolysis of the feces as described by Mendel and Fine.[21] The mineral constituents were estimated in a similar manner to that described for urine. The indol and skatol were determined upon samples of the moist feces, with the aid of Ehrlich's aldehyde.[22] The feces slightly acidified with sulphuric acid were subjected to steam distillation until they failed to give a reaction with this reagent. A portion of the distillate was treated with the reagent to the maximum color, extracted with chloroform, and matched up in a Duboscq colorimeter with a similar extract prepared from mixtures of pure indol and skatol, showing the same color as the specimen under examination. It is believed that in this way an approximation of the amounts of both indol and skatol present was obtained.

Case Histories. A brief history of the cases upon which this study was made follows. A more detailed consideration of the case histories will be taken up in a subsequent paper of this series.

Case 1.—J. A. (Pellagra Commission, No. 1, Union County). Fairly well nourished man, aged sixty years; lesions rather slight; some scaling on hands; no evidence of diarrhea.

Case 2.—M. F. (Pellagra Commission, No. 1, Spartanburg County). Thin, pale, rather poorly nourished girl, aged seventeen years; no marked lesions; had had ovariotomy; no evidence of diarrhea.

Case 3.—M. McH. (Pellagra Commission, No. 2, Spartanburg County). Fairly well nourished woman, aged thirty-seven years; marked erythema on backs of hands and wrists; some erythema on face and mouth; developed acute mania while in hospital; *Strongyloides intestinalis* observed; moderate diarrhea.

Case 4.—C. T. (Pellagra Commission, No. 12, Spartanburg County). Well-nourished woman, aged forty years; very slight scaling on hands; not sufficiently definite for diagnosis; showed marked improvement.

[19] Amer. Jour. Sci., 1908, xxvi, 555; also Myers, Jour. Biol. Chem., 1909, vi, 115.

[20] Jour. Biol. Chem., 1909–10, vii, 83; 1911–12, x, 187.

[21] Ibid., 1911, x, 339.

[22] Herter and Foster, Jour. Biol. Chem., 1906, ii, 267.

Case 5.—R. N. (Pellagra Commission, No. 9, Spartanburg County). Moderately well-nourished woman, aged thirty-two years; some scaling on forearms; had had erythema before coming to hospital; recovered while in hospital.

Case 6.—M. L. (Pellagra Commission, No. 68, Spartanburg County). Tall, thin, poorly nourished woman, aged thirty-six years; said to have had tuberculosis, but no evidence of this could be found while patient was in hospital; some erythema and desquamation on back of hands; condition cleared up quickly.

Case 7.—E. C. (Pellagra Commission, No. 113, Spartanburg County). Well-nourished girl, aged twenty-years; marked thickening of palms of hands; extensive desquamation on back of hands, forearms, elbows, dorsal surfaces of feet, on and around knees; irregular girdle of desquamation about waist; erythema not evident; case recovered very quickly.

Case 8.—M. T. (Pellagra Commission, No. 114, Spartanburg County). Fairly well-nourished girl, aged about eighteen years; little erythema and desquamation on backs of hands and forearms; recovered quickly.

Case 9.—L. G. (Pellagra Commission, No. 115, Spartanburg County). Tall, thin, poorly nourished woman, aged twenty-eight years; scaling on forearms and backs of hands, also slightly in front of neck; dull mentally, although said to have been bright previous to attack.

Case 10.—M. S. (Pellagra Commission, No. 21, Spartanburg County). Rather tall, thin, poorly nourished woman, aged twenty-eight years; extensive lesions on backs of hands, forearms, arms, shoulders; girdle of erythema around neck; had ovarian cyst.

Case 11.—B. B. (Pellagra Commission, No. 158, Spartanburg County). Fairly well nourished woman, aged thirty-three years; slight erythema, desquamation and pigmentation on backs of wrists; lesions did not cover great area; had pulmonary tuberculosis as demonstrated by an examination of sputum.

Case 12.—A. N. (Pellagra Commission, No. 206, Spartanburg County). Fairly well-nourished woman, aged forty-three years; erythema, pigmentation, and desquamation up to middle of back of forearms.

Case 13.—C. McC. (Pellagra Commission, No. 170, Spartanburg County). Poorly nourished woman, aged thirty-five years; extensive desquamation and discoloration of skin on backs of hands, forearms, arms, shoulders, and around neck; palms of hands much thickened, also deep fissures at points of fingers; marked diarrhea; mentality evidently low; delusions and hallucinations; recovered.

Case 14.—W. L. (Pellagra Commission. No. 166, Spartanburg County). Fairly well nourished woman, aged thirty-five years;

mild desquamation on forearms. In this case no complete metabolism study was conducted, though an analysis of a twenty-four hour urine, gastric contents, and a qualitative examination of feces were made.

Gastric Analyses. The gastric analyses have shown very interesting results, especially when considered in connection with the indican estimations of the urine. In 8 of the 14 cases free hydrochloric acid was absent. The total acidities were low, and pepsin was generally absent, or present only in small quantity. Though considerable amounts of indican were observed in all cases, the quantity was excessive in those with anacidity, reaching in one case nearly a quarter of a gram a day. To emphasize this relationship the data given in Table I have been arranged in order of the amounts of the average daily indican elimination. This association of high indican elimination, with diminished acidity, is indicative of the strong inhibitory influence of the normally acid gastric juice upon putrefaction in the alimentary canal, or at least a certain type of putrefaction. As may be observed, some of the cases with low indicanuria and with free hydrochloric acid present in the gastric juice have a fairly high elimination of ethereal sulphates, but, in general, the total ethereal sulphates as well as the indoxyl-potassium-sulphate are increased in anacidity. Still another factor which may play a part is the activity of the pepsin, especially in the cases where hydrochloric acid is present. Case 12 (A. N.), with only a slightly subnormal acidity, but with a low peptic activity, showed an elimination of indican next in amount to the cases with anachlorhydria. In this series of cases, anacidity was found in about the same percentage of cases as reported by Johnson. Cecconi in the 12 cases which he examined made qualitative tests for indican. Though all of his cases showed an absence of free hydrochloric acid, no uniform relation appeared to exist between the anacidity and the indican, if we are to accept the qualitative tests for indican as representative of the quantitative elimination.

Food Intakes. In general the food intakes may be viewed as indicating the general condition of the patients, since they were allowed considerable liberty in the choice of food, and further provided with all they desired. The food intakes, as shown in Table III, amounted in all cases to from 75 to 110 grams of protein (12 to 18 grams of nitrogen) and 2300 to 3000 calories per day, with the exception of Case 2 (M. F.), during the first period of observation, and Case 3 (M. McH.) during both periods of observation. With the same exceptions all the cases showed a decided plus nitrogen balance during the period of observation, the degree of nitrogen retention being in proportion in general to the gain in weight as shown in the tabulated results. Case 2 (M. F.) during the first period of nine days, with an intake of 8.9 grams of nitrogen, showed a slight plus daily balance of 0.6 gram, though a decided plus balance was observed with the gain in weight during the second period. Case 3 (M. McH.), with a nitrogen intake of 5.0 grams during the first period, showed a minus daily balance of 1.4 grams, with a decided loss in weight. During the second period, with a nitrogen intake of 7.2 grams, she gained slightly in weight and showed a plus daily balance of 1 gram nitrogen. Corn in the form of corn-flakes was consumed in all the experiments, while Case 2 (M. F.) ate considerable quantities of corn-bread during the second period of observation. During this period of seven days she gained four pounds in weight, showed an average daily nitrogen balance of plus 4.1 grams, and otherwise showed general improvement.

Table I.—Gastric Analyses in Comparison with Certain Data of Urine and Feces. Tabulated in Order of Indican Elimination.

Patient.	Gastric analyses.					Urine.			Feces.	
	Volume of contents.	Free HCl.	Total acidity.	Lactic acid.	Peptic content[23] (Rose.)	Indican. Daily average.	Ethereal sulphates as SO_3 Daily average.	Ratio ethereal to inorganic SO_3.	Indol. Daily average.	Skatol. Daily average.
	C.c.					Mg.	Mg.		Mg.	Mg.
13—C. McC.	270	0	5	+	0.5	240	181	1 to 8	—	—
4—C. T.	90	0	8	+	0	208	194	1 to 7	5	10
	180	0	7	+	0					
	50	0	6	+	0					
1—J. A.	94	0	4	+	0	151	207	1 to 6	0	28
	130	0	4	++						
2—M. F.	135	0	14	+	0	128	126	1 to 8	0	2
	60	0	12	+	0	48	98	1 to 11	3	3
9—L. G.	70	0	12	++	0	95	203	1 to 6	11	34
	200	0	4		1					
3—M. McH.	188	0	7	+	2	69	97	1 to 7	2	9
	3	0	—		—	91	122	1 to 5	7	7
	140	0	20	++	7					
8—M. T.	140	0	8	++	0	88	161	1 to 11	3	12
11—B. B.	300	0	4	+	2	71	126	1 to 11	21	51
12—A. N.	65	18	43	..	0.5	65	124	1 to 17	Tr.	Tr.
	20	36	60	..	0.5					
14—W. L.	90	40	64	..	7	57	..	..	—	—
6—M. L.	135	15	32	+	7	45	149	1 to 11	0	1
5—R. N.	35	22	42	..	5	43	59	1 to 20	14	0
	270	14	38	..	10					
	45	26	54	+	7					
10—M. S.	170	8	26	..	16	23	117	1 to 11	2	19
	57	2	20	+	2					
7—E. C.	340	17	34	+	2	21	147	1 to 8	0	16

As the tabulated data show, the food intake, with the few exceptions mentioned, was generally up to the standard set by Atwater, and thus far above the minimum figures given by Chittenden. Both the protein and the calorific intake appear to have been

[23] Normally the peptic activity of the gastric juice after the Ewald meal is 8 to 11 by the Rose method.

ample as judged by these standards, though perhaps the proportion of fat to carbohydrate is a little higher than ordinarily found.

These data hardly allow of comparison with the results observed by Wussow and Grindley[24] at the Peoria State Hospital, for the reason that, with one exception, they were all women and, further, were below the normal average weight. At Peoria they found the general diet supplied per man per day: Protein, 73.5 grams; carbohydrate, 444 grams; fat, 56 grams; energy, 2568 calories; mineral matter, 23.23 grams, of which 1.07 grams were phosphorus; while the corn diet gave protein, 87.2 grams; carbohydrate, 463 grams; fat, 79 grams; energy, 2898 calories; total mineral matter, 27.91 grams, of which 1.64 grams were phosphorus. In general the diet of our patients appeared to furnish a somewhat larger amount of protein and fat, but a smaller amount of carbohydrate. The diets employed by Camurri are likewise of interest in this connection. His mixed diet contained 131 grams protein, 430 grams carbohydrate, 66 grams fat, 24.85 grams mineral matter, and had an energy equivalent of 2600 calories, while his corn diet contained 96 grams protein, 617 grams carbohydrate, 64 grams fat, 26.45 grams mineral matter, and furnished 3450 calories. Camurri calls attention to the small relative amounts of sodium and calcium furnished by certain dietaries. The figures which we have calculated for the salt intake would appear to indicate that in this particular our diet was adequate and well balanced.

Composition of the Urine. The discussion of the urine can best be prefaced by the general statement that the chemical composition of the urine in pellagra does not markedly differ from what one might observe in other individuals of a similar physical condition, except in one particular, the increase in the quantity of the bodies derived from intestinal putrefaction—namely, the ethereal sulphates, and especially the indican. It is perhaps of some significance that a few hyalin casts were observed in 6 out of the 14 cases, while in 2, traces of albumin were detected.

The volume of urine eliminated and the specific gravity gave figures such as one might have anticipated with the fluid and food intake, the average volumes varying between 300 and 1800 c.c., with specific gravities of 1.029 to 1.013. As shown in Table II, the figures for total acidity, chlorides, phosphates, inorganic sulphates, neutral sulphur, for the mineral elements, calcium, magnesium, sodium, and potassium (figures for sodium and potassium not included in table) are such as one might expect under the given dietary conditions, and the same may be said in regard to the various nitrogenous constituents.

[24] Report of the Pellagra Commission of the State of Illinois, 1911, p. 197.

TABLE II.—Summary Table. Average Daily Composition of the Urine.[25]

Patient.	Severity of condition.	Sex.	Age.	Wt. at beginn'g of exper't.	Weight at end of experi'nt.	Average weight	Length of experiment.	Date, 1912.	Volume of urine.	Specific gravity.	Qualitative and Microscopic examination of urine.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Undetermined N.	Creatinin coefficient.
			Yrs.	Lbs.	Lbs.	Kgms.			C.c.			Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	
1—J. A.	Moderately severe: chronic	M.	60	143	145	65.3	9	June 14 to 23	912	1.019	Occasional granular casts, occasional leucocytes.	9.40	7.68	.51	.08	.36	.02	0.75	5.5
2—M. F.	Moderately severe; chronic	F.	17	76	75	34.2	9	June 9 to 18	676	1.023	Faint trace of albumin on several occasions, moderate number of pus cells.	7.74	6.75	.25	.06	.20	0	0.48	5.8
2—M. F. Period 2	Moderately severe; chronic	F.	17	78	82	36.3	7	June 29 to July 6	877	1.020	Negative.	7.25	6.07	.30	.05	.22	0	0.61	6.1
3—M. McH.	Severe; acute	F.	37	88	85	39.0	10	June 9 to 19	304	1.028	Moderate number pus cells.	5.89	4.73	.33	.06	.21	.04	0.52	5.4
3—M. McH. Period 2	Severe; acute	F.	37	85	86	38.1	7	June 29 to July 6	318	1.029	Moderate number pus cells.	4.87	3.85	.21	.07	.22	.01	0.51	5.8
4—C. T.	Mild; chronic	F.	40	121	122	54.9	9	July 7 to 16	1439	1.018	Negative.	9.47	7.75	.50	.08	.35	.02	0.77	6.4
5—R. N.	Moderately severe; chronic	F.	32	87	88	39.7	9	July 7 to 16	1198	1.019	Occasional hyaline cast on one day.	8.05	6.09	.41	.08	.23	.09	1.15	5.8
6—M. L.	Moderately severe; chronic	F.	36	94	100	43.8	9	July 21 to 30	1256	1.019	Negative.	10.71	8.94	.56	.09	.30	0	0.82	6.9
7—E. C.	Moderately severe; acute	F.	20	145	150	66.9	7	August 5 to 12	1496	1.014	Occasional hyaline casts on two days.	8.08	6.50	.41	.13	.33	.01	0.70	4.9
8—M. T.	Mild; acute	F.	18	116	118	53.1	7	August 5 to 12	1444	1.017	Occasional hyaline casts on one day.	10.62	9.08	.49	.13	.36	0	0.56	6.8
9—L. G.	Moderately severe; chronic	F.	28	114	118	52.0	8	August 17 to 25	1393	1.015	Trace of albumin on first three days and occasional hyaline casts on first five days.	9.12	7.55	.48	.11	.26	.03	0.69	5.0
10—M. S.	Severe; chronic	F.	28	89	91	41.3	10	August 17 to 27	839	1.023	Negative.	8.64	7.24	.47	.11	.23	0	0.59	5.6
11—B. B.	Mild; chronic	F.	33	90	94	41.7	7	August 23 to 30	987	1.017	Moderate number pus and red blood cells observed on several days and an occasional hyaline cast on one day.	8.80	7.59	.41	.05	.21	.02	0.52	5.0
12—A. N.	Mild; acute	F.	43	91	95	42.2	7	September 12 to 19	1833	1.013	Negative.	12.88	10.92	.35	.05	.25	0	1.31	5.9
13—C. McC.	Severe; chronic	F.	35	70	72	32.0	2	September 18 to 20	646	1.019	Many pus cells.	9.45	7.66	.67	...	.14	.11	...	4.4

[25] The tables of the individual metabolism studies from which these average figures have been computed will be found at the end of the paper.

TABLE II (CONCLUDED).—Average Daily Composition of the Urine.

Patient.	In percentage of total nitrogen.						Urea.	Ammonia.	Uric acid.	Creatinin.	Creatin.	Total acidity terms n/10 acid.	Calcium as CaO.	Magnesium as MgO.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ratio ethereal: Inorganic SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican (indoxyl-potassium-sulphate).
	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Undetermined N.															
							Gms.	Gm.	Gm.	Gm.	Gm.	C.c.	Gm.	Gm.	Gms.	Gms.	Gms.		Gm.	Gm.	Mgms.
1	81.7	5.4	0.9	3.8	0.2	8.0	16.5	.61	.24	.97	.06	429	.18	.13	6.08	2.01	1.352	1 to 6	.207	.213	151
2	87.2	3.2	.8	2.6	...	6.2	14.5	.30	.18	.54	0	303	.16	.08	5.14	1.85	1.067	1 to 8	.126	.203	97
2	83.7	4.1	.7	3.0	...	8.5	13.0	.36	.15	.59	0	332	.20	.07	7.88	2.04	1.064	1 to 11	.098	.263	48
3	80.3	5.6	1.0	3.6	.7	8.8	10.1	.40	.18	.57	.12	262	.14	.08	1.73	1.35	.705	1 to 7	.097	.122	69
3	79.1	4.3	1.4	4.5	.2	10.5	8.3	.26	.21	.59	.03	195	.09	.05	3.21	1.32	.577	1 to 5	.122	.154	91
4	81.8	5.3	.8	3.7	.2	8.2	16.6	.61	.24	.94	.06	300	.27	.18	14.05	2.09	1.332	1 to 7	.194	.193	208
5	75.7	5.1	1.0	2.9	1.1	14.2	13.1	.50	.24	.62	.28	315	.15	.12	14.07	2.16	1.150	1 to 20	.059	.168	43
6	83.5	5.2	.8	2.8	...	7.7	19.2	.68	.27	.81	0	257	.16	.07	12.90	1.88	1.635	1 to 11	.149	.203	45
7	80.4	5.1	1.6	4.1	.1	8.7	13.9	.50	.39	.87	.03	353	.39	.25	8.98	2.17	1.189	1 to 8	.147	.250	21
8	85.5	4.6	1.2	3.4	...	5.3	19.5	.60	.39	.97	0	339	.26	.23	9.83	2.56	1.727	1 to 11	.161	.280	88
9	82.8	5.3	1.2	2.9	.3	7.5	16.2	.58	.33	.70	.09	348	.15	.18	9.40	1.92	1.275	1 to 6	.203	.233	95
10	83.8	5.4	1.3	2.7	...	6.8	15.5	.57	.33	.62	0	264	.33	.09	9.46	2.12	1.274	1 to 11	.117	.279	23
11	86.2	4.7	.6	2.4	.2	6.9	16.3	.50	.15	.57	.06	413	.22	.12	6.94	2.21	1.370	1 to 11	.126	.270	71
12	84.8	2.7	.4	2.0	...	10.1	22.7	.43	.15	.67	0	461	.30	.30	8.71	3.36	2.156	1 to 17	.124	.446	65
13	81.0	7.1	...	1.5	1.2	....	16.4	.81	...	.37	.35	367	.25	.09	4.50	2.17	1.462	1 to 8	.181	.208	240

ABLE III.—Average Daily Food Intake, with Nitrogen Balance.

Patient.	Protein.	Fat.	Carbo-hydrates.	Calories.	Calcium as CaO.	Magnesium as MgO.	Sodium as Na_2O.	Potassium as K_2O.	Phosphates as P_2O_5.	Chlorides as Cl.	Food N.	Urinary plus fecal. N.	N balance.	Approximate daily change in weight.
	Grams.	Grams.	Grams.		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Kilogram.
1—J. A.	79	126	260	2490	2.0	0.4	3.3	3.0	3.4	4.3	12.6	10.4	+2.2	+.10
2—M. F.	56	89	174	1720	1.8	0.3	2.7	2.6	2.7	3.6	8.9	8.3	+0.6	—.05
2—M. F. Period 2	78	103	315	2500	2.1	0.5	4.0	3.5	3.9	5.2	12.5	8.4	+4.1	+.26
3—M. McH.	31	36	122	940	1.2	0.1	0.8	0.1	1.7	1.4	5.0	6.4	—1.4	—.14
3—M. McH. Period 2	45	70	182	1540	1.3	0.2	2.1	2.1	2.0	2.9	7.2	6.2	+1.0	+.06
4—C. T.	79	98	278	2310	2.4	0.4	6.5	3.4	3.7	8.2	12.7	11.0	+1.7	+.05
5—R. N.	81	125	285	2590	2.4	0.4	7.1	3.3	3.9	8.9	12.9	10.4	+2.5	+.05
6—M. L.	91	134	281	2700	2.5	0.4	7.3	3.8	4.0	9.0	14.5	11.5	+3.0	+.30
7—E. C.	83	153	328	3020	2.3	0.5	4.6	4.0	3.8	6.8	13.3	9.9	+3.4	+.32
8—M. T.	88	77	372	2530	2.0	0.5	3.7	4.0	3.7	5.0	14.0	12.1	+1.9	+.13
9—L. G.	87	117	288	2550	2.3	0.4	4.4	4.0	3.8	6.5	13.9	10.6	+3.3	+.23
10—M. S.	76	109	261	2330	1.9	0.4	4.9	3.6	3.4	6.3	12.1	9.7	+2.4	+.09
11—B. B.	101	124	280	2640	2.6	0.5	4.2	4.3	4.4	5.3	16.1	11.1	+5.0	+.26
12—A. N.	113	131	339	3000	2.9	0.5	5.0	4.6	5.0	6.3	18.0	14.3	+3.7	+.26
13—C. McC.	106	125	190	2310	3.2	0.4	4.1	3.9	5.1	5.1	16.9	12.2	+4.7	+.45

TABLE IV.—Average Daily Composition of the Feces.

Patient.	Moist feces.	Air dry feces.	Moisture.	Nitrogen.	Nitrogen.	Protein utilization.	Ether extract.	Ether extract.	Fat utilization.	Carbohydrate as glucose.	Carbohydrate as glucose.	Carbohydrate utilization.	Ash.	Ash.	Calcium as CaO.	Magnesium as MgO.	Phosphatesas P_2O_5.	Chlorides as Cl.	Indol.	Skatol.
	Gms.	Gms.	Per cent.	Gms.	Per cent.	Per cent.	Gms.	Per cent.	Per cent.	Gms.	Per cent.	Per cent.	Gms.	Per cent.	Gms.	Gm.	Gms.	Gms.	Mgms.	Mgms.
1—J. A.	103	21.6	79	1.01	4.67	92	6.9	31.9	94	.6	2.57	99.8	4.49	20.8	1.40	.25	1.08	.23	0	28
2—M. F.	56	13.7	76	.51	3.71	94	3.2	23.2	96	.4	2.77	99.8	3.06	22.3	1.26	.18	.71	.06	0	2
2—M. F. Period 2	90	23.6	74	1.13	4.81	91	2.7	11.4	98	.9	3.62	99.7	4.95	21.0	2.00	.31	1.01	.11	3	3
3—M. McH.	59	9.7	84	.54	5.53	90	2.1	21.7	94	.2	2.57	99.8	2.16	22.3	.80	.12	.62	.15	2	9
3—M. McH. Period 2	182	22.0	88	1.36	6.27	81	3.2	14.6	95	1.7	7.57	99.0	3.96	18.0	1.08	.26	.76	.42	7	7
4—C. T.	113	24.4	78	1.49	6.10	88	4.5	18.3	95	.6	2.53	99.8	5.05	20.7	1.94	.33	1.39	.38	5	10
5—R. N.	233	36.4	84	2.35	6.45	81	2.9	8.0	98	3.3	9.00	99.0	5.68	15.6	2.17	.35	1.17	.85	14	0
6—M. L.	73	19.0	74	.75	3.97	94	4.5	23.7	97	.8	4.14	99.7	4.52	23.8	1.75	.34	1.44	.14	0	1
7—E. C.	148	28.6	79	1.84	6.43	87	6.4	22.2	96	1.1	4.05	99.6	4.49	15.7	1.70	.20	1.16	.43	0	16
8—M. T.	129	23.1	82	1.49	6.46	89	4.4	19.2	94	.9	4.00	99.8	3.74	16.2	1.49	.25	.97	.33	3	12
9—L. G.	200	31.0	85	1.47	4.75	89	10.9	35.2	91	1.2	3.90	99.6	5.86	18.9	1.99	.33	1.49	.26	11	34
10—M. S.	195	22.8	88	1.10	5.98	91	3.3	14.3	97	1.3	5.67	99.5	4.33	19.0	1.44	.30	.88	.40	2	19
11—B. B.	367	41.1	89	2.28	5.55	86	10.5	25.5	92	1.4	3.36	99.5	7.15	17.4	2.40	.40	1.60	.67	21	51
12—A. N.	147	27.4	81	1.41	5.13	92	5.3	19.4	96	1.2	4.53	99.6	5.84	21.3	2.65	.43	1.03	.41	Faint	Reaction
13—C. McC.	772	42.0	95	2.70	6.44	79	11.1	26.3	89	Trace	Trace	100.0	11.47	27.3	2.47	.36	2.44	2.19	0	0

The elimination of total nitrogen, urea, ammonia, uric acid, and creatinin is perhaps slightly below the so-called normal, though the constituents dependent upon exogenous factors, namely, the urea and ammonia, are in accord with the diet, and those of endogenous origin, namely, the uric acid and creatinin, are such as might be observed in other individuals of similar physical condition. Since Folin[26] first considered the distribution of the nitrogenous constituents in normal urine a large amount of work has been done on this subject. The large amount of data collected in the publications of the Referee Board[27] is unusually good confirmation of the statements of Folin in this particular. Although our data for the percentage of ammonia and undetermined nitrogen are slightly above the so-called normal figures and the other constituents slightly below, these differences are readily interpreted as due to the diet and the physical condition of the patients. As Folin has so well shown, with a reduction of the nitrogen-intake the urinary constituents of exogenous origin necessarily form a smaller percentage of the total nitrogen, and our figures for urea nitrogen, generally 83 per cent., are in accord with the nitrogen of the food. As the endogenous metabolism of the body was at a low state of activity, due to the rather poor physical condition of the individuals, we would hardly expect the uric acid (purin-free diet) and creatinin nitrogen to form an increased percentage of the total nitrogen. On the contrary the percentage of nitrogen in this form is rather below the normal.

An examination of the absolute amounts of the various nitrogenous constituents eliminated by the different individuals shows that in general the urea varied between 10 and 20 grams, the ammonia between 0.3 and 0.8 gram, the uric acid between 0.15 and 0.39 gram, and the creatinin between 0.4 and 1 gram. The absolute amount of the undetermined nitrogen in general falls within normal limits, though, as mentioned above, it forms a rather high percentage of the total nitrogen. In Cases 2 and 12, however, the figures are considerably higher than those found in other cases of the series.

The creatinin elimination is below normal in all cases, this fact being particularly well shown by the creatinin coefficients. Normally, coefficients of 7 to 11 are found, while here the figures vary between 5 and 7. As recently discussed by one of us[28] (Myers), the creatinin elimination is lowered in conditions associated with decreased body efficiency. This general inefficiency is further brought out by the fact that 10 out of the 14 cases eliminated creatin, though in only 2 cases was it present in large amount.

The elimination of the mineral constituents hardly requires

[26] Amer. Jour. Phys., 1905, xiii, 66.

[27] United States Dept. of Agric., Report No. 88, 1909, and No. 94. 1911.

[28] Amer. Jour. Med. Sci., 1910, cxxxix, 256.

further comment, except for that part containing an organic radicle, namely, the ethereal sulphates. Certain of the facts in this connection are best brought out in Table I, in which the data are arranged in order of the amounts of indican eliminated. The absolute amounts of the ethereal sulphates appear to be increased in a few instances, in which case there exists a low ratio to the ethereal sulphates. This is especially pronounced in the cases of anacidity, in which very large amounts of indican were eliminated. Here the indican appears to parallel the total ethereal sulphates, but apparently for the reason that the indican forms a considerable part of the total ethereal sulphates. The low ratio of inorganic to ethereal sulphates was observed in the cases reported by Camurri.

Composition of the Feces. The examination of the feces as shown in Table IV revealed widely varying conditions as to volume and consistency—watery stools, soft stools, well-formed stools, and hard stools—the average daily elimination amounting to from 60 to 700 grams of moist feces and 20 to 40 grams of air-dried feces, the moisture varying between 75 and 95 per cent. The microscopic examination of the feces has not yielded data of special significance, though in certain cases evidence of digestive inefficiency has been observed, and in some cases considerable mucus, probably in part due to the diarrhea. In several instances strongly positive fermentation tests with Schmidt tubes have been observed, notably in Case 3 (M. McH.), period 2, though the estimation of the carbohydrate content of the feces ought to be a more adequate criterion. The daily fecal nitrogen was found as low as 0.5 gram where the nitrogen intake was low, and as high as 2.7 grams in the reverse condition, accompanied by severe diarrhea. These figures fall within the normal limits, however, and the percentage of nitrogen in the air-dried feces cannot be said to be excessive, though perhaps slightly above the normal average in a few cases. In 3 cases (Case 3, period 2, Case 5, and Case 13) the so-called protein utilization was below the other figures observed, but probably in part due to the diarrhea. The daily fat eliminated varied from 2 to 11 grams, with percentages of the air-dried feces ranging between 8 and 35 per cent. The fat utilization was good in all cases, though the figures for Cases 9, 11, and 13 were slightly below that observed in other cases. The figures for the carbohydrate were from direct estimation, and are therefore much more reliable than the results generally reported as determined by difference. The tabulated data show that the utilization was 99.5 to 99.8 per cent. in all but 2 cases (Case 3, period 2, and Case 5), where the utilization was 99 per cent. and the percentage content in the feces 7.6 and 9 per cent. These results show quite conclusively that the ability of the pellagrins to absorb their food is only slightly if at all impaired and that this is in part due to the diarrhea. The data on the feces reported by Camurri bring out similar points, though he has only five sets of average figures with which to make comparison.

The examination of the feces has included quantitative determinations of calcium, magnesium, phosphates, chlorides, as shown in Table IV, and also of sodium and potassium. These data have not revealed any apparent derangement of mineral metabolism, though certain interesting relationships have been brought to light, which will be presented in a subsequent paper.

The feces of pellagrous individuals have a most characteristic aromatic odor, and the estimations of the indol and skatol would indicate that this odor was due to the large amounts of these aromatic bodies found to be present. Normally only traces of these bodies are present, and from the investigation of Herter[29] and also of one of us[30] (Myers) with Fisher and Diefendorf, the amounts detected, especially of skatol, may be regarded as decidedly abnormal and indicative of peculiar bacterial conditions in the intestine. When these results are compared with the acidity determinations in the gastric juice, some relation between the amount of skatol formation and anacidity is apparent.

Summary. The ability of individuals suffering from pellagra to utilize the various foodstuffs as indicated by our series of fifteen experiments appears to be only slightly if at all below the normal.

The elimination of mineral and nitrogenous constituents in the urine is such as would be anticipated under the dietary and physical conditions of the individuals. A lowered physiologic efficiency is indicated by the low creatinin coefficients and the elimination of small amounts of creatin in the urine. The presence of a few hyalin casts in about 45 per cent. of the cases points to some possible irritation of the kidney.

Anacidity is a condition common in pellagra, found in eight of our fourteen cases. It is generally associated with an entire absence of pepsin, or with pepsin in only very minute quantities.

Individuals suffering from pellagra show a marked indicanuria, which is excessive in the cases with gastric inefficiency. Though the ethereal sulphate hardly parallels the indoxyl-potassium sulphate, the quantities eliminated are much higher where anacidity exists and they furthermore hold a higher ratio to the inorganic sulphates.

The feces contain decidedly abnormal amounts of indol and skatol, especially the latter.

The presence of excessive amounts of indican in the urine, associated with a high elimination of ethereal sulphates, when considered in connection with the abnormal amounts of indol and skatol in the feces, points to some unusual bacterial conditions in the intestine. From the data at hand this putrefaction would appear to take place rather high up in the intestine.

[29] Bacterial Infections of the Digestive Tract, 1907, p. 239.

[30] Zentralbl. f. Stoffwechsel, 1908, ix, 849; Amer. Jour. Insanity, 1909, lxv, 607.

Analyses of Daily Urines Including Daily Nitrogen Balance.

Case I.—Mr. J. A. (Pellagra Commission No. 1, Union County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_4.	Ethereal sulphates as SO_4.	Neutral sulphur as SO_4.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
1912.		C.c.		C.c.	Gms.	Gms.	Gms.	Gm.	Gm.	Mgms.	Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	Gms.	Gms.	Gms.
June 14 to 15	6	1185	1.020	425	9.78	2.02	1.445	.283	.242	102	11.31	9.39	.51	.11	.38	.05	1.01	12.34	11.8	— .5
June 15 to 16	7	1200	1.015	301	6.00	1.76	1.131	.227	.161	144	8.94	7.08	.43	.08	.34	.02	1.01	9.95	12.7	+2.7
June 16 to 17	8	630	1.020	393	3.40	2.14	1.158	.107	.210	120	7.42	5.74	.55	.07	.38	0	1.01	8.43	12.3	+3.9
June 17 to 18	9	1085	1.015	393	4.80	2.02	1.393	.125	.190	212	8.68	6.97	.53	.05	.34	0	1.01	9.69	11.3	+1.6
June 18 to 19	10	675	1.021	403	4.50	2.06	1.407	.172	.153	195	8.39	6.75	.55	.06	.34	.05	1.01	9.40	14.8	+5.4
June 19 to 20	11	855	1.020	538	5.00	2.07	1.574	.174	.258	147	10.10	8.56	.30	.08	.34	.05	1.01	11.11	12.4	+1.3
June 20 to 21	12	960	1.016	481	6.10	1.94	1.331	.275	.204	100	9.42	7.72	.60	.10	.34	.04	1.01	10.43	14.6	+4.2
June 21 to 22	13	860	1.022	525	8.06	2.07	1.720	.247	.234	189	10.43	8.52	.61	.09	.41	0	1.01	11.44	12.4	+1.0
June 22 to 23	14	762	1.018	405	7.10	2.02	1.407	.235	.189	150	9.91	8.36	.49	.07	.40	0	1.01	10.92	12.6	+1.7
Average . .	6 to 14	912	1.019	429	6.08	2.01	1.352	.207	.213	151	9.40	7.68	.51	.08	.36	.02	1.01	10.41	12.6	+2.2

Urine acid in reaction to litmus on all days tabulated. No albumin or sugar detected on any day. Microscopic examination of urinary sediment showed occasional granular casts and leukocytes on all days except the twelfth.

CASE II.—Miss M. F. (Pellagra Commission No. 1, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
1912.		C.c.		C.c.	Gms.	Gms.	Gms.	Gm.	Gm.	Mgms.	Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	Gms.	Gms.	Gms.
June 9 to 10	1	545	1.024	303	5.30	1.40	.798	.121	.230	81	6.08	5.07	.37	.06	.19	0	.51	5.58	9.5	+3.9
June 10 to 11	2	730	1.020	308	4.70	1.96	.993	.129	.243	29	7.38	6.22	.25	.06	.21	0	.51	7.89	10.2	+2.3
June 11 to 12	3	710	1.021	373	4.80	2.14	1.303	.139	.266	32	8.72	8.01	.30	.07	.20	0	.51	9.23	8.8	— .4
June 12 to 13	4	413	1.030	373	4.40	2.11	.999	.140	.212	162	8.09	7.03	.20	.07	.21	0	.51	8.60	8.5	— .1
June 13 to 14	5	765	1.023	273	6.00	1.88	1.166	.145	.187	139	9.18	8.06	.20	.07	.20	0	.51	9.69	10.8	+1.1
June 14 to 15	6	885	1.020	325	6.20	2.11	1.132	.149	.176	139	8.40	7.30	.24	.06	.20	0	.51	8.91	8.8	— .1
June 15 to 16	7	1020	1.016	186	8.04	1.63	.912	.123	.163	106	7.25	6.21	.28	.05	.18	0	.51	7.76	8.6	+ .8
June 16 to 17	8	560	1.017	217	2.80	1.40	.761	.089	.188	65	5.50	4.63	.20	.05	.18	0	.51	6.01	5.0	—1.0
June 17 to 18	9	460	1.034	370	4.00	1.98	1.540	.097	.167	121	9.09	8.17	.22	.07	.21	0	.51	9.60	9.7	+ .1
Average . .	1 to 9	676	1.023	303	5.14	1.85	1.067	.126	.203	97	7.74	6.75	.25	.06	.20	0	.51	8.25	8.9	+0.6

Urine acid in reaction to litmus on all days. Faint trace of albumin detected on third, fifth, and seventh day of observation. Microscopic examination of urine revealed a moderate number of pus and many epithelial cells on all days.

CASE II.—Miss M. F. (Period 2.)

June 29 to 30	1	440	1.030	308	5.80	1.65	.885	.052	.156	68	5.44	4.43	.28	.06	.22	0	1.13	6.57	16.5	+9.9
June 30 to July 1	2	990	1.015	353	7.80	1.81	.896	.106	.172	44	6.84	5.47	.44	.05	.22	0	1.13	7.97	10.0	+2.0
July 1 to 2	3	1320	1.014	332	11.10	2.49	1.079	.114	.397	63	7.89	6.59	.29	.06	.22	0	1.13	9.02	8.8	— 2
July 2 to 3	4	778	1.020	303	5.80	2.11	1.014	.092	.284	44	7.09	5.66	.15	.04	.22	0	1.13	8.22	12.0	+3.8
July 3 to 4	5	1155	1.020	315	8.60	1.99	1.243	.099	.321	33	8.37	7.08	.36	.03	.23	0	1.13	9.50	13.9	+4.4
July 4 to 5	6	605	1.022	363	7.35	2.17	1.249	.116	.254	39	7.78	6.62	.31	.07	.21	0	1.13	8.91	13.9	+5.0
July 5 to 6	7	850	1.020	350	8.70	2.07	1.079	.105	.255	44	7.36	6.63	.24	.04	.22	0	1.13	8.49	12.8	+4.3
Average . .	1 to 7	877	1.020	332	7.88	2.04	1.064	.098	.263	48	7.25	6.07	.30	.05	.22	0	1.13	8.38	12.5	+4.1

Urine acid in reaction to litmus on all days. No albumin or sugar detected. The microscopic examination generally showed a moderate number of epithelial cells and a few leukocytes.

CASE III.—Mrs. M. McH. (Pellagra Commission No. 2, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
1912.		C.c.		C.c.	Gms.	Gms.	Gms.	Gm.	Gm.	Mgms.	Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	Gms.	Gms.	Gms.
June 9 to 10	1	505	1.022	456	3.46	2.01	1.243	.104	.203	98	8.30	6.65	.46	.07	.27	0	.54	8.84	8.4	— .4
June 10 to 11	2	267	1.029	328	1.90	1.46	.527	.093	.179	55	4.89	4.14	.21	.07	.22	0	.54	5.43	4.6	— .8
June 11 to 12	3	205	1.033	213	1.30	1.22	.731	.089	.127	93	4.93	3.99	.27	.05	.20	.01	.54	5.47	5.2	— .3
June 12 to 13	4	293	...	373	0.86	2.02	.952	.125	.133	102	7.37	6.00	.40	.04	.25	.05	.54	7.91	4.5	—3.4
June 13 to 14	5	285	1.030	208	0.96	1.16	.798	.132	.093	81	7.33	5.82	.32	.12	.20	.05	.54	7.87	6.2	—1.7
June 14 to 15	6	190	1.032	170	0.80	0.95	.547	.099	.067	65	4.38	3.89	.21	.06	.19	0	.54	4.92	7.2	+2.3
June 15 to 16	7	325	1.027	223	1.30	1.30	.547	.063	.138	49	5.46	4.26	.36	.03	.20	.05	.54	6.00	5.2	— .8
June 16 to 17	8	285	1.025	199	0.90	1.07	.608	.072	.085	32	5.16	4.06	.29	.03	.15	.04	.54	5.70	5.2	— .5
June 17 to 18	9	365	1.028	256	2.90	1.32	.861	.094	.093	75	6.20	4.98	.36	.05	.19	.11	.54	6.74	3.1	—3.6
June 18 to 19	10	315	1.030	198	2.90	1.03	.433	.095	.151	40	4.80	3.48	.41	.04	.19	.05	.54	5.34	0.8	—4.5
Average . .	1 to 10	304	1.028	262	1.73	1.35	.705	.097	.122	69	5.89	4.73	.33	.06	.21	.04	.54	6.43	5.0	—1.4

Urine acid in reaction on all days. No albumin or sugar present. The microscopic examination of the urinary sediment generally showed a moderate number of pus and epithelial cells.

CASE III.—Mrs. M. McH. (Period 2.)

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
June 29 to 30	1	540	1.022	250	5.87	1.68	.911	.125	.186	108	7.15	5.91	.11	.10	.27	.03	1.36	8.51	9.4	+ .9
June 30 to July 1	2	290	1.030	183	2.10	1.04	.468	.099	.149	108	3.50	2.77	.21	.03	.17	.02	1.36	4.86	5.0	+ .1
July 1 to 2	3	267	1.031	216	2.40	1.29	.536	.134	.171	113	5.00	3.82	.25	.07	.22	0	1.36	6.36	6.2	— .2
July 2 to 3	4	350	1.029	103	4.20	1.18	.534	.128	.146	95	4.89	3.82	.17	.04	.21	.03	1.36	6.25	6.4	+ .1
July 3 to 4	5	270	1.031	..	2.20	1.68	.656	.100	.160	63	5.75	3.95	.95	.11	.27	0	1.36	7.11	9.0	+1.9
July 4 to 5	6	200	1.032	..	2.60	1.07	.351	.074	.131	63	3.10	1.49	1.06	.10	.18	0	1.36	4.46	4.6	+ .1
July 5 to 6	7	308	1.027	223	3.10	1.30	.582	.123	.135	84	4.72	3.59	.30	.05	.23	0	1.36	6.08	9.4	+3.3
Average . .	1 to 7	318	1.029	195*	3.21	1.32	.577	.122	.154	91	4.87	3.85*	.21*	.07	.22	.01	1.36	6.23	7.2	+1.0

Urine alkaline on fifth and sixth day, acid on other days. No albumin or sugar present. Urinary sediment showed uniformly a moderate number of leukocytes.

* Average data for acidity, urea, and ammonia do not include urines of fifth and sixth day.

Case IV.—Mrs. C. T. (Pellagra Commission No. 12, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
1912.		C.c.		C.c.	Gms.	Gms.	Gms.	Gm.	Gm.	Mgms.	Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	Gms.	Gms.	Gms.
July 7 to 8	1	1340	1.013	255	10.65	1.50	1.148	.194	.175	284	7.89	6.32	.48	.07	.32	0	1.49	9.38	11.5	+2.1
July 8 to 9	2	710	1.025	225	8.30	1.63	1.196	.195	.156	228	7.96	6.51	.36	.09	.28	0	1.49	9.45	10.9	+1.4
July 9 to 10	3	1135	1.018	252	10.74	2.04	1.259	.197	.207	187	9.05	7.37	.46	.08	.31	.03	1.49	10.54	12.9	+2.4
July 10 to 11	4	805	1.025	245	11.00	2.05	1.254	.170	.181	189	8.50	7.16	.41	.08	.30	0	1.49	9.99	12.9	+1.9
July 11 to 12	5	1780	1.015	284	15.78	2.45	1.491	.183	.264	176	10.89	8.84	.63	.06	.47	0	1.49	12.38	11.7	— .7
July 12 to 13	6	1720	1.020	281	19.44	2.55	1.498	.250	.122	227	10.45	8.74	.45	.09	.47	0	1.49	11.94	14.4	+2.5
July 13 to 14	7	1960	1.015	390	17.34	2.16	1.405	.175	.184	160	10.58	8.59	.47	.06	.33	.03	1.49	12.07	14.5	+2.4
July 14 to 15	8	1660	1.015	329	14.76	2.04	1.184	.190	.234	199	9.25	7.91	.57	.08	.31	.05	1.49	10.74	13.7	+3.0
July 15 to 16	9	1845	1.015	440	18.40	2.37	1.556	.192	.213	221	10.64	8.30	.64	.07	.36	.05	1.49	12.13	12.4	+ .3
Average . .	1 to 9	1439	1.018	300	14.05	2.09	1.332	.194	.193	208	9.47	7.75	.50	.08	.35	.02	1.49	10.96	12.7	+1.7

Urine acid in reaction to litmus on all days. Tests for albumin and sugar negative. Microscopic examination showed the presence of a few leukocytes and a moderate number of epithelial cells on the various days.

Case V.—Mrs. R. N. (Pellagra Commission No. 9, Spartanburg County).

July 7 to 8	1	820	1.020	235	9.90	1.67	.862	.016	.188	27	5.84	4.55	.34	.07	.20	.07	2.35	8.19	10.9	+2.8
July 8 to 9	2	530	1.027	363	6.95	1.96	1.053	.060	.128	48	6.75	4.93	.33	.10	.22	.11	2.35	9.10	10.6	+1.5
July 9 to 10	3	800	1.023	278	9.95	2.25	1.047	.064	.192	23	7.78	5.99	.30	.11	.23	.11	2.35	10.13	11.9	+1.8
July 10 to 11	4	980	1.018	330	11.00	2.30	1.084	.033	.142	33	7.11	5.61	.44	.09	.22	.08	2.35	9.46	13.2	+3.7
July 11 to 12	5	1575	1.017	279	18.72	2.41	1.200	.090	.232	59	9.21	7.00	.55	.07	.25	.09	2.35	11.56	11.6	0
July 12 to 13	6	1335	1.017	240	17.25	2.12	1.303	.053	.270	54	9.54	6.51	.37	.08	.23	.08	2.35	11.89	14.7	+2.8
July 13 to 14	7	1545	1.017	356	17.60	2.25	1.273	.059	.095	37	9.24	6.15	.46	.09	.23	.11	2.35	11.59	14.1	+2.5
July 14 to 15	8	1760	1.015	378	17.64	2.21	1.210	.050	.126	43	8.54	7.05	.45	.08	.24	.10	2.35	10.89	12.5	+1.6
July 15 to 16	9	1440	1.018	379	17.62	2.24	1.325	.107	.143	60	8.39	6.99	.49	.07	.24	.08	2.35	10.74	15.3	+4.6
Average . .	1 to 9	1198	1.019	315	14.07	2.16	1.150	.059	.168	43	8.05	6.09	.41	.08	.23	.09	2.35	10.40	12.9	+2.5

Urine acid in reaction to litmus on all days. Tests for albumin and sugar negative. The microscopic examination showed an occasional hyaline cast on the fifth day, and a few leukocytes and epithelial cells on all days.

Case VI.—Mrs. M. L. (Pellagra Commission No. 68, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican.	Total N.	Urea N.	Ammonia N	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
1912.		C.c.		C.c.	Gms.	Gms.	Gms.	Gm.	Gm.	Mgms.	Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	Gms.	Gms.	Gms.
July 21 to 22	1	700	1.020	194	7.70	1.30	1.067	.110	.205	37	7.97	6.50	.40	.10	.30	0	.75	8.72	8.7	0
July 22 to 23	2	590	1.018	265	7.60	1.68	1.318	.125	.213	44	8.09	6.50	.40	.09	.28	0	.75	8.84	12.0	+3.2
July 23 to 24	3	1100	1.017	250	9.68	1.51	1.219	.127	.182	42	8.39	7.10	.49	.07	.26	0	.75	9.14	11.7	+2.6
July 24 to 25	4	1338	1.020	259	14.10	1.93	1.695	.192	.181	59	11.67	9.95	.63	.08	.31	0	.75	12.42	16.9	+4.5
July 25 to 26	5	1410	1.018	278	11.25	1.91	1.706	.218	.206	51	11.85	10.08	.50	.10	.29	0	.75	12.60	17.4	+4.8
July 26 to 27	6	1560	1.018	...	17.04	2.02	1.811	.164	.231	44	11.00	8.83	1.63	.09	.30	0	.75	11.75	17.8	+6.0
July 27 to 28	7	1440	1.017	...	14.60	2.03	1.551	.147	.189	37	10.26	6.81	1.66	.09	.29	0	.75	11.01	11.7	+ .7
July 28 to 29	8	1280	1.019	182	9.36	1.68	1.961	.125	.223	44	11.78	9.30	.90	.10	.34	0	.75	12.53	13.9	+1.4
July 29 to 30	9	1885	1.020	371	24.70	2.85	2.390	.135	.195	49	15.37	13.19	.62	.13	.36	0	.75	16.12	20.6	+4.5
Average . .	1 to 9	1256	1.019	257*	12.90	1.88	1.635	.149	.203	45	10.71	8.94*	.56*	.09	.30	0	.75	11.46	14.5	+3.0

Urine acid in reaction to litmus on all days, except the sixth and seventh Albumin and sugar absent. The microscopic examination of the urinary sediment showed a few epithelial cells and a moderate number of leukocytes.

* Average data for acidity, urea, and ammonia do not include urines of the sixth and seventh day.

Case VII.—Miss E. C. (Pellagra Commission No. 113, Spartanburg County).

August 5 to 6	1	1200	1.015	288	6.80	1.78	1.128	.162	.154	7	7.70	6.16	.44	.13	.31	.02	1.84	9.54	13.4	+3.9
August 6 to 7	2	1325	1.014	413	9.10	2.30	1.102	.127	.269	11	7.66	5.96	.55	.13	.31	.03	1.84	9.50	13.2	+3.7
August 7 to 8	3	1675	1.012	344	14.41	2.21	1.213	.153	.267	21	8.27	6.60	.43	.13	.33	.04	1.84	10.11	12.8	+2.7
August 8 to 9	4	710	1.020	215	7.00	1.33	.782	.088	.272	18	5.41	4.34	.22	.11	.23	0	1.84	7.25	13.2	+5.9
August 9 to 10	5	1600	1.013	426	9.12	2.24	1.198	.152	.269	35	8.37	6.67	.43	.13	.37	0	1.84	10.21	13.3	+3.1
August 10 to 11	6	2560	1.010	416	10.92	2.63	1.420	.162	.293	32	9.64	7.83	.47	.12	.39	0	1.84	11.48	14.6	+3.1
August 11 to 12	7	1400	1.017	371	7.42	2.68	1.580	.183	.225	26	9.49	7.94	.32	.13	.35	0	1.84	11.33	13.2	+1.9
Average . .	1 to 7	1496	1.014	353	8.98	2.17	1.189	.147	.250	21	8.08	6.50	.41	.13	.33	.01	1.84	9.92	13.4	+3.5

Urine acid in reaction to litmus on all days No albumin or sugar detected. The microscopic examination showed the presence of an occasional hyaline cast on the first and seventh day and a few leukocytes and epithelial cells on all days.

Case VIII.—Miss M. T. (Pellagra Commission No. 114, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_4.	Ethereal sulphates as SO_4.	Neutral sulphur as SO_4.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
1912.		C.c.		C.c.	Gms.	Gms.	Gms.	Gm.	Gm.	Mgms.	Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	Gms.	Gms.	Gms.
August 5 to 6	1	1220	1.018	319	11.44	2.23	1.670	.195	.257	88	11.50	9.24	.54	.13	.36	0	1.49	13.99	14.4	+ .4
August 6 to 7	2	1900	1.013	342	16.34	2.56	1.668	.172	.336	88	10.23	9.14	.56	.12	.38	0	1.49	11.72	15.5	+3.8
August 7 to 8	3	1445	1.017	356	13.50	2.53	1.815	.185	.402	165	11.04	9.52	.51	.13	.38	0	1.49	13.53	12.6	+1.1
August 8 to 9	4	2400	1.011	444	7.20	3.30	1.794	.156	.254	71	12.26	10.02	.62	.13	.45	0	1.49	13.75	12.6	+ .8
August 9 to 10	5	1430	1.016	307	9.30	2.57	1.908	.158	.264	60	11.50	10.00	.40	.18	.40	0	1.49	12.99	14.6	+1.6
August 10 to 11	6	1130	1.016	324	6.00	2.22	1.771	.135	.210	62	10.62	9.02	.47	.13	.33	0	1.49	12.11	11.6	— .5
August 11 to 12	7	580	1.027	283	5.00	2.54	1.464	.130	.237	77	8.18	6.65	.34	.11	.22	0	1.49	9.67	17.2	+7.5
Average . .	1 to 7	1444	1.017	339	9.83	2.56	1.727	.161	.280	88	10.62	9.08	.49	.13	.36	0	1.49	12.11	14.0	+1.9

Urine acid to litmus on all days. No albumin or sugar present. An occasional hyaline cast observed in the urinary sediment of the first day and a few leukocytes and epithelial cells on all days.

Case IX.—Miss L. G. (Pellagra Commission No. 115, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_4.	Ethereal sulphates as SO_4.	Neutral sulphur as SO_4.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
August 17 to 18	1	1320	1.012	330	5.40	1.44	1.042	.188	.215	94	7.66	6.13	.48	.09	.25	.02	1.47	9.13	10.7	+1.6
August 18 to 19	2	1017	1.016	255	6.00	1.74	.988	.196	.216	88	7.55	6.04	.27	.12	.26	.04	1.47	9.02	9.9	+ .9
August 19 to 20	3	780	1.020	303	6.60	1.65	1.125	.231	.187	110	8.33	7.05	.43	.12	.25	.03	1.47	9.80	12.1	+2.3
August 20 to 21	4	1260	1.015	419	9.90	1.98	1.362	.204	.217	82	10.04	8.24	.57	.13	.26	.03	1.47	11.51	15.4	+3.9
August 21 to 22	5	1860	1.014	365	13.00	2.50	1.435	.203	.214	104	9.91	8.47	.47	.11	.29	.03	1.47	11.38	13.6	+2.2
August 22 to 23	6	1360	1.016	349	10.00	1.85	1.309	.216	.183	88	9.21	7.62	.41	.12	.25	.05	1.47	10.68	15.7	+5.0
August 23 to 24	7	1910	1.015	380	12.80	2.18	1.558	.228	.334	98	10.52	8.71	.65	.12	.30	.02	1.47	11.99	16.6	+4.6
August 24 to 25	8	1640	1.012	385	11.60	2.00	1.383	.159	.296	93	9.73	8.14	.55	.09	.25	.03	1.47	11.20	16.8	+5.6
Average . .	1 to 8	1393	1.015	348	9.40	1.92	1.275	.203	.233	95	9.12	7.55	.48	.11	.26	.03	1.47	10.60	13.9	+3.3

Urine acid to litmus on all days. Trace of albumin detected on the first three days of period but not on days following. No sugar present. The microscopic examination showed occasional hyaline casts on the first five days and a few leukocytes and epithelial cells on all days.

CASE X.—Mrs. M. S. (Pellagra Commission No. 21, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
1912.		C.c.		C.c.	Gms.	Gms.	Gms.	Gm.	Gm.	Mgms.	Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	Gms.	Gms.	Gms.
August 17 to 18	1	1640	1.011	173	10.03	2.17	1.112	.110	.492	25	10.90	9.16	.50	.11	.24	0	1.10	12.00	9.9	—2.1
August 18 to 19	2	675	1.020	172	8.55	1.76	1.001	.099	.402	18	6.44	5.10	.40	.10	.22	0	1.10	7.54	10.1	+2.6
August 19 to 20	3	525	1.025	162	6.45	1.51	.912	.118	.218	17	5.69	4.48	.38	.08	.19	0	1.10	6.79	9.0	+2.2
August 20 to 21	4	750	1.025	205	9.00	2.00	1.206	.130	.214	22	8.36	7.30	.35	.12	.23	0	1.10	9.46	12.0	+2.5
August 21 to 22	5	985	1.021	285	11.30	2.22	1.308	.132	.237	31	8.91	7.45	.55	.11	.23	0	1.10	10.01	12.6	+2.6
August 22 to 23	6	766	1.027	320	10.85	2.24	1.360	.118	.288	19	8.21	6.84	.55	.11	.23	0	1.10	9.31	13.8	+4.5
August 23 to 24	7	650	1.028	358	8.15	2.12	1.382	.098	.228	18	8.70	7.30	.48	.10	.22	0	1.10	9.80	13.0	+3.2
August 24 to 25	8	850	1.026	350	10.75	2.45	1.513	.133	.290	29	10.16	8.60	.46	.10	.25	0	1.10	11.26	14.0	+2.7
August 25 to 26	9	705	1.025	265	9.50	2.19	1.305	.109	.184	19	8.57	7.18	.49	.10	.22	0	1.10	9.67	12.0	+2.3
August 26 to 27	10	840	1.018	353	10.05	2.55	1.643	.139	.234	29	10.43	9.02	.51	.13	.24	0	1.10	11.53	14.6	+3.1
Average . .	1 to 10	839	1.023	264	9.46	2.12	1.274	.117	.279	23	8.64	7.24	.47	.11	.23	0	1.10	9.74	12.1	+2.4

Urine acid to litmus on all days. No albumin or sugar present. The microscopic examination showed uniformly a few leukocytes and many epithelial cells in the sediment.

CASE XI.—Mrs. B. B. (Pellagra Commission No. 158, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
August 23 to 24	1	1200	1.011	380	6.00	2.17	1.223	.137	.310	81	9.01	7.78	.32	.04	.20	.03	2.28	11.29	15.9	+4.6
August 24 to 25	2	800	1.016	377	5.10	2.12	1.292	.091	.218	31	8.07	7.02	.40	.06	.21	.01	2.28	10.35	14.6	+4.2
August 25 to 26	3	700	1.018	456	6.70	2.10	1.195	.100	.200	40	8.06	6 65	.46	.07	.22	.07	2.28	10.34	14.1	+3.7
August 26 to 27	4	840	1 018	368	6.20	1.94	1.303	.147	.240	84	8.36	7.10	.38	.04	.20	.02	2.28	10.64	15.4	+4.8
August 27 to 28	5	970	1.016	425	6.80	2.34	1.321	.085	.271	48	8.51	7.67	.44	.04	.21	0	2.28	10.79	16.7	+5.9
August 28 to 29	6	1200	1.019	450	8.90	2.37	1.465	.150	.340	110	9.78	8.51	.46	.04	.22	.01	2.28	12.06	18.7	+6.6
August 29 to 30	7	1200	1.020	438	8.90	2.43	1.442	.170	.310	101	9.71	8.43	.40	.04	.23	.01	2.28	11.99	17.1	+5.1
Average . .	1 to 7	987	1.017	413	6.94	2.21	1.370	.126	.270	71	8.80	7.59	.41	.05	.21	.02	2.28	11.08	16.1	+5.0

Urine acid to litmus on all days. Tests for albumin and sugar negative. Microscopic examination showed the presence of a considerable number of red blood cells and leukocytes on the first three days, and in addition an occasional hyaline cast on the fourth day, moderate number of leukocytes, epithelial cells, and uric acid crystals on remaining days.

CASE XII.—Mrs. A. N. (Pellagra Commission No. 206, Spartanburg County).

Date.	Day.	Volume of urine.	Specific gravity.	Total acidity terms n/10 acid.	Chlorides as NaCl.	Phosphates as P_2O_5.	Inorganic sulphates as SO_3.	Ethereal sulphates as SO_3.	Neutral sulphur as SO_3.	Indican.	Total N.	Urea N.	Ammonia N.	Uric acid N.	Creatinin N.	Creatin N.	Fecal N.	Urinary plus fecal N.	Food N.	N Balance.
1912.		C.c.		C.c.	Gms.	Gms.	Gms.	Gm.	Gm.	Mgms.	Gms.	Gms.	Gm.	Gm.	Gm.	Gm.	Gms.	Gms.	Gms.	Gms.
September 12 to 13	1	2130	1.010	484	7.57	3.23	2.191	.124	.461	67	13.44	11.65	.40	.05	.26	0	1.41	14.85	18.2	+3.3
September 13 to 14	2	1613	1.014	429	7.82	3.04	2.061	.114	.559	83	12.45	10.33	.47	.05	.26	0	1.41	13.86	18.2	+4.3
September 14 to 15	3	2060	1.013	462	11.55	3.20	2.215	.130	.695	71	13.91	11.29	.40	.06	.24	0	1.41	15.32	16.4	+1.1
September 15 to 16	4	1625	1.014	442	8.50	4.01	2.022	.088	.385	0	11.68	10.05	.18	.06	.22	0	1.41	13.09	20.1	+7.0
September 16 to 17	5	1550	1.014	476	7.36	3.38	2.035	.116	.340	61	11.68	9.92	.40	.03	.24	0	1.41	13.09	15.4	+2.3
September 17 to 18	6	1825	1.014	418	8.55	3.07	2.230	.126	.329	67	13.15	11.08	.26	.05	.26	0	1.41	14.56	20.3	+5.7
September 18 to 19	7	2025	1.012	514	9.66	3.60	2.336	.170	.354	109	13.85	12.12	.38	.05	.28	0	1.41	15.26	16.8	+1.5
Average . . .	1 to 7	1833	1.013	461	8.71	3.36	2.156	.124	.446	65	12.88	10.92	.35	.05	.25	0	1.41	14.29	17.9	+3.6

Urine acid in reaction to litmus on all days. No albumin or sugar present. Microscopic examination of sediment showed a moderate number of leukocytes and epithelial cells on all days.

CASE XIII.—Mrs. C. McC. (Pellagra Commission No. 170, Spartanburg County).

September 18 to 19	1	753	1.016	367	4.70	2.00	1.680	.170	.240	190	10.67	8.68	.74	...	.14	.13	2.70	13.37	16.7	+3.3
September 19 to 20	2	539*	1.021	...	4.20	2.33	1.245	.192	.175	291	8.23	6.64	.63	...	.13	.09	2.70	10.93	17.1	+6.2
Average . . .	1 to 2	646	1.019	367	4.50	2.17	1.462	.181	.208	240	9.45	7.66	.67	...	.14	.11	2.70	12.15	16.9	+4.7

Urine acid in reaction to litmus on both days. No albumin or sugar present. Microscopic examination of urinary sediment showed a rather large number of pus cells and a few epithelial cells.

* A small amount of urine was lost on this day, though a correction was made. As the samples following were incomplete they are not included.

CASE XIV.—Mrs. W. L. (Pellagra Commission No. 166, Spartanburg County).

August 30 to 31	1	1810	1.014	...	13.58	....	....	....	....	57	13.15	10.70	.64	...	.30	.06				

Urine acid in reaction to litmus. No sugar or albumin present. Microscopic examination showed a few leukocytes and a moderately large number of epithelial cells.

V.

SOME HEMATOLOGICAL FINDINGS IN PELLAGRA.[1]

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Introduction. The material upon which the following report is based was obtained from cases of pellagra which were sent from the field headquarters of the Commission at Spartanburg, South Carolina, together with slide specimens of pellagrous blood taken from cases in South Carolina and forwarded for study to the New York Post-Graduate Medical School and Hospital during the summer and early fall months of 1912. In spite of the fact that the number of cases under consideration at that time was not large, nevertheless, it seemed advisable to record briefly the most important points in connection with the work that had already been done.

The blood was examined with a view of determining the hemoglobin content, the number of red and white cells per cubic millimeter, the differential leukocyte count, and at the same time the general morphologic characteristics of the blood in stained preparations. A few observations were also made on the coagulation time.

A review of the literature on this particular phase of the hematology of pellagra reveals an agreement of opinion in regard to the presence of a mild degree of secondary anemia of the chlorotic type without any marked structural or tinctorial alterations in the red corpuscles unless the anemia is pronounced. The majority of investigators state that the total leukocyte count varies, and that occasionally a leukocytosis exists which in most instances cannot be accounted for by the presence of a definite complication. The differential leukocyte count has apparently proved to be the most interesting and variable feature, and, judging from the available data, a fairly constant departure from the normal seems to be found in a large number of cases. Lavinder, in 1909, found "a relative large mononuclear increase with an absence of eosinophilia,

[1] Reprinted from the American Journal of the Medical Sciences, April, 1913, No. 4, vol. cxlv, p. 507.

except in cases with such complications as roundworms or hookworms." Sambon, working in Italy, also noticed a relative increase of the large mononuclear leukocytes. Contrary to these findings, Buhlig at the Peoria State Hospital, failed to demonstrate any increase in the large mononuclears. Bardin, quoted by Niles, found in uncomplicated cases of pellagra a lymphocytosis, with a corresponding reduction in polynuclears and a marked reduction in eosinophiles. Lavinder states that Fiorini, Gavini, and Masini in Italy found a decided eosinophilia. In the recent work of the Illinois Pellagra Commission no significant changes were observed in the differential leukocyte count.

Technique Employed. The blood was taken for examination in the midforenoon or midafternoon. The percentage of hemoglobin was estimated with the Sahli hemoglobinometer, two "readings" being made and the results averaged; this method was found quite satisfactory. The erythrocytes were counted with a Thoma-Zeiss apparatus, using a dilution of 1 to 200 and counting the corpuscles on the four corner "blocks" of twenty-five small squares in two drops. The average was then taken and the number of cells per cubic millimeter computed on this basis. In estimating the number of leukocytes a Zappert-Ewing chamber was used, thus affording an opportunity of counting 9 square millimeters in one drop. Two such determinations were made from a dilution of 1 to 20 in a "Rieder" pipet and the average taken; the usual calculation was then made. A difference of not more than twenty cells per field (high power) in the red count and eight cells per field (1 square millimeter, low power) in the white count was permissible. If a greater discrepancy existed a third drop was usually sufficient to rectify it, in either count.

For differential leukocyte counting films were made on clean, new slides, and a preparation selected in every case, on which the distribution of the corpuscles was moderately thin. Five hundred cells were counted over the midportion of each slide, care being taken not to encroach too closely on the ends, where frequently there is a relative increase in the more bulky leukocytes. The blood was stained with Wright's modification of Leishman's polychrome eosin-methylene blue mixture. The following classification was adopted: Polynuclear neutrophiles, small lymphocytes, large lymphocytes, large mononuclears, transitionals, eosinophiles, and mast cells. Differentiation between the small and large lymphocytes was to a certain extent unsatisfactory, inasmuch as intermediate gradations in size were occasionally encountered. Mononuclear cells measuring 12 to 15 microns in diameter, and having a comparatively wide zone of protoplasm, were classified as large lymphocytes; these were generally found to contain round nuclei staining not quite so intensely as the nucleus of the small lymphocyte. The large mononuclear leukocyte was recognized by its size, being two to three times that of a red blood corpuscle and containing a pale oval nucleus, frequently eccentric in position; the protoplasm was usually abundant, and feebly basic. It was realized that distinction between these two cells is a matter of no little difficulty, and depends to a large extent upon the personal equation, which forms an important factor in this much-debated question in the cytology of the blood. The reason for attempting to classify these types separately arose from the desire to ascertain whether the so-called large mononuclear leukocyte exhibited any relative or absolute variation from normal limits.

The patients examined were divided into two groups, A and B. Under Group A were included those cases that were under observation in the hospital at the time the examinations were made. These patients received no medicine, and were allowed a liberal diet. In Group A the hemoglobin percentages were determined, the red and white cells counted, and differential leukocyte counts made; this series of investigations is designated as "complete blood counts." As will be seen in Table I, several such complete counts were made on most of the cases. Under Group B (Table II) are included those cases in which only differential leukocyte counts were done, it not being convenient to make a more detailed examination at the time.

Analysis of Findings. In Table I the hemoglobin percentages show considerable variability, ranging from 58 to 107 per cent., with an average of 83 per cent. The erythrocytes are not markedly decreased, the lowest number being 3,920,000 per c. mm. As will be observed, several counts are 5,000,000 and over, the highest figures being 5,440,000. This occurred in the only male patient of the group, and was associated with a moderate reduction of the hemoglobin (65 per cent.). The patient was a poorly nourished individual, who was suffering from a mild attack of pellagra of about one year's duration. The majority of the members of this group appeared decidedly pale and anemic, according to general clinical criteria, and it was a matter of surprise to note the comparatively slight reduction in erythrocytes and hemoglobin that existed. The average red-cell count was 4,758,000 per c.mm. The color index was 1 or 1 plus in twelve determinations, the highest index being 1.3. In twenty instances it was under 1, the lowest being 0.6; the average index was 0.8. A careful examination of the stained blood films exhibited practically no changes in size, shape, or coloring of the red cells; nucleated corpuscles were never seen nor were there any staining variations from the normal, such as polychromatophilia and basophilic granulation. The average leukocyte count was 10,403 per c.mm., a trifle above the maximum normal.

Table I (Group A).—Complete Blood Counts

No.	Date.	Sex.	Age.	Hemoglobin. Per cent.	Erythrocytes. Per c.mm.	Color index.	Leukocytes. Per c.mm.	Differential leukocyte counts. Polynuclears. Per cent.	Polynuclears. No.	Small lymphocytes. Per cent.	Small lymphocytes. No	Large lymphocytes. Per cent.	Large lymphocytes. No.	Large mononuclears Per cent.	Large mononuclears No.	Transitionals. Per cent.	Transitionals. No.	Eosinophiles. Per cent.	Eosinophiles. No.	Mast cells. Per cent.	Mast cells. No.	Stage of disease and clinical remarks.
	1912																					
1	June 4	F.	36	70	5,290,000	0.6	6,300	49.60	3125	40.00	2520	3.00	189	3.40	214	0.60	38	3.00	189	0.40	25	First attack, severe; duration, three weeks; watery diarrhea; strongyloides intestinalis numerous in stool.
	June 15			85	5,430,000	0.7	7,000	52.80	3696	27.20	1904	6.20	434	2.60	182	1.60	112	8.00	560	1.60	112	
	June 24			85	5,200,000	0.8	7,400	43.60	3227	40.00	2960	10.00	740	1.20	89	1.40	103	3.40	251	0.40	30	
	July 1			83	5,140,000	0.8	9,000	59.30	5337	24.60	2214	8.70	783	2.00	180	0.70	63	3.70	333	1.00	90	
	July 23			88	5,060,000	0.8	9,100	47.40	4313	42.00	3822	2.80	255	2.80	255	2.00	182	2.40	218	0.60	55	
2	June 4	F.	17	60	4,620,000	0.7	8,300	71.00	5893	18.00	1494	2.20	183	3.00	249	2.20	182	3.00	249	0.60	50	Recurrent attack, severe;[2] duration, three weeks.
	June 14			84	4,640,000	0.9	8,800	50.40	4435	33.40	2940	5.80	510	1.80	158	4.20	370	4.00	353	0.40	35	
	July 1			87	4,700,000	1.0	8,200	63.40	5199	21.20	1738	5.40	443	3.60	295	1.40	115	4.40	361	0.60	49	
3	June 4	M.	60	65	5,440,000	0.6	6,500	66.60	4329	24.00	1560	1.40	91	4.20	273	2.00	130	1.40	91	0.40	26	First attack, mild; duration, one year.
	June 12			98	5,040,000	1.0	7,100	55.80	3962	35.00	2485	1.60	114	4.40	312	1.40	99	1.60	114	0.20	14	
	June 19			95	5,000,000	0.9	8,000	55.00	4400	31.00	2480	6.75	540	2.00	160	1.00	80	3.75	300	0.50	40	
	June 25			93	4,900,000	0.9	7,200	62.00	4464	27.40	1972	4.80	346	2.00	144	0.80	58	2.60	187	0.40	29	
4	July 6	F.	40	105	4,000,000	1.3	8,000	41.15	3295	37.00	2960	13.35	1068	4.35	348	2.25	180	1.90	153	....	..	Recurrent attack, mild; duration, two and one-half months.
	July 16			100	4,560,000	1.0	7,200	55.00	3960	33.00	2376	2.20	159	4.20	303	1.60	115	3.60	259	0.40	29	
	July 27			102	5,100,000	1.0	10,000	45.50	4550	39.00	3900	8.20	820	5.50	550	1.30	130	....	...	0.50	50[3]	
5	July 6	F.	32	98	4,200,000	1.1	10,000	41.60	4160	42.30	4230	9.70	970	2.70	270	2.20	220	1.40	140	0.10	10	Recurrent attack, severe; duration, two months.
	July 16			102	4,250,000	1.2	8,000	50.20	4016	36.40	2912	5.40	432	3.20	256	0.40	32	4.40	352			
	July 27			107	4,400,000	1.2	11,000	56.50	6215	28.00	3080	6.50	715	5.00	550	1.00	110	3.00	330			
6	July 31	F.	18	88	4,800,000	0.9	9,000	69.00	6210	21.60	1944	4.40	396	1.80	162	1.40	126	1.80	162	....	..	First attack, mild; duration one month; no intestinal parasites found in stools.
	Aug. 8			86	5,000,000	0.8	14,000	60.20	8420	21.40	2996	5.60	784	3.40	476	1.40	196	7.80	1092	0.20	28	
7	July 31	F.	20	91	4,800,000	0.9	13,000	56.60	7358	37.20	4836	2.80	364	2.00	260	0.20	26	1.20	156			First attack, mild; duration, two weeks.
	Aug. 8			81	4,800,000	0.8	9,000	58.80	5292	32.00	2880	2.40	216	0.60	54	0.60	54	5.40	486	0.20	18	
8	July 17	F.	36	100	4,500,000	1.1	12,000	71.20	8544	15.00	1700	5.40	648	5.60	672	1.40	168	1.00	120	0.40	48	Recurrent attack, mild; duration, 3 weeks.
	Aug. 8			90	5,000,000	0.9	16,800	76.40	12835	16.20	2721	1.20	202	3.00	504	1.20	202	2.00	336			
9	Aug. 8	F.	28	78	4,800,000	0.8	10,000	60.00	6000	32.00	3200	3.00	300	1.00	100	1.00	100	3.00	300	....	..	Recurrent attack, severe; duration, 3 mos.
10	Aug. 4	F.	38	67	5,000,000	0.6	14,400	78.60	11318	17.20	2477	1.80	259	0.80	115	....	...	1.20	173	0.40	58	First attack, mild; duration, one month; chronic pulmonary tuberculosis.
	Aug. 17			70	4,320,000	0.8	11,000	66.25	7288	22.50	2475	2.50	275	1.00	110	4.50	495	2.50	275	0.75	82	
11	Sept. 7	F.	43	58	4,410,000	0.6	10,800	68.60	7409	26.60	2872	1.80	194	0.20	22	0.20	22	2.00	216	0.60	65	Recurrent attack, mild; duration, five months.
	Sept. 17			85	3,920,000	1.0	16,000	61.80	10358	32.00	5312	2.80	465	1.60	267	1.40	232	0.40	66			
12	Sept. 12	F.	34	65	5,400,000	0.6	18,000	72.60	13068	18.60	3348	3.20	576	1.00	180	2.40	432	2.20	396	....	..	Recurrent attack, mild; duration, four months.
	Sept. 24			100	4,380,000	1.1	9,100	61.30	5578	31.50	2866	3.50	319	1.30	118	1.50	109	0.90	73			
	Sept. 28			97	4,140,000	1.1	12,700	64.20	8143	26.40	3353	4.00	508	2.00	254	1.20	152	1.80	229	0.40	61	
	Average		33	83	4,758,000	0.8	10,403	59.13	4887	29.36	2828	4.63	446	2.59	252	1.50	144	2.73	263	0.34	31	

[2] The term "severe" implies the presence of gastro-intestinal symptoms, nervous manifestations, and extensive skin lesions.
[3] Two hundred and twenty leukocytes counted.

No.	Sex.	Age.	Polynuclears.	Small lymphocytes.	Large lymphocytes.	Large mononuclears.	Transitionals.	Eosinophiles.	Mast cells.	Stage of disease and clinical remarks.
1	M.	23	52.80	34.40	1.20	1.60	1.00	9.00	....	Recurrent attack, severe; duration, one month; stools not examined.
2	F.	34	59.20	32.00	2.40	2.40	2.00	2.00	....	First attack, severe; duration, one month.
3	F.	30	56.00	32.00	3.40	1.00	0.40	7.20	....	Recurrent attack, mild; duration, two months; stools not examined.
4	F.	19	56.00	33.40	1.80	2.00	1.80	5.00	....	First attack, mild; duration, one month; no intestinal parasites found in stools.
5	F.	40	66.00	28.00	4.00	1.00	....	1.00	....	First attack, mild; duration, two months.
6	F.	35	69.80	23.60	2.20	2.40	0.60	1.20	0.20	First attack, mild; duration, one month.
7	F.	26	49.20	39.00	4.00	1.40	1.60	3.40	1.40	Recurrent attack, mild; duration, two months.
8	F.	21	50.00	40.20	4.20	2.60	1.20	1.60	0.20	First attack, severe; duration, one month.
9	F.	30	60.60	32.80	2.80	2.60	0.40	0.80	....	First attack, severe; duration, two months.
10	F.	38	58.40	31.60	4.00	1.60	2.00	2.40	....	Recurrent attack, mild; duration, two months.
11	F.	38	56.80	31.60	2.40	2.80	2.00	4.00	0.40	Recurrent attack, mild; duration, four months.
12	F.	30	51.20	36.40	4.40	2.40	2.40	3.20	....	First attack, mild; duration, two months.
13	F.	35	61.00	30.60	4.40	2.40	1.00	0.60	....	First attack, mild; duration, two months.
14	F.	36	56.40	35.00	4.20	1.40	1.20	1.80	....	Recurrent attack, mild; duration, two months.
15	F.	27	34.80	50.40	5.20	4.80	0.40	2.80	1.60	Recurrent attack, mild; duration, five months; recovering.[4]
16	F.	44	37.80	40.40	10.00	4.80	0.40	5.60	1.00	Recurrent attack, mild; duration, one month.
17	F.	32	47.60	40.40	5.20	1.20	2.00	2.60	1.00	First attack, mild; duration, three months; recovering.
18	F.	36	62.60	26.00	3.00	0.20	0.40	7.80	....	Recurrent attack, mild; duration, four months; recovering; no intestinal parasites found in stools.
19	F.	28	68.00	21.80	3.40	2.00	1.00	3.80	....	Recurrent attack, severe; duration, five months.
20	M.	25	62.00	27.00	6.00	....	1.00	3.00	1.00	Recurrent attack, mild; duration, three months; recovering.
21	M.	36	57.00	31.00	5.00	0.50	1.50	5.00	....	Recurrent attack, mild; duration, six months.
22	F.	34	50.00	33.00	8.00	5.00	1.00	2.00	1.00	First attack, mild; duration, one month.
23	F.	19	55.00	38.00	4.00	1.00	0.20	1.00	0.80	Recurrent attack, mild; duration, three months; recovering.
24	M.	35	50.00	41.00	5.00	3.00	1.00	....	....	First attack, severe; duration, two months; recovering.
25	F.	32	64.00	23.00	7.00	1.00	....	4.00	1.00	First attack, mild; duration, four months.
26	F.	26	56.00	32.00	8.00	0.80	0.80	2.00	0.40	Recurrent attack, mild; duration, two months.
27	F.	40	60.00	30.00	7.00	2.00	....	1.00	....	First attack, mild; duration, three months.
28	M.	22	54.00	38.00	6.00	1.00	....	1.00	....	First attack, severe; duration, two months.
29	F.	48	63.00	25.00	8.00	....	1.00	3.00	....	Recurrent attack, severe; duration, three months
30	M.	39	54.60	32.40	5.20	1.20	0.60	6.00	....	First attack, mild; duration, five months; stools not examined.
31	F.	40	58.00	30.00	6.00	3.00	....	3.00	....	Recurrent attack, mild; duration, four months; recovering.
32	F.	34	60.00	27.00	8.00	3.00	....	2.00	....	First attack, mild; duration, two months.
33	F.	17	37.50	44.00	10.00	4.50	0.50	3.00	0.50	First attack, mild; duration, two months.
34	F.	38	73.60	20.00	3.20	1.00	1.00	1.20	....	First attack, severe; duration, four months.
35	F.	22	58.20	28.60	7.20	2.00	1.00	3.00	....	First attack, severe; duration, one month.
36	M.	58	60.20	26.20	9.40	2.00	....	2.20	....	First attack, severe; duration, five months.
37	M.	8	54.40	32.00	9.60	2.00	1.00	0.60	0.40	First attack, severe; duration, three months; recovering.
Average		29	56.00	32.37	5.28	1.98	0.87	2.94	0.26	

[4] The term "recovering" means that the patient had no active signs or symptoms of pellagra when the blood was examined.

A slight or moderate leukocytosis existed in several cases at some time during their residence in the hospital. No complications could be discovered in these patients. One patient with chronic pulmonary tuberculosis and much emaciation had a leukocytosis of 11,000 to 14,000; she had an irregular temperature, not exceeding 100.2° F. All the other cases were afebrile, and frequently had subnormal temperatures.

The differential leukocyte count revealed an absolute polynucleosis in those cases associated with a leukocytosis of over 10,000, except in one instance. Three of these cases, however, showed a slight relative decrease in the polynuclears. Out of thirty-two differential counts in this group, twenty-four gave a relative and, in addition, an absolute lymphocytosis, including under this term both small and large forms of lymphocytes. The average total lymphocytosis of the series was 33.99 per cent. The average large mononuclear count was 2.59 per cent. The highest percentage recorded was 5.5 per cent. The transitional forms averaged 1.5 per cent. These last two types taken together (Ehrlich's classification) form 1 to 6 per cent. of the leukocytes in normal blood; therefore, from the above figures it cannot be said that they show any constant alteration from the normal. The average eosinophile count of 2.73 per cent. is within normal limits. A few cases showed slight eosinophilia, the highest being 8 per cent. in which patient *Strongyloides intestinalis* was found in the stools.

The coagulation time was determined in the first three cases with a Brodie-Russell coagulometer and was found to be six minutes and twenty seconds, four minutes and eight seconds, four minutes and twenty-five seconds, respectively, all of which readings are within the normal range for this instrument.

Table II. The differential leukocyte count on a series of slides taken from 37 cases at their homes in South Carolina was carefully determined without discovering any essential variation from the average results obtained in Group A. The average lymphocytosis of 37.65 per cent. is a little higher than in the previous group.

SUMMARY. From a consideration of the above data it is evident that there occasionally exists in pellagra a variable degree of chloranemia, which, however, is not a prominent feature of the attack. The disease, apparently, may be present for some time without leading to any anemic changes. Whether the anemia is due to the actual existence of pellagra, or is the result of an indefinite train of antecedent conditions extending over a period of time before the inception of the disease, is difficult to say. On the other hand, many cases are perfectly well up to the onset of the attack.

One of the most noteworthy features in connection with the leukocytes is the not infrequent presence of a leukocytosis, which appears to be inexplicable in the light of our present knowledge of the disease. This might suggest the possibility of an infectious

etiology of obscure origin, or may be due to complicating disturbances. The lymphocytosis is interesting and is probably in accordance with the general cachectic condition of most pellagrins who are also often the subjects of gastro-intestinal disorders.

This investigation would seem to indicate that there are no characteristic or constant variations in the large mononuclear leukocytes and eosinophiles.

The writer wishes to thank Drs. P. S. Barrett, R. M. Brown, S. S. Irwin, and E. Kister, of the resident hospital staff, for assistance in making the blood examinations.

VI.

OBSERVATIONS ON THE INTESTINAL BACTERIA IN PELLAGRA.[1]

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(From the Laboratories of the New York Post-Graduate Medical School and Hospital.)

A general survey of the fecal bacteria in pellagra was undertaken in 1910 and 1911 by the Illinois State Pellagra Commission. A brief summary of that work has been published[2] and the detailed record of the work has also recently appeared.[3] In general it was ascertained that the fecal bacteria in pellagra, when examined directly with the microscope, are different from the normal in their quantitative relationships, and that unusual kinds of bacteria, more or less heterogeneous in nature, are present. The cultural tests also brought to development unusual quantities of certain normal types, *Bacillus bifidus*, *Bacillus welchii*, and micrococci, in some cases, as well as a considerable variety of bacterial forms not ordinarily found in the feces of healthy men. None of these changes appeared to be constant. During the acute attack accompanied by diarrhea the Gram-positive cocci were nearly always abnormally numerous, and the Gram-negative bacilli were less numerous than normal in these cases. These changes were also observed in the subacute cases and even persisted to a slight degree after recovery from the skin lesions. The percentage of these cocci and bacilli are indicated in Chart I, along with data of similar observations on healthy men[4] for comparison. These changes, which were nearly constant, were such as might be expected as a natural result of the digestive derangement. There was no indication of a substitution of the normal intestinal bacteria by

[1] Reprinted from the American Journal of the Medical Sciences, June, 1913, No. 6, vol. cxlv, p. 801.

[2] Pellagra in Illinois, Arch. Int. Med., August and September, 1912, x, 123 to 168, 219 to 249

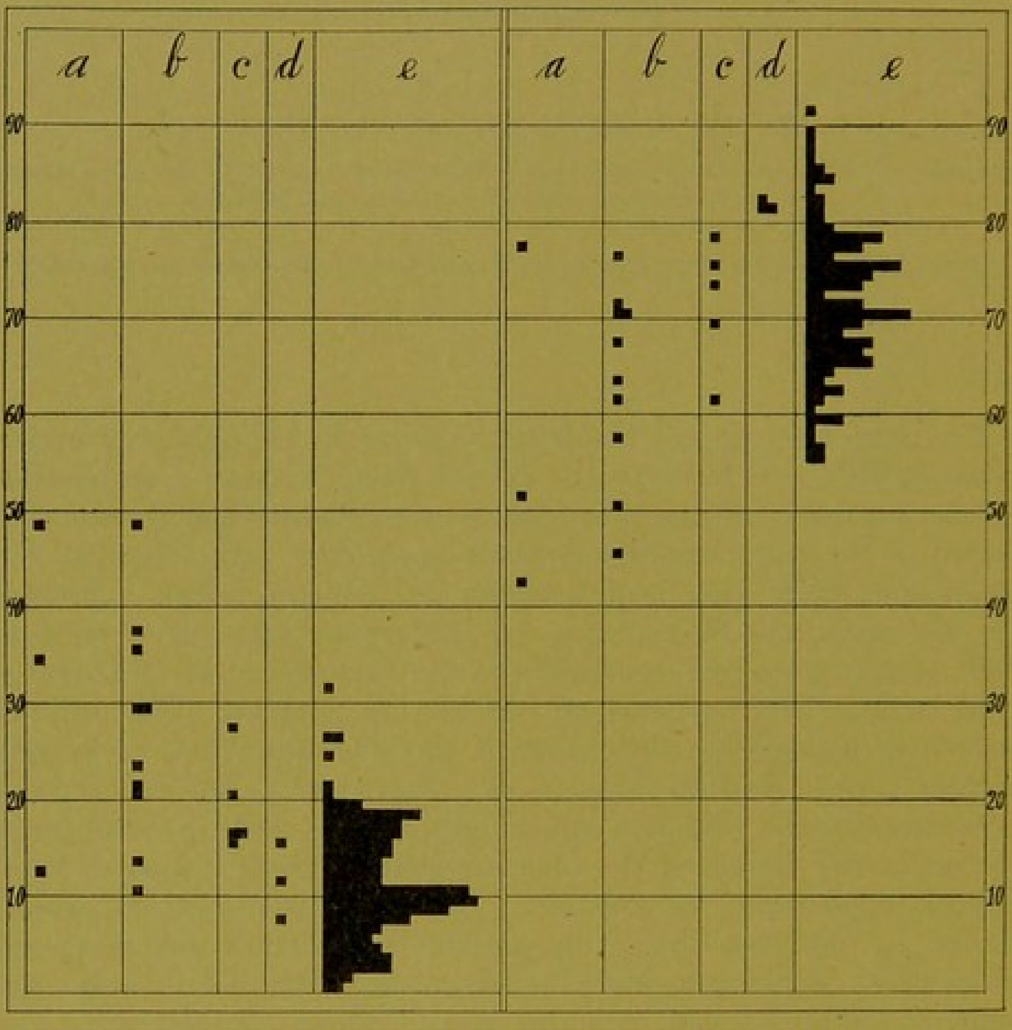
[3] Report of the Pellagra Commission of the State of Illinois, Springfield, Illinois. 1912.

[4] Jour. Infect. Dis., April, 1909, vi, 123 to 169.

an abnormal invader. The abnormal types were various in nature and in no case dominant in numbers.

During the course of the primary examinations subcultures were made from a number of colonies and preserved for subsequent study. One hundred of these bacterial strains were subjected to

CHART I.—Percentage of gram-positive cocci and of Gram-negative bacilli in the feces.
Gram-positive cocci. Gram-negative bacilli.



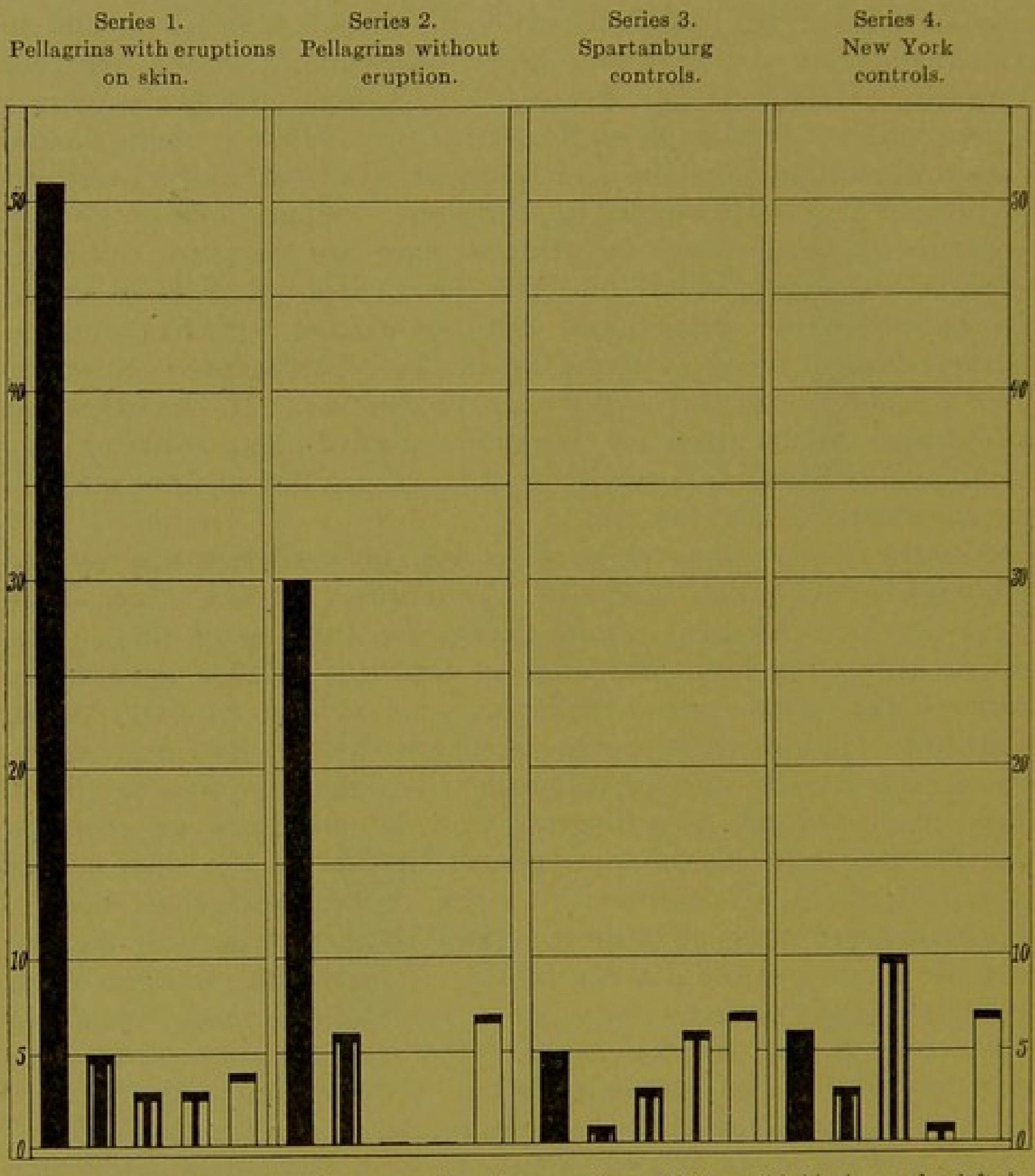
Percentage of Gram-positive micrococci and of Gram-negative bacilli in the feces: (*a*) three examinations in acute pellagra; (*b*) ten examinations in subacute pellagra; (*c*) four examinations after recent recovery from pellagra; (*d*) three examinations in insane individuals not pellagrins; (*e*) one hundred and thirty-seven examinations in healthy men. The data for *a*, *b*, *c*, and *d* are taken from MacNeal, Allison, and York, Report of the Pellagra Commission of the State of Illinois, Springfield, 1912, pp. 55 to 160, and the data for *e* from MacNeal, Latzer, and Kerr, the Fecal Bacteria of Healthy Men, Jour. Infect. Dis., 1909, vi, 123 to 169.

agglutination tests, using the blood serum from cases of pellagra and from normal individuals. Three of the one hundred strains reacted in a somewhat suggestive manner. These were strains Nos. 14, 35, and 67. All were derived from cases of pellagra at Peoria, Illinois. They were agglutinated by sera of pellagrins at Peoria, at Kankakee, and at Chicago. The suggestion of a specific relationship to the disease was considerably weakened by the fact that these bacteria were also agglutinated by the sera of insane patients, not pellagrins, at Peoria and at Kankakee, and by the sera of apparently normal persons at Kankakee, Chicago, and Urbana, Illinois. Two of these bacterial strains, Nos. 14 and 67, appear to be identical in nature. The organism is a short rod about 4.0 μ long by 1.4 μ thick on the average. The size is variable, however, variations in length from 2.4 to 6.2 μ, and in thickness from 1.0 to 1.6 μ being observed in young vigorous cultures. Gelatin is not liquefied. In litmus milk the organism grows without producing an acid reaction. There is slight coagulation after four days and a slow digestion of the casein. No gas is produced in broth containing dextrose, levulose, lactose, saccharose, or maltose. Fresh cultures on agar are colorless, but later assume an orange color, and this production of pigment seems to become more pronounced with continued artificial culture. Strains Nos. 14 and 67 agree in all these characters, and strain No. 35 in all except the pigment production. It has remained colorless. Inoculation of animals (guinea-pigs, rabbits, and monkeys) has been followed by loss of weight, but has not resulted in the death of any animal.

Further study along these lines has been undertaken by the Thompson-McFadden Pellagra Commission at the New York Post-Graduate Medical School during the summer of 1912. The opportunity was here presented to test this culture against the sera of pellagrins from a different part of the country, South Carolina. These recent cases have been divided into four series: First, 66 pellagrins showing lesions on the skin at the time the blood was taken; second, 43 pellagrins who did not show an eruption at the time but in whom a reliable history of the disease was obtained; third, 22 individuals living in the pellagrous district, Spartanburg County, South Carolina, but free from any sign or definite history of the disease; fourth, 27 individuals in New York, including clinic patients and some physicians who kindly furnished their own blood for this work. The agglutination tests were performed by the macroscopic method, a suspension of the bacteria in salt solution being mixed with an equal volume of a 20 per cent. solution of the serum in a small tube for each test, the final dilution of the serum being one part in ten. It was incubated for an hour and the progress of events recorded at intervals of fifteen minutes. Complete clumping and precipitation of the bacteria to the bottom of the tube was recorded as a complete reaction. Grades of almost complete, marked, slight, and negative were also distinguished. The results are shown graphically in Chart II.

Of the 66 sera in the first series, from pellagrins with the skin eruption, 51 gave complete agglutination, 5 almost complete, 3 slight, and 4 negative reactions. The 43 sera of the second series gave reactions distributed as follows: complete 30, almost complete 6, marked none, slight none, negative 7. Of the whole 109 different sera from pellagrins, 74.3 per cent. gave complete agglutination, 10.1 per cent. almost complete, 2.7 per cent. marked, 2.8 per cent. slight, and 10.1 per cent. negative reactions. The

CHART II.—Results of agglutination tests.



Results of the agglutination tests. Complete reactions (1) in solid black at the left in each series; then in order (2) almost complete, (3) marked, (4) slight, and (5) negative reactions.

22 sera of the third series, non-pellagrins of South Carolina, gave 5 complete agglutinations, 1 almost complete, 3 marked, 6 slight, and 7 negative reactions. The 27 New York controls gave 6 complete agglutinations, 3 almost complete, 10 marked, 1 slight, and 7 negative reactions. Of the total 49 controls, 22.5 per cent. gave complete agglutination, 8.2 per cent. almost complete, 26.5 per

cent. marked, 14.3 per cent. slight, and 28.5 per cent. negative results. These findings are obviously not sufficiently clear-cut to warrant the assumption of a specific agglutination reaction of this bacterium with the serum of pellagrins, and yet they are such as to stimulate further work along this line.

The conservatism of this statement is not due to the fact that we have employed serum dilutions of one in ten instead of higher dilutions, for many of these positive sera have been tested in higher dilutions, up to one in four hundred, and have produced definite agglutination in such strength. The suggestion of specificity is, however, seriously opposed by the fact that sera from apparently normal individuals give precisely parallel results in some instances.

We have attempted to employ the complement-fixation test on a number of sera, using an antigen prepared from a culture of strain No. 67. Positive results have been obtained in a few cases, but it has not been possible to try it in a sufficient number of cases to determine the value of the test. We are also attempting to perfect a precipitin test. We hope that it may be possible, by employing these in conjunction with the agglutination test, to obtain more decisive results during the coming pellagra season.

A few cutaneous and intracutaneous tests on patients were performed during the year of 1912, using a vaccine made from a culture of strain No. 67. Of the 9 patients to whom the cutaneous test was applied, 1 gave a moderate reaction, 3 a slight reaction, and 5 were negative. The intracutaneous test on the same 9 patients gave a marked reaction in 1; a marked and a moderate reaction in another case in 2 tests; a slight reaction in 3 cases; a slight reaction and a negative reaction in another case in 2 tests; and a negative reaction in the 3 remaining cases; 2 controls gave negative results, one of them in two tests. The behavior of the cases, especially those on whom the test was repeated, seemed to suggest a difference in the reaction according to the stage of the disease, but the cases tested are still too few to bear analysis along this line.

While these various experiments with this culture were in progress we have undertaken to isolate further bacterial strains from the intestinal contents of pellagrins brought to New York for study. These cultures have been isolated by the methods previously employed, more especially by plating on blood-agar and ascitic-fluid-agar, from the feces, and also from the intestinal juice obtained through the Einhorn duodenal tube; 693 new bacterial strains were isolated in this way during 1912, and these have been tested against sera of pellagrins and others in approximately 2000 agglutination tests. This work is not yet completed, but it seems certain that we have failed to isolate any germ similar to strain No. 67 from the feces of these new cases. From the duodenal fluid, however, a few strains have been obtained which have given positive agglutination tests with the serum of cases of pellagra, and which seem to agree in their biologic characters, so far as they have been tested, with strain No. 67.

It is evident that this phase of the investigation is in an unfinished condition, and we do not wish to draw any definite conclusions at this time. This report will give an idea of one of the avenues along which we have approached the possible bacteriologic phase of the problem of pellagra, and indicates one of the lines we hope to follow during the present year.

PELLAGRA II

SECOND PROGRESS REPORT

OF THE

THOMPSON-McFADDEN PELLAGRA COMMISSION

OF THE

NEW YORK POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL

BY

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CONTENTS

FURTHER STUDIES OF THE THOMPSON-McFADDEN PELLAGRA COMMISSION

A SUMMARY OF THE SECOND PROGRESS REPORT *

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The First Progress Report of the Thompson-McFadden Pellagra Commission was published in successive numbers of the *American Journal of Medical Sciences* from April to September in 1913, and a summary of this material appeared in The Journal of the American Medical Association, Jan. 3, 1914. The chief conclusions from the first year's work were stated as follows:

1. The supposition that the ingestion of good or spoiled maize is the essential cause of pellagra is not supported by our study.

2. Pellagra is in all probability a specific infectious disease communicable from person to person by means at present unknown.

3. We have discovered no evidence incriminating flies of the genus *Simulium* in the causation of pellagra, except their universal distribution throughout the area studied. If it is distributed by a blood-sucking insect, *Stomoxys calcitrans* would appear to be the most probable carrier.

4. We are inclined to regard intimate association in the household and the contamination of food with the excretions of pellagrins as possible modes of distribution of the disease.

5. No specific cause of pellagra has been recognized.

It was decided that our efforts during the second year should be devoted especially to a continuation of the field study of pellagra to see whether a further

* From the New York Post-Graduate Medical School and Hospital.
* Read before the joint meeting of the Section on Preventive Medicine and the Section on Pharmacology at the Sixty-Fifth Annual Session of the American Medical Association, Atlantic City, June, 1914.
* Reprinted from The Journal of the American Medical Association, Jan. 3, 1914, Vol. LXII, pp. 8-12.

and more intensive investigation of the occurrence and distribution of the disease would yield further evidence confirming our ideas of its infectious nature and additional data indicating the particular manner of its transmission from person to person. The field work of the first year had laid a good foundation for further and more detailed observations in the same territory during the second year. At the same time, however, the attempts to transmit pellagra to animals, the studies of the blood and of the intestinal micro-organisms, and the observations on treatment of pellagra were continued. The detailed accounts of certain portions of this work are to appear in early numbers of the *Archives of Internal Medicine,* and some phases of the work are illustrated in an exhibit displayed at the present session of the American Medical Association.

At the end of 1912 we were able to present records of 282 cases of pellagra in Spartanburg County. In 1913 this number was increased to 847 cases which had occurred in the county and concerning which we have recorded more or less detailed information.

The geographical distribution of pellagra in Spartanburg County has continued to be very uneven, the large active foci of the disease being in and near the large centers of population and especially in the industrial communities surrounding the cotton mills. The agricultural population seemed to be, on the whole, much less affected by the disease. In 780 of these cases we know the race of the patient and the place in which he lived at the time the disease was recognized; 680 of them were white and 100 negroes, a morbidity rate of 119 per ten thousand among the whites and 38 per ten thousand in the negroes. This ratio of 3 : 1 is not considered to be necessarily indicative of a relative racial resistance to pellagra in negroes, but rather as the end-result of the influence of several factors. In Spartanburg County about one-fourth of the entire population resides in cotton-mill villages, and it is in these communities, made up almost entirely of white persons, that pellagra is most prevalent. The congestion of population in these communities in conjunction with the poor hygienic conditions under which the people live, as compared with the relative isolation of the bulk of the colored population on farms, appears to us to be an important factor governing racial distribution in Spartanburg County.

The age and sex was ascertained for 740 of the pellagrins, 528 being females and 212 males. The distribution according to sex and age at time of record showed much the same features as were noted in 1912. There was no case under the age of one year and only one, a negro baby, in the second year.[1] In the third year there were 12 cases and between the ages of 2 and 10 years no less than 94 cases, nearly equally divided between boys and girls. Among females, those between 12 and 17 years of age were relatively least frequently affected by pellagra, the age period under 2 years being excepted. In females beyond the age of 17 the pellagra morbidity rose abruptly so that the number of recorded cases in the age period from 20 to 44 equals about 2.5 per cent. of the women now present in the county in that age period, a ratio much higher than was observed in any other group of the population. Women beyond 44 years of age were somewhat less frequently affected by pellagra. In males the number of cases was large from the third to the eighth year, then somewhat less until the lowest morbidity was reached at puberty and maintained from the fourteenth to the twenty-first year, after which there was a gradual increase to old age, the rate after 50 being approximately equal to the rate for females of the same age.

The remarkable features of the data seem to be the almost complete absence of pellagra under the age of 2, its very slight prevalence for the five years following puberty in both sexes, and its slight prevalence in adult males under 50 years of age; further its enormous prevalence in adult females, somewhat less marked prevalence in children of both sexes from 2 to 10 years of age and the almost equally marked prevalence in old age in both sexes. These features of the age and sex distribution we believe to be due in part to differences in individual resistance to pellagra and in part to differences in exposure to the disease, especially by association with other pellagrins.

The data in regard to occupation are available for 726 pellagrins, of whom 413 lived in cotton-mill

1. We have seen a few definite cases of pellagra in very young children outside of Spartanburg County, one patient from Laurens, S. C., 1½ years old, and one at Clinton, S. C., 13 months of age. We have records of the cases of several other patients less than 2 years old which have been reported to us by reliable observers.

villages and 313 lived elsewhere. Of those not living in cotton-mill villages (313), more than half, actually 171, were women engaged in housework exclusively; there were 25 children without occupation; 37 farmers; and the remaining 60 pellagrins represented 19 different occupations, among them 5 merchants, 3 machinists, 1 college student, 1 butcher, 1 postmaster, 1 railroad fireman and 1 printer. Of the 413 pellagrins in mill villages, 133 were women engaged exclusively in housework; 96 were children without occupation; and 110 were women working part or all of the time in the cotton mills. The 71 adult males were practically all mill hands. The remarkable feature of the occupational study seems to be the lack of definite connection between occupation and pellagra. Although the disease was most prevalent in the families of cotton-mill workers, more than half of the cases in these industrial communities were in women and children who never worked in the mills. The suggestion that housework as an occupation favors the development of pellagra is weakened to some extent by the fact that women mill workers were slightly more subject to the disease than the housekeepers in the same mill villages, when due regard is given to the total number of individuals thus engaged. Nevertheless it does seem to us that the high pellagra morbidity in women, children and in old persons of both sexes points to the home as the place where the disease originates in most instances.

The question of the frequency of association between individuals developing pellagra for the first time and persons previously suffering from the disease was suggested by the work of 1912. During 1913 the very complete data secured concerning the population of six mill villages have made possible a study of this question. In this population of 5,514 persons there were 115 cases of pellagra incident in 1912 and 1913. In only 19 of these 115 cases did we fail to find antecedent pellagrins living in the same house or next door, and in 7 of these 19 instances the incident cases had antecedent pellagrin relatives with whom there was evident association. The very definite evidence of close association with a preexisting case in more than 80 per cent. of all new cases in these six villages is the most striking feature of this study of association, and it strongly suggests that association is a factor in the spread of pellagra of much greater importance than has previously been thought to be the case. The essential elements in this association have not been fully examined into as yet. Considerable attention is being devoted to ectoparasites, such as lice and bedbugs, as well as to contact and food contamination as possible factors.

An important feature of the work in 1913 has been the house-to-house study of all the population of the mill-working class in six representative mill villages in Spartanburg County, during which the vital statistics of each person and the food habits of each family were recorded. The data recorded in this way cover a population of more than 5,000 people and have made possible approximately accurate statistical studies of the correlation between the occurrence of pellagra and various *other* ascertained factors. Thus it was found that of the 3,135 persons eating corn meal daily, 98, or 3.1 per cent., were pellagrins, while of the 681 using this food rarely or never, 41, or 6 per cent., were pellagrins. We have analyzed these data in regard to the use of shipped corn meal, local corn meal, any corn meal, fresh meat, canned (tinned) foods, eggs and milk, without discovering any indication that the more frequent use of any one of these foods is associated with an increase in pellagra which would suggest a causal relationship. Those who used meat daily and those who used milk rarely or never did seem to be somewhat more subject to the disease, but the correlation was far from complete. In fact, we found many cases of pellagra among people abstaining from fresh meat altogether, and several cases in persons taking sweet milk or buttermilk regularly once or even twice a day. Our attempt to discover in this way the essential pellagra-producing food or the essential pellagra-preventing food has not been crowned with success and the evidence suggests, to us at any rate, that neither of them exists in the dietary of the population which we have studied.

In this same population our recorded data have enabled us to ascertain whether or not there was any distinct tendency for new cases of pellagra to develop in close proximity to preexisting cases. For the purposes of this study the population of these villages was divided into three zones. The first zone included all persons living in the same house with a preexisting case of pellagra; the second zone all persons living next door to a preexisting case; and the third zone all persons in the same village living at a greater distance than next door from a preexisting case. The result of this study indicated that of the 819 persons in the first zone, that is, living in the same house with a preexisting case of pellagra, 54, or 6.59 per cent., acquired pellagra during the two years 1912 and 1913; in the second zone 1.72 per cent. acquired the disease and in the third zone only 0.52 per cent.

The correlation shown in this study between the incidence of new cases of pellagra and the proximity of domicile to preexisting cases was more striking than we had been led to expect by the results of our first year's work, and it appears to emphasize the significance of very close relationship between the primary and secondary case, such as is provided by actual residence in the same household or in adjacent houses. From the viewpoint of the possibility of transmission of pellagra by blood-sucking insects, one result of this observation has been to direct attention to those insects most intimately domiciled with man, such as the louse, flea and bedbug, rather than to winged blood-sucking insects with a considerable range of flight.

We are confident that such a remarkable indication of the importance of proximity could not have been disclosed except by the intensive study of the disease in the same locality over a long period of time. Certainly the work of our first year did not reveal it. It seems to us that the conclusion is now clearly warranted that in these mill villages pellagra is in some way transmitted to non-pellagrous persons from a preexisting case and that one of the important factors in this transmission is residence in the immediate neighborhood of a pellagrin.

Another feature of our field work in 1913 has been the survey of communities offering marked contrasts in certain particulars. All the mill villages of Spartanburg County were found to be endemic centers of pellagra. All these villages have been using unscreened surface or pail privies for the disposal of human excrement. A careful survey of two other mill villages, one in Oconee County and the other in Chester County, S. C., failed to disclose any cases of pellagra which had certainly originated in these villages, although cases which had originated elsewhere were present. In these villages every house was provided with a water-carriage flush closet connected with a sewer and this seemed to us to be their most important distinguishing characteristic. In the city of Spartanburg, S. C., the active foci of the disease were confined to those sections of the city in which unscreened surface or pail privies were in use. Of the 241 cases in the city of Spartanburg itself, for which data on disposal of sewage were available, it was found that 230 were using unscreened surface or pail privies. In only eleven instances, or 5 per cent. of the total, was a water-carriage system of disposal employed, and several of these cases arose in sections of the city where unscreened surface privies were in use by their neighbors, some of whom were pellagrins. In several other cities we have learned by more superficial surveys that pellagra is far more prevalent in the unsewered sections than elsewhere. In certain hospitals for the insane we have ascertained that pellagra is usually most prevalent and persistent in the wards housing untidy patients.

All these observations have compelled us to regard inefficient methods for disposal of human excrement as an important epidemiologic feature of those communities in which pellagra is endemic and have led us to recommend the installation of water-carriage systems of sewage disposal as a prophylactic measure against this disease.

Our extension studies beyond Spartanburg County have also included a very complete survey of one village, the peculiar topography of which was of great interest. One portion of this village was near a large pond and nearly every family in this section had suffered from tertian or estivo-autumnal malaria. Another portion of the village was on a swiftly running stream, while the remainder was located on a rather steep hillside. Our survey showed that malaria occurred almost exclusively near the pond, but that dysentery, typhoid fever and pellagra had been endemic in all three sections of the village without evident regard to topography.

These studies were also extended to a large island off the coast of South Carolina, the distinguishing characteristic of which was the absence of streams in which *Simulium* could breed. Pellagra was found to be endemic on this island. In May, 1913, one member of the commission and Mr. A. H. Jennings of the U. S. Bureau of Entomology investigated the epidemiology of pellagra in Texas. Our investigations were undertaken in the so-called Panhandle in the northwestern part of Texas where the rainfall is very slight and where running streams are remarkably scarce. In this region we found cases of pellagra originating. *Simulium* was unknown in this section and the nearest possible breeding places for insects of this genus were from 60 to 125 miles away. It was quite impossible that *Simulium* could have been concerned in the etiology of these cases. These and other observations to be published at a later date have further confirmed us in the conclusion based on our investigations of the prevalence, distribution and habits of *Simulium* in Spartanburg County, namely, that in the territory studied, flies of the genus *Simulium* did not fulfill the necessary conditions to serve as an efficient transmitter of pellagra.

The laboratory studies during 1913 included the inoculation of numerous monkeys, *Macacus rhesus*, with filtered and unfiltered suspensions of material from pellagrins, including saliva, duodenal fluid, feces, tissues from the pharynx, stomach, intestines, brain, spinal cord, blood and lymph from the cutaneous lesions. In addition, monkeys were repeatedly subjected by Mr. A. H. Jennings and Mr. W. V. King to the bites of stable-flies (*Stomoxys calcitrans*) which had been allowed to bite pellagrins, these biting experiments being continued as long as the flies could be kept alive. A considerable proportion of these monkeys died with symptoms of dysentery late in the season and in each case a careful necropsy, including histologic study of the various organs, has been made by Dr. Paul A. Schule. This work has failed to disclose any conclusive evidence that pellagra had been produced in these animals.

The bacteriologic work was directed particularly to the discovery of specific serologic or other allergic reactions on the part of pellagrins toward the various bacterial strains isolated from the intestine. Approximately one thousand bacterial strains have been isolated and studied in this way, but the results of this work have still been inconclusive.

The studies of the cytology of the blood by Dr. O. S. Hillman and Dr. Schule have not disclosed any constant abnormality. A lymphocytosis was observed in approximately 75 per cent. of the cases examined by them.

Heredity as a factor in pellagra has been studied by Dr. C. B. Davenport and Dr. Elizabeth Muncey in collaboration with us. The study of family histories gave some indication of inherited susceptibility to pellagra, but no evidence of inheritance of the disease. Furthermore the apparent transmission of the disease from a woman to her daughter-in-law seemed to be about as common as to her own daughter, provided living conditions and associations were similar, so that even inherited susceptibility cannot be considered as established. This work is being continued this year.

Concerning treatment and prognosis we hope to make a more complete statement at a later time. The fourteen pellagra patients transported to New York by us in 1912 all returned home free from active manifestations of the disease. Two of them died during the following winter of other ailments and eight others have shown recurrent manifestations of the disease, three of them in a severe form. Three cases remained free from recurrence in 1913 and one has not been traced. We are inclined to regard the results of hygienic and dietetic treatment in adults as very comparable to those in tuberculosis, that is to say, the immediate results are often good and the disease appears to be arrested, but on return to former environment and living conditions, recurrence and further progress of the disease is to be expected in the majority of the cases. In children, on the other hand, permanent recovery at home without special treatment is the rule.

SUMMARY

1. The large active foci of pellagra in Spartanburg County were found in and near the large centers of population, and particularly in the cotton-mill villages.

2. Children under the age of 2, adolescents for about five years following puberty and adult males in the active period of life were least frequently affected by pellagra. On the other hand, women from 20 to 44 years of age, old persons of both sexes and children from 2 to 10 years of age were most frequently affected.

3. No definite connection between occupation and the occurrence of pellagra has been found, although the high pellagra morbidity in the women and children points to the home as the place in which the disease is usually contracted.

4. In the group of incident cases most thoroughly studied, evidence of close association with a preexisting case was disclosed in more than 80 per cent.

5. A house-to-house canvass of the homes of over 5,000 people living in six endemic foci of pellagra failed to disclose any definite relation of the disease to any element of the dietary.

6. In these six villages new cases of pellagra originated almost exclusively in a house in which a preexisting pellagrin was living, or next door to such a house, suggesting that the disease has spread from old cases as centers.

7. So far as we have observed, pellagra has spread most rapidly in districts where insanitary methods of sewage disposal have been in use.

8. Additional evidence has been obtained to support the conclusion that flies of the genus *Simulium* have nothing to do with pellagra.

9. Animal inoculations and the experimental study of intestinal bacteria have not yielded conclusive results.

10. The studies of the blood have shown a lymphocytosis in most cases, but have not disclosed any constant abnormality characteristic of pellagra.

11. There is no evidence of inheritance of pellagra.

12. The immediate results of hygienic and dietetic treatment in adults have been good, but after returning to former conditions of environment, most of the cases have recurred. In children, prognosis is very much more favorable.

II

INTRODUCTION TO THE SECOND PROGRESS REPORT OF THE THOMPSON-McFADDEN PELLAGRA COMMISSION *

J. F. SILER, M.D. P. E. GARRISON, M.D.
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The investigations of the Thompson-McFadden Pellagra Commission have been directed especially toward the study of the etiological factors in pellagra. We conceive this problem to include not only a study of the nature of the disease, the recognition and identification of the essential infecting or intoxicating agent, or the recognition of the dietary elements, the deficiency of which may give rise to pellagra, but also necessarily a study of the disease in its endemic centers, a study of the people who live there, their habits of life, their environment and occupations and their food, and, especially, a careful scrutiny of those respects in which the non-pellagrins of such a population differ from the pellagrins living in the same regions.

During the course of this work we have undertaken to record every known case of pellagra existing within a limited geographical district,[1] namely, Spartanburg County, S. C., to examine personally each suspected case, and to record a detailed history of each pellagrin in whom a reliable diagnosis could be made. The records actually made in respect to each case are quite elaborate and include a complete history of the individual from birth, with particular attention to foods, occupations, residences, relationships and diseases, as well as a careful description of the present environment and life of the individual. By the aid of maps of Spartanburg County, and larger more detailed maps of the more thickly populated districts, each known case of pellagra has been located, and the houses known to have been occupied at any time by a pellagrin have been designated.

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* From the Division of Tropical Medicine, Department of the Laboratories, New York Post-Graduate Medical School and Hospital.

* Read in part before Section K, American Association for the Advancement of Science, Atlanta, Ga., Jan. 2, 1914.

1. The general plan of the epidemiological studies in 1912 has beeen outlined in detail in Section II of the First Progress Report. See Siler and Garrison: Am. Jour. Med. Sc., 1913, cxlvi, 42.

* Reprinted from the Archives of Internal Medicine, September, 1914, Vol. xiv, pp. 289-292.

In intimate collaboration with this commission, the Bureau of Entomology of the United States Department of Agriculture has undertaken a comprehensive study of the insects which occur in the region studied, with special attention to their possible relationship to pellagra. This work included a general entomological survey of the territory, an examination of all insects found there in association with man, and a particular study of those species the biology of which suggested a possible relation to the spread of pellagra.

Detailed clinical and pathological studies were carried out on selected patients. Fourteen of these patients were transferred to the Post-Graduate Hospital in New York and treated there during the continuance of the active manifestations of the disease. During their residence in the hospital a careful study of their metabolism in general and, in particular, of the utilization of foods, was carried out. For hematological studies, blood was obtained from these patients and also from pellagrins at their homes in the South. The hospital cases also furnished an important part of the material for study of intestinal micro-organisms and for experimental inoculation of animals, although other cases have also been utilized in this work. Finally, these cases were the objects of a clinical study, and their hospital records present information concerning the course of the attack of pellagra when it is uninfluenced by attempts at specific medication.

Certain progress reports on the investigations of the commission in 1912 were presented at the National Pellagra Conference at Columbia, S. C., in October of that year, and these reports have been published in succeeding numbers of the *American Journal of the Medical Sciences*[2] from March to August, 1913. A summary of these reports was presented at the Pellagra Meeting in Spartanburg, S. C., Sept. 5, 1913 and appeared in the *Journal of the American Medical Association*,[3] Jan. 3, 1914. These papers have since been brought together and issued as the First Progress Report of the Thompson-McFadden Pellagra Commission.

A considerable part of the work done in 1912 has not been included in these published reports for various reasons, but chiefly because of

2. Hillman, O. S.: Some Hematological Findings in Pellagra, Am. Jour. Med. Sc., 1913, cxlv, 507. Myers, V. C., and Fine, M. S.: Metabolism in Pellagra, ibid., 1913, cxlv, 705. MacNeal, W. J.: Observations on the Intestinal Bacteria in Pellagra, ibid., 1913, cxlv, 801. Siler, J. F., and Garrison, P. E.: An Intensive Study of the Epidemiology of Pellagra, Report of Progress, ibid., 1913, cxlvi, 42, 238. Jennings, A. H., and King, W. V.: An intensive Study of Insects as a Possible Etiologic Factor in Pellagra, ibid., 1913, clxvi, 411.

3. Siler, J. F., Garrison, P. E., and MacNeal, W. J.: Pellagra: A Summary of the First Progress Report of the Thompson-McFadden Pellagra Commission, Jour. Am. Med. Assn., 1914, lxii, 8.

incompleteness of the work. This applies especially to the attempts to produce pellagra in animals by experimental inoculation, the clinical observations on the pellagrous patients treated in the hospital and the pathological study of necropsy material.

The work done in 1913 has been directly continuous with that of 1912, and supplements and extends the observations of that year. Our main efforts have been devoted to the epidemiologic studies, chiefly because these studies were expected to indicate the fruitful fields for other experimental investigations. The method of epidemiologic study has been continued along the same lines as before, and has been further developed in two special directions; first, we have endeavored to obtain more complete information concerning every person living in certain selected industrial and rural communities in which pellagra is prevalent; and second, we have extended our field of observation to cover other selected communities resembling these in many respects, but showing marked differences in certain particulars, as, for example, in the prevalence of pellagra; the presence or absence of certain insects; the possession of a topography which would necessitate a difference in insect fauna; in the density of population, or in the method of disposal of human wastes.

Inasmuch as the work of 1912 had shown an especially high prevalence of pellagra in the cotton-mill villages, several of these were selected for intensive detailed study, and one rural district in which many cases of pellagra had occurred was studied in a similar way. The communities selected for observation because they exhibited special features could not be examined in such detail, as in many instances they were situated at a distance from our working base. For this study we selected certain mill villages situated in Oconee, Chester and Union counties in South Carolina; a rural district in Georgetown County, on the coast of South Carolina; a large island off the coast near Charleston, S. C., and a portion of the arid region of Texas. At the courteous invitation of Dr. L. W. Sambon, we were enabled to extend these observations to the British West Indies.

The metabolism studies of 1912 had yielded definite negative information and seemed to be sufficiently complete and were therefore discontinued. The study of the blood has been continued and a further report will be forthcoming. Further observations on the intestinal micro-organisms have been made and the attempts to produce pellagra in animals have been zealously pushed. The clinical observations have been continued in cases of pellagra treated in a hospital in Spartanburg, S. C.

The cooperation of the Bureau of Entomology of the United States Department of Agriculture has continued during the past year. The work undertaken by this bureau has included a particularly careful study of insects in the endemic foci of pellagra and carefully controlled attempts at the experimental transmission of pellagra by means of certain of these insects.

We desire to make special acknowledgment to Dr. L. O. Howard, chief of the Bureau of Entomology, and to the field workers of the bureau, Mr. A. H. Jennings, Mr. W. V. King and Mr. A. W. J. Pomeroy, for this cooperation.

We are indebted to the American Genetic Association for the cooperation of its representative, Dr. Elizabeth Muncey, who has made a study of heredity in pellagra; to the Board of Administration of the state of Illinois for the collaboration of Dr. H. Douglas Singer, who spent several weeks with us studying the early nervous and mental manifestations of pellagra; to Dr. J. W. Babcock of Columbia, S. C., for generous assistance and valuable material; to Dr. E. M. Green, clinical director of the Georgia State Sanitarium, Milledgeville, Ga., and to members of his staff for similar cooperation; to Dr. J. A. Hayne, secretary of the South Carolina State Board of Health, for much valuable information and assistance; to Dr. L. W. Sambon of London, and to the government officials of Jamaica, Panama, Barbados and Trinidad, for courteous assistance and extensive records relating to pellagra.

Our field laboratory has been visited during 1913 by a number of noted scientists and students of pellagra; among them Dr. J. W. Babcock of the South Carolina State Hospital, Columbia, S. C.; Surg.-Gen. Rupert Blue of the United States Public Health Service, Washington, D. C.; P. A. Surg. R. M. Grimm of the United States Public Health Service; Dr. W. D. Hunter of the Bureau of Entomology, United States Department of Agriculture; Mr. M. E. MacGregor of Cambridge University, Cambridge, England; Mr. Paul Marchal of the French Department of Agriculture, Paris; Mr. C. W. Mason of Cambridge University, Cambridge, England; Dr. George N. Miller of the New York Post-Graduate Medical School and Hospital, New York; Drs. G. M. Niles, S. R. Roberts and G. C. Mizell of Atlanta, Ga.; Dr. L. W. Sambon of the London School of Tropical Medicine, London; and Dr. E. J. Wood of Wilmington, N. C. We are grateful to these men for their encouragement and counsel.

We desire to make special acknowledgment to Dr. Paul A. Schule, whose addition to the staff of the commission has contributed much to the success of the year's work.

It is our purpose to present, as the Second Progress Report of this commission, a series of papers by the various investigators, dealing with several phases of the work of the year 1913.

Twentieth Street and Second Avenue.

A STATISTICAL STUDY OF THE RELATION OF PELLAGRA TO USE OF CERTAIN FOODS AND TO LOCATION OF DOMICILE IN SIX SELECTED INDUSTRIAL COMMUNITIES *

J. F. SILER, M.D., P. E. GARRISON, M.D.,
AND
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Our most intensive epidemiologic studies have been carried out in six cotton-mill villages in Spartanburg County, S. C., selected as fairly representative of the many mill villages in that part of the country. In each of these villages the family of each operative was visited at his home and a complete record was taken on a uniform printed card, of the location of the house, the sex, age, relationship, occupation, period of present residence and association with pellagra, of each inhabitant. On the reverse side of the same card was recorded the frequency of use of certain important elements of the diet and the condition of the house in respect to screening and general condition.

Whenever a case of pellagra was found, the usual complete history of the individual was taken, and this included a record of the previous residences of the individual, the time of the first attack and a very complete record of his diet. These records make possible statistical studies of the distribution of pellagra in these populations to ascertain its correlation with various other things, as, for example, age, sex, occupation, use of particular foods, location of the domicile or sanitary condition of the home. They seem to us to be of peculiar value for the study of the influence of foods on pellagra and for an inquiry as to the possible bearing which location of domicile may have in the causation of this disease. In the present paper we purpose to present, first, a study of the relation of pellagra to certain foods, and second, a study of the relation between the domicile of existing cases of pellagra and the domicile of the new cases which originated in

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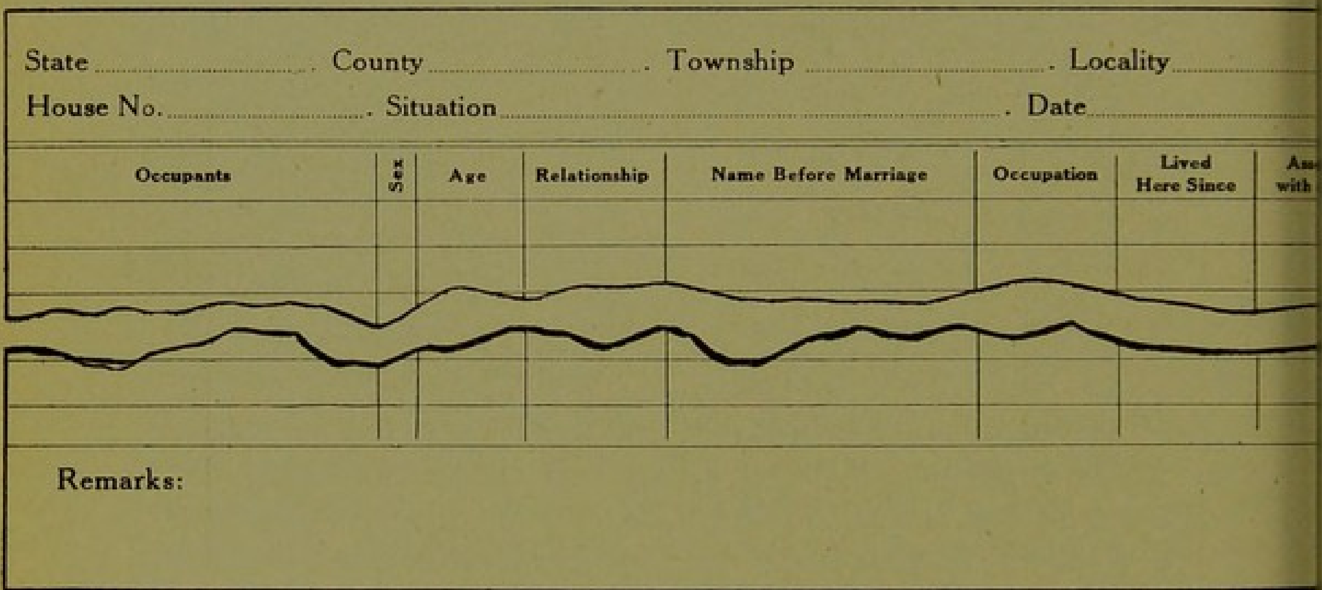
these villages. The two studies have been carried out by much the same method, and because of their interrelationships and the sharp contrast in their results, it has been thought best to present them in a single contribution.

THE RELATION OF PELLAGRA TO THE USE OF PARTICULAR FOODS

In view of the apparent importance of nutrition as an etiological factor in pellagra, and because of the confident belief of many authorities that the disease is due to deficiency in diet, either general or special, or that it is a specific food intoxication, we have undertaken a careful investigation of the dietary habits, not only of pellagrins and their families, but also of all the remaining population of the same class living under the same conditions, in certain selected



State .... County .... Township .... Locality ....
House No. .... Situation .... Date ....

Occupants	Sex	Age	Relationship	Name Before Marriage	Occupation	Lived Here Since	Ass... with

Remarks:

Fig. 1.—Census card used in the house-to-house canvas.

industrial communities. Approximately five thousand persons have been included in these studies. The facts were ascertained for each family by personal interview with a member of the family, usually the housewife. We recorded the diet served in the family as a whole, and each member of the household is considered as belonging to the dietary group of his family. For each pellagrin, the individual diet was recorded in detail, but for the comparative study which we present in this section, each of these persons is considered as belonging to the dietary group of his family, not only because this makes them strictly comparable to the other individuals, but also because the individual peculiarities in the diet of pellagrins, particularly the omission of corn from the diet, may often be regarded as secondary to the development of the disease.

In obtaining the data a uniform printed card was used and the record was made concerning the frequency of the use of shipped corn-meal, locally grown corn-meal, and the quality of the meal used; concerning the use of grits, corn-sirup, corn whisky, wheat flour, fresh

Name .... Locality ....

House No. .... Street ....

Corn Products Used : Corn meal, grits, syrup, whiskey.

Source of Supply of Meal :

Exclusively, mostly, rarely, never.

Shipped and ground in nearby State ....

Local corn, ground locally ....

Use of Corn Products :

Daily, habitually, rarely, never.

Corn meal ....

Hominy or grits ....

Character of Meal :

Shipped meal .... good, musty ....

Local meal .... good, musty ....

Daily, habitually, rarely, never.

Wheat flour ....

Fresh meat ....

Cured meat (bacon) ....

Lard ....

Canned meats or vegetables ....

Milk ....

Eggs ....

Butter ....

House :

Screened .... effective .... Sanitation : good, poor.

Remarks : ....

Fig. 2.—Reverse side of the census card.

meats, cured meats, canned meats, vegetables and fruits (tinned foods), and concerning leaf-lard, compound lard, vegetable oils, milk, butter and eggs. In respect to the frequency of use, we recognized seven classes: first, daily use which is self-explanatory; second, habitual use, meaning as often as twice a week on the average; third, part time daily, which means daily use during certain seasons of the year; fourth, part time habitually, or habitual use during certain seasons; fifth, rarely, which means use less frequently than twice a week; sixth, part time rarely; and seventh, never.

DIETARY ELEMENTS DISMISSED FROM CONSIDERATION

Certain of these articles were not very commonly used and there is evidently no important reason for giving them detailed consideration. This applies particularly to corn-grits and corn-sirup. Corn whisky was not used by many, possibly in part because of legal restriction of the liquor traffic in the territory studied. For the most part, it was used only by the adult males, a class of the population in which pellagra was not very prevalent. It has not, therefore, seemed worth while to assemble and analyze the data in regard to it. Wheat flour was used daily by every family in the population studied. No distinction between pellagrins and non-pellagrins could be ascertained in respect to this dietary element. The recorded data in respect to lard are difficult to analyze because so many different brands were used and we have not, as yet, obtained reliable information concerning their composition. The remaining foods concerning which information has been gathered, namely, shipped corn-meal, local corn-meal, fresh meat, canned (tinned) foods, milk and eggs will be considered.

METHOD OF PRESENTATION

The general method of analyzing these data consists in dividing the population into several groups, distinguished from each other by the frequency with which the particular food was used, and then comparing the relative number of cases of pellagra in the different groups. Four distinct possibilities present themselves. We may consider as a unit each family present in the village at the time of our census, and compare the families in which pellagra existed with the total families present, or we may consider each individual in the same population as a unit and compare the total existing pellagrins with the total population. These two analyses might be expected to agree with each other fairly well, and should indicate the possible relation of diet to the presence of pellagra, both new and recurrent cases being considered together. Third, we may consider as a unit each family of which we have record, which lived in the particular village in 1912 or 1913 and compare the families in which *new cases* of pellagra appeared, with the total families, and fourth, we may examine the same population in a similar way, considering each individual person as a unit. The last two analyses might be expected to agree with each other and should reveal the relation of these dietary constituents to new cases of pellagra. The latter would probably be a more accurate indication of the importance of the particular foods as predisposing factors, or as vehicles of the directly active etiological agents. Because of the manifest importance of this dietary phase of the subject of pellagra, we have undertaken to study our data in all four of the ways mentioned.

SHIPPED CORN-MEAL

The records in regard to the use of shipped corn include 853 families, present in the six villages in the year 1913, in 137 of which one or more pellagrins existed at the time. The distribution of these 853 families in respect to the frequency of use of shipped corn-meal is indicated in Table 1.

3LE 1.—Distribution of Total Families According to Frequency of Use of Shipped Corn-Meal

age	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	47	14	8	11	5	2	15	102
V	44	18	4	16	2	0	11	95
›	116	51	22	12	2	1	18	222
a	38	15	10	10	6	3	19	101
\	33	22	14	6	1	2	4	82
p	130	40	27	14	8	1	31	251
l..	408	160	85	69	24	9	98	853

It will be noted that this foodstuff was a staple article of diet, used daily by nearly half the families and never used by only about 11 per cent. of them. There was evidently not much difference between the various villages in the use of this food. At the larger mills, P and Sp, more than half the families used it daily, while in one village, Sa, only 38 of 101 families did so. The other villages are intermediate in this respect.

The distribution of the 137 families in which pellagra was present, in respect to frequency of use of shipped corn-meal, is indicated in Table 2.

By grouping together those families using shipped corn-meal habitually, part time daily and part time habitually under the heading, *Habitually,* and the groups using it rarely, part time rarely and never, together under the heading *Rarely,* Tables 3 and 4 are obtained.

TABLE 2.—Families Containing One or More Cases of Pellagra Distributed According to Frequency of Use of Shipped Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	5	3	1	2	0	0	2	13
W	10	6	1	1	0	0	1	19
P	10	9	5	2	0	0	2	28
Sa	11	4	2	3	1	2	6	29
A	7	5	4	0	0	0	1	17
Sp	13	6	2	5	1	1	3	31
Total..	56	33	15	13	2	3	15	137

TABLE 3.—Summarized Distribution of Families According to Frequency of Use of Shipped Corn-Meal

Village	Total Families			Pellagrin Families		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	47	30	25	5	5	3
W	44	36	15	10	7	2
P	116	65	41	10	11	7
Sa	38	31	32	11	8	10
A	33	29	20	7	5	5
Sp	130	62	59	13	12	6
Total	408	253	192	56	48	33

TABLE 4.—Pellagrin Families in Total Families in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	10.6	16.7	12.0	12.7
W	22.7	19.4	13.3	20.0
P	8.6	16.9	17.1	12.6
Sa	28.9	25.8	31.3	28.7
A	21.2	17.2	25.0	20.7
Sp	10.0	19.4	10.2	12.4
Total.........	13.7	19.0	17.2	16.1

The large villages, Sp and P, show relatively fewer families with cases of pellagra, while in the village Sa, in which shipped corn-meal was less frequently used, nearly 29 per cent. of the families contained one or more cases. In three of the villages, P, Sa and A, the families rarely or never using shipped meal were most frequently afflicted with pellagra. In only one village, W, is the percentage of pellagrin families highest in the group using this food daily, and for the total families of the six villages this group shows relatively the least pellagra. The figures are rather irregular and inconsistent, but on the whole they seem to us to indicate that families containing one or more pellagrins tend in some instances to restrict their use of shipped corn-meal. The tables do not reveal any positive correlation between the use of this food and the occurrence of pellagra.

The 853 families just considered included 5,151 persons, among whom 196 were pellagrins. The distribution of these 5,151 persons in respect to the frequency of use of shipped corn-meal is shown in Table 5.

LE 5.—Distribution of Total Individuals According to Frequency of Use of Shipped Corn-Meal

ge	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
	286	75	38	71	40	13	65	588
	275	92	20	90	14	0	74	565
	737	331	121	74	16	5	82	1,366
	244	101	49	63	35	20	123	635
	171	138	102	81	3	7	23	525
	800	225	151	88	44	4	160	1,472
..	2,513	962	481	467	152	49	527	5,151

On the whole, approximately half these persons were members of families in which shipped corn-meal was used daily. In the large villages, P and Sp, more than half the persons were members of such families, while in the village A, less than one-third of the population took this food daily, and in Sa, considerably less than half. The distribution of the 196 pellagrins in this population in respect to the frequency of use of shipped corn-meal is given in Table 6.

A consideration of the pellagra morbidity in each village for each of the seven degrees of frequency in the use of shipped corn-meal is omitted because of the small size of certain of the groups. By assembling the figures into groups representing three degrees of frequency, namely, daily, *habitually* and *rarely* (including never) it is possible to obtain groups of some size (Tables 7 and 8).

TABLE 6.—Distribution of Pellagrins According to Frequency of Use of Shipped Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	8	3	1	3	0	0	4	19
W	11	7	3	2	0	0	1	24
P	10	11	8	4	0	0	4	37
Sa	16	4	2	3	2	3	13	43
A	12	7	7	0	0	0	1	27
Sp	19	9	5	6	1	1	5	46
Total..	76	41	26	18	3	4	28	196

TABLE 7.—Summarized Distribution According to Frequency of Use of Shipped Corn-Meal

Village	Total Population			Individual Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	286	186	116	8	6	5
W	275	196	94	11	9	4
P	737	421	208	10	15	12
Sa	244	199	192	16	9	18
A	171	222	132	12	7	8
Sp	800	357	315	19	16	11
Total	2,513	1,581	1,057	76	62	58

TABLE 8.—Pellagra Morbidity in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	2.80	3.22	4.31	3.23
W	4.00	4.59	4.26	4.25
P	1.36	3.56	5.77	2.71
Sa	6.56	4.52	9.37	6.77
A	7.02	3.15	6.06	5.14
Sp	2.38	4.48	3.49	3.13
Total.........	3.02	3.92	5.49	3.81

The comparative study of pellagra morbidity in these groups for each of the six villages shows no definite consistent tendency for it to vary with the frequency of use of shipped corn-meal. In three villages, I, P and Sp, and in the total population of the six villages considered together, the pellagra morbidity varies inversely with the frequency of ingestion of this food, that is, those who eat it every day have the least pellagra, and those persons taking it rarely show the greatest morbidity. In the other three villages the relationship is irregular. The total pellagra morbidity in the larger villages, P and Sp, in which shipped corn-meal was most extensively used, is the lowest, namely, 2.71 and 3.13 per cent., respectively, while the greatest relative morbidity is shown by the villages Sa and A, in which shipped corn-meal was least used. This consideration of individuals leads, therefore, to the same general conclusion as did the consideration of the families, namely, that there is slightly more pellagra in those who use shipped corn less frequently. As has been suggested, this may be due to a tendency of some pellagrins to restrict their ingestion of this food. At any rate it is clearly evident that this examination of our recorded data has failed to reveal any close connection between the use of shipped corn-meal and the existence of pellagra in the population of these six mill villages.

In order to ascertain more exactly the probable importance of shipped corn-meal in the causation of pellagra, we have undertaken a study of cases of the disease which originated in these six mill villages during the period of our observations (1912 and 1913). In this study we have included all families residing in the particular village at the time of our census in 1913, and in addition all other families on our records in which cases of pellagra originated in the respective village in 1912 or 1913. The population considered is therefore not exactly the same as that utilized above, but it is very largely identical with it. The records include 865 families, and in 85 of these families one or more cases of pellagra developed in 1912 or 1913.

The distribution of these 865 families according to the frequency of use of shipped corn-meal is indicated in Table 9.

Table 9 is very similar to Table 1, but includes a few more families which had moved away from the respective village after one or more of their members had contracted pellagra there. The distribution of the 85 families in which cases of pellagra originated in 1912 or 1913 in these villages is given in Table 10.

Assembling the families into three groups in respect to frequency of use of shipped corn-meal, the figures in Table 11 are obtained.

There is evidently no consistent relationship between the frequency of the use of shipped corn-meal and the occurrence of new cases of

TABLE 9.—Distribution of Total Families According to Frequency of Use of Shipped Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	49	15	8	11	6	2	15	106
W	45	18	4	16	2	1	12	98
P	116	51	22	12	2	1	18	222
Sa	40	15	10	10	6	3	19	103
A	33	22	14	6	1	3	4	83
Sp	131	40	27	14	8	1	32	253
Total..	414	161	85	69	25	11	100	865

TABLE 10.—Distribution of Families in Which New Cases of Pellagra Occurred in 1912 or 1913, According to Frequency of Use of Shipped Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	7	3	1	2	1	0	2	16
W	6	1	0	1	0	1	2	11
P	8	4	5	1	0	0	1	19
Sa	6	2	0	0	1	2	1	12
A	3	4	2	0	0	1	0	10
Sp	8	3	1	2	0	0	3	17
Total..	38	17	9	6	2	4	9	85

TABLE 11.—Summarized Distribution of Families According to Frequency of Use of Shipped Corn-Meal

Village	Total Families			Families with Incident Pellagra		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	49	32	25	7	6	3
W	45	36	17	6	2	3
P	116	65	41	8	5	6
Sa	40	31	32	6	3	3
A	33	29	21	3	4	3
Sp	131	62	60	8	5	4
Total	414	255	196	38	25	22

pellagra to be seen in these tables. The figures for the six villages combined suggest rather that new cases were slightly more frequent in families using this food product rarely or never. Here also, the lowest incidence of pellagra is in the large villages, P and Sp, the only ones in which shipped corn-meal was used daily by more than half the families.

TABLE 12.—FAMILIES WITH INCIDENT PELLAGRA IN TOTAL FAMILIES IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	14.3	18.8	12.0	15.1
W	13.3	5.6	17.6	11.2
P	6.9	7.7	14.6	8.6
Sa	15.0	9.7	9.4	11.7
A	9.1	13.8	14.3	12.0
Sp	6.1	8.1	6.7	6.7
Total.........	9.2	9.8	11.2	9.8

ABLE 13.—DISTRIBUTION OF INDIVIDUALS ACCORDING TO FREQUENCY OF USE OF SHIPPED CORN-MEAL

lage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	300	89	38	71	44	13	65	620
W	272	86	20	89	14	6	77	564
P	736	324	119	72	16	5	79	1,351
a	248	99	47	60	34	20	112	620
A	165	135	99	81	3	12	23	518
p	794	219	149	84	43	3	165	1,457
al..	2,515	952	472	457	154	59	521	5,130

The 865 families just considered included 5,130 persons who did not have pellagra at the beginning of the year 1912, so far as we have been able to ascertain. Persons known to have contracted pellagra previous to 1912 have been excluded from this number. Of these 5,130 persons, 110 contracted pellagra during the years 1912 and 1913. The distribution of the 5,130 individuals of this population in respect to the frequency of the use of shipped corn in their families is shown in Table 13.

Table 13 resembles Table 5, but the population considered is not quite the same. Old cases of pellagra existing previous to 1912 are excluded from this table and some other persons have been included who, although not residing in these villages at the time of our census in 1913, nevertheless did reside there in 1912 or 1913 when some member of their family contracted pellagra. The 110 persons who contracted pellagra in these villages in 1912 and 1913 were distributed according to frequency of use of shipped corn by their families as follows:

TABLE 14.—DISTRIBUTION OF INCIDENT PELLAGRINS ACCORDING TO FREQUENCY OF SHIPPED CORN-MEAL

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	10	3	1	3	1	0	4	22
W	6	1	0	1	0	3	2	13
P	9	4	6	2	0	0	1	22
Sa	6	2	0	0	1	3	2	14
A	6	4	4	0	0	1	0	15
Sp	11	3	3	2	0	0	5	24
Total..	48	17	14	8	2	7	14	110

By assembling these figures into the groups representing the three degrees of frequency of use of shipped corn-meal, Tables 15 and 16 are obtained.

It is clearly evident, from these tables, that the occurrence of new cases of pellagra in these mill villages shows no definite consistent tendency to vary with the frequency of use of shipped corn-meal. On the contrary, in every one of these six villages the incidence of the disease actually observed was highest in that portion of the population which rarely or never used this foodstuff. In the total population of the six villages the occurrence of new cases of pellagra was almost twice as frequent in those using shipped meal rarely as in the groups using it daily or habitually. These results lend no support to the conception that pellagra is caused by the ingestion of shipped corn-meal in these particular mill villages and they seem to us to render very insecure the theory that imported or shipped corn may anywhere be regarded as the essential cause of pellagra.

LOCAL CORN-MEAL

The recorded data in regard to the use of local or home-grown corn-meal relate to 866 families present at the time of our ceusus, of which 134 contained one or more cases of pellagra at that time. The distribution of these 866 families in respect to the frequency of use of local corn-meal is given in Table 17.

TABLE 15.—SUMMARIZED DISTRIBUTION ACCORDING TO FREQUENCY OF USE OF SHIPPED CORN-MEAL

Village	Total Population			Incident Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	300	204	116	10	7	5
W	272	189	103	6	2	5
P	736	412	203	9	6	7
Sa	248	193	179	6	3	5
A	165	219	134	6	4	5
Sp	794	346	317	11	5	8
Total	2,515	1,563	1,052	48	27	35

TABLE 16.—INCIDENCE OF PELLAGRA IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	3.33	3.43	4.31	3.55
W	2.21	1.06	4.85	2.30
P	1.22	1.46	3.45	1.63
Sa	2.42	1.55	2.79	2.26
A	3.64	1.83	3.73	2.90
Sp	1.39	1.44	2.52	1.65
Total.........	1.91	1.73	3.33	2.14

T..E 17.—DISTRIBUTION OF TOTAL FAMILIES ACCORDING TO FREQUENCY OF USE OF LOCAL CORN-MEAL

..ge	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
	5	7	1	11	5	2	72	103
	8	3	1	16	3	0	77	108
	8	4	4	12	2	1	192	223
	10	7	2	10	6	3	60	98
	0	1	4	7	1	2	67	82
	5	3	2	13	7	1	221	252
T.. ..	36	25	14	69	24	9	689	866

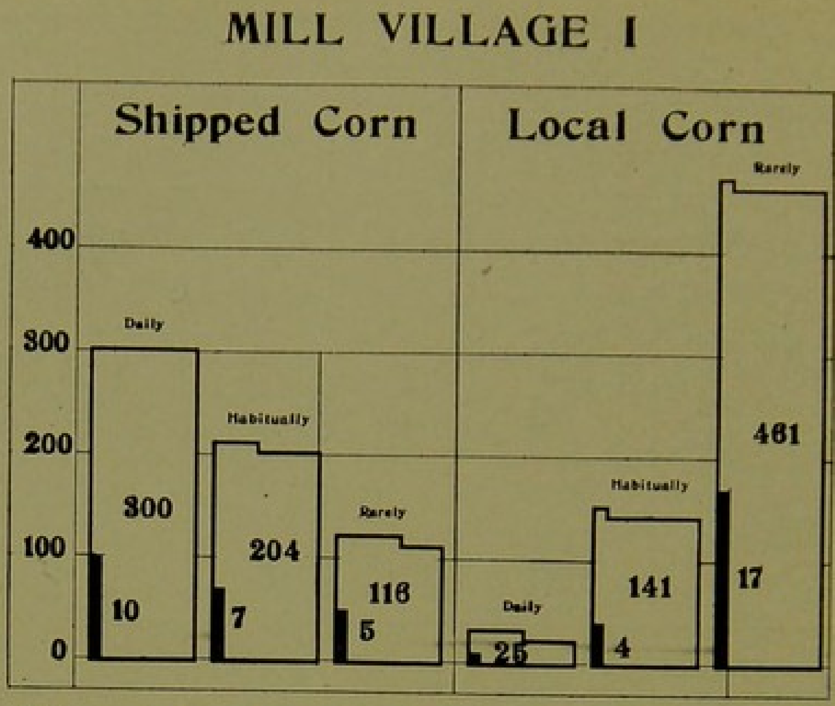


Fig. 3.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

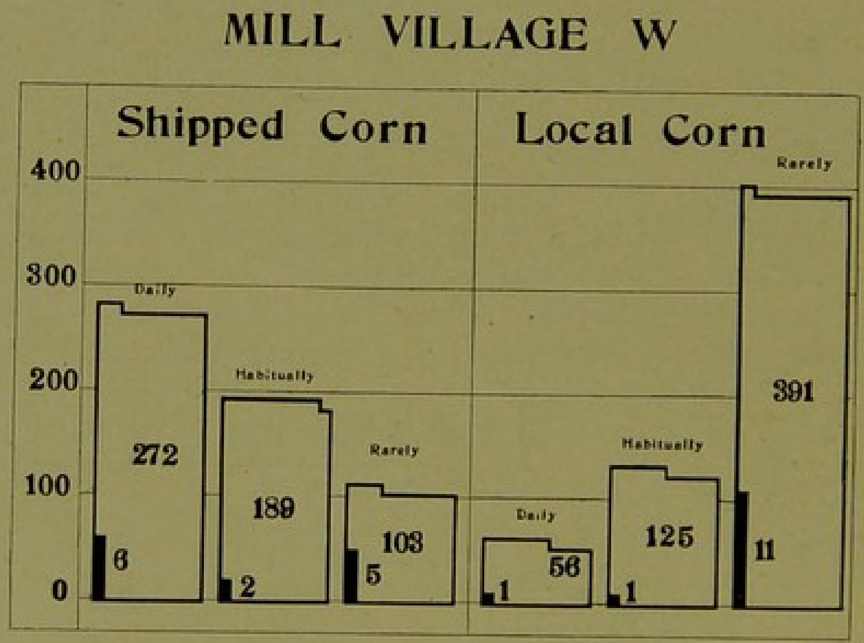


Fig. 4.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE P

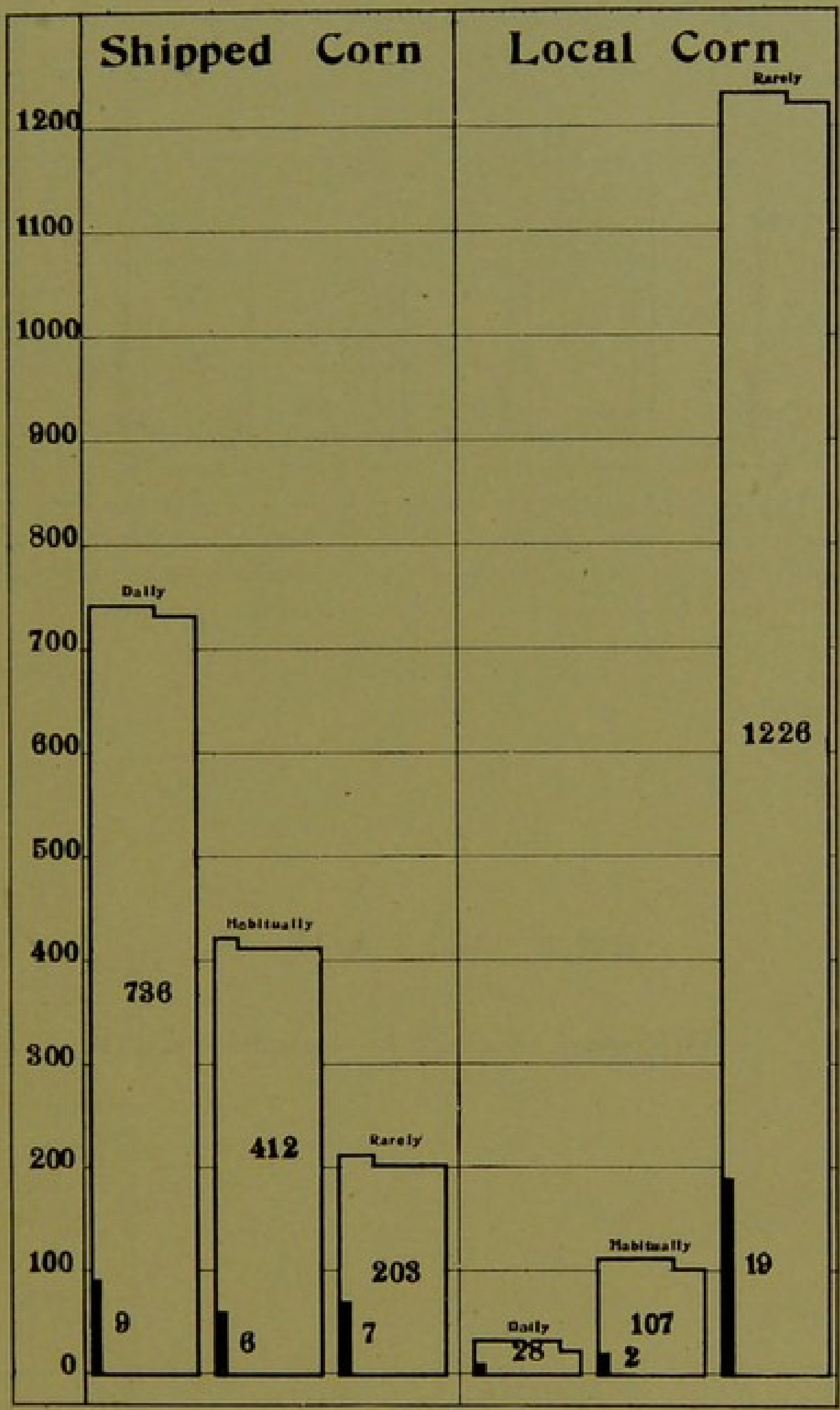


Fig. 5.—The area of each large white column indicates the number of non-pellagrin individauls using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE SA

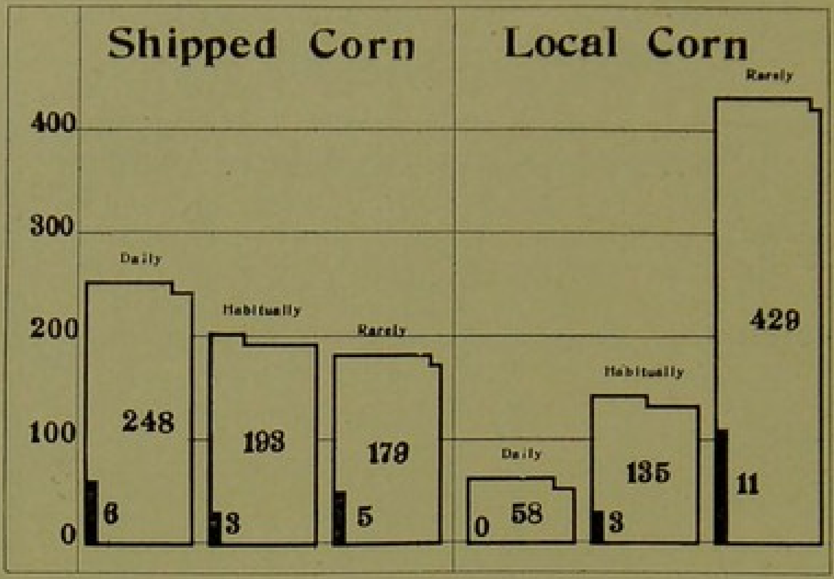


Fig. 6.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE A

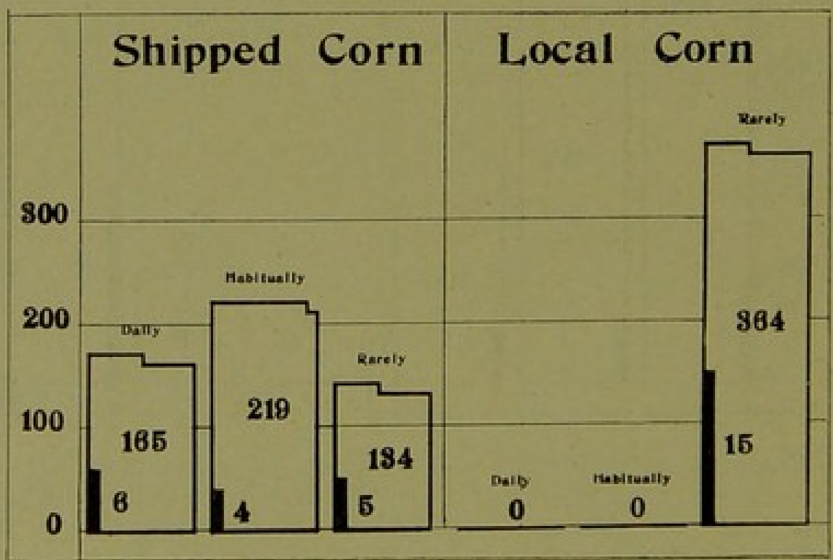


Fig. 7.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

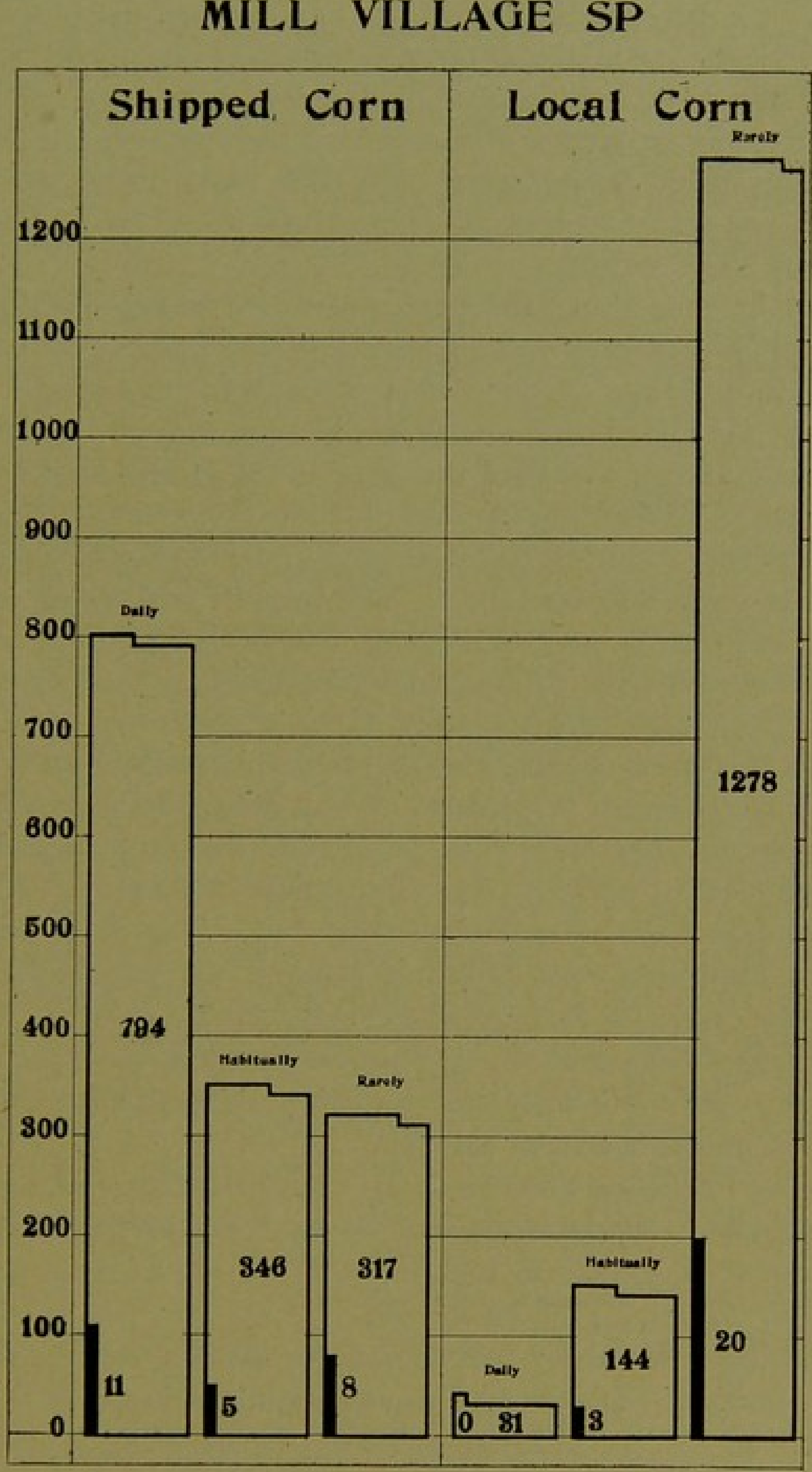


Fig. 8.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

It will be noted at once that local corn was not very extensively used. More than three-quarters of the total families never used it. It was most largely used in the village Sa, and used by relatively least number of families in the large villages of P and Sp. The distribution of the 134 families containing one or more cases of pellagra in respect to the frequency of use of local corn is shown in Table 18.

By assembling these figures into the usual three summarized groups in respect to frequency of use of the food, the figures shown in Table 19 are obtained.

It will be noted that the percentage of families having one or more cases of pellagra was highest in the village Sa, namely, 24.5 per cent., in which, as we have seen above, local corn-meal was most extensively used; and was lowest in the large villages, P and Sp, in which this foodstuff was used the least. This is undoubtedly due, in our opinion, to a tendency of some families living in pellagrous districts to restrict their use of shipped corn and substitute for it, in whole or in part, local corn-meal. The theories concerning causation of the disease which may be held by the local physicians or by the people themselves also seems to be reflected to some extent in the food data. In respect to frequency of use of local corn-meal in relation to the existence of pellagra, the data indicate no particular connection. The highest percentage of pellagrin families occurred in those using this food rarely or never, but the percentage in those who never used it, namely, 15.4, was practically the same as the general percentage for all families, namely, 15.5. In general those families using local corn-meal daily had pellagra less frequently, but the number of families in this group (namely, 36) is, after all, too small to be of much significance. It does show, however, that families using local corn-meal daily and avoiding shipped meal altogether, nevertheless did suffer from pellagra.

These 866 families were made up of 5,089 persons of whom 194 were pellagrins. The distribution of the 5,089 persons and of the 194 pellagrins in respect to the frequency of use of local corn-meal is shown in Tables 21, 22, 23 and 24.

It is evident that the frequency of use of local corn-meal has no definite consistent relation to the pellagra morbidity. In the whole population of the six villages, the 201 persons using it daily show a somewhat smaller proportionate number of cases than the larger group using it rarely or never. Yet, in two villages, I and P, the highest morbidity was among those using this food daily; in two others, Sa and Sp, the highest morbidity was among those using it habitually, and in the remaining two villages, W and A, those persons using local corn rarely or never had the most pellagra. This food

BLE 18.—Families Containing One or More Cases of Pellagra, Distributed According to Frequency of Use of Local Corn-Meal

age	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
:	1	0	1	2	0	0	10	14
V	1	0	0	1	0	0	18	20
›	1	1	0	2	0	0	24	28
a	1	4	0	3	1	2	13	24
ι	0	0	2	0	0	0	15	17
p	0	0	0	4	0	1	26	31
1..	4	5	3	12	1	3	106	134

TABLE 19.—Summarized Distribution of Families According to Frequency of Use of Local Corn-Meal

Village	Total Families			Pellagrin Families		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	5	23	75	1	2	11
W	8	22	78	1	1	18
P	8	18	197	1	3	24
Sa	10	23	65	1	8	15
A	0	9	73	0	0	17
Sp	5	23	224	0	4	27
Total	36	118	712	4	18	112

TABLE 20.—Pellagrin Families in Total Families in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	20.0	8.7	14.7	13.6
W	12.5	4.5	23.1	18.5
P	12.5	16.7	12.2	12.6
Sa	10.0	34.8	23.1	24.5
A	....	0.0	23.3	20.7
Sp	0.0	17.4	12.1	12.3
Total.........	11.1	15.3	15.7	15.5

TABLE 21.—Distribution of Total Individuals According to Frequency of Use of Local Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	25	26	8	71	40	13	413	596
W	56	22	4	90	14	0	389	575
P	30	20	21	74	16	5	1,210	1,376
Sa	59	47	8	63	35	20	404	636
A	0	11	18	45	3	7	352	436
Sp	31	20	12	84	37	4	1,282	1,470
Total..	201	146	71	427	145	49	4,050	5,089

TABLE 22.—Distribution of Pellagrins According to Frequency of Use of Local Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	1	0	3	3	0	0	13	20
W	1	0	0	2	0	0	20	23
P	3	1	0	4	0	0	29	37
Sa	1	8	0	3	2	3	23	40
A	0	0	2	0	0	0	25	27
Sp	0	0	0	5	0	1	41	47
Total..	6	9	5	17	2	4	151	194

TABLE 23.—Summarized Distribution According to Frequency of Use of Local Corn-Meal

Village	Total Population			Individual Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	25	137	434	1	3	16
W	56	126	393	1	2	20
P	30	110	1,236	3	5	29
Sa	59	145	432	1	13	26
A	0	59	377	0	0	27
Sp	31	141	1,298	0	5	42
Total	201	718	4,170	6	28	160

was most commonly used in the village Sa, in which pellagra was very prevalent, and was used hardly at all in village A, in which pellagra morbidity was almost as high.

It remains now to study the population free from pellagra at the beginning of the year 1912 and the cases which developed in this population during 1912 and 1913, concerning which we have data in regard to the frequency of use of local corn-meal. The distribution of the total families (875) in this population and of the families in which new cases of pellagra occurred (84) are shown in Tables 25, 26, 27 and 28.

TABLE 24.—PELLAGRA MORBIDITY IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	4.00	2.19	3.69	3.36
W	1.79	1.59	5.09	4.00
P	10.00	4.55	2.35	2.69
Sa	1.69	8.97	6.02	6.29
A	....	0.00	7.16	6.19
Sp	0.00	3.55	3.24	3.20
Total.........	2.99	3.90	3.84	3.81

BLE 25.—DISTRIBUTION OF TOTAL FAMILIES ACCORDING TO FREQUENCY OF USE OF LOCAL CORN-MEAL

lage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	5	7	1	11	6	2	75	107
W	8	3	1	16	2	1	79	110
P	8	4	4	12	2	1	192	223
;a	10	7	2	10	6	3	62	100
A	0	1	2	7	1	3	67	81
;p	5	4	2	13	7	1	222	254
al..	36	26	12	69	24	11	697	875

Approximately 80 per cent. of the families here considered did not use local corn-meal, so that the groups using it are composed of only a few families each. It is perfectly evident, however, that new cases of pellagra occurred in one or more families in every group without any definite consistent relation to the frequency of use of local corn-meal.

TABLE 26.—Distribution of Families in which New Cases of Pellagra Occurred in 1912 and 1913, According to Frequency of Use of Local Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	1	0	1	2	1	0	11	16
W	1	0	0	1	0	1	8	11
P	1	0	0	1	0	0	17	19
Sa	0	1	0	0	1	2	8	12
A	0	0	0	0	0	1	9	10
Sp	0	1	0	2	0	0	13	16
Total..	3	2	1	6	2	4	66	84

TABLE 27.—Summarized Distribution of Families According to Frequency of Use of Local Corn-Meal

Village	Total Families			Families with Incident Pellagra		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	5	24	78	1	3	12
W	8	21	81	1	1	9
P	8	18	197	1	1	17
Sa	10	23	67	0	2	10
A	0	9	72	0	0	10
Sp	5	24	225	0	3	13
Total	36	119	720	3	10	71

TABLE 28.—Families with Incident Pellagra in Total Families in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	20.0	12.5	15.4	15.0
W	12.5	4.8	11.1	10.0
P	12.5	5.6	8.6	8.5
Sa	0.0	8.7	14.9	12.0
A	....	0.0	13.9	12.3
Sp	0.0	12.5	5.8	6.3
Total.........	8.3	8.4	9.9	9.6

In the 875 families just considered, there were 4,999 persons who were not pellagrins, so far as we could ascertain, at the beginning of the year 1912. Of these 4,999 persons, 109 contracted the disease during 1912 and 1913. The distribution according to the use of local corn-meal in their families, of the 4,999 total individuals and of the 109 who became pellagrins in 1912 and 1913, is shown in Tables 29, 30, 31 and 32.

3LE 29.—Distribution of Individuals According to Frequency of Use of Local Corn-Meal

age	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
	25	26	8	71	44	13	440	627
V	56	22	4	89	14	6	381	572
	28	19	21	72	16	5	1,200	1,361
a	58	41	8	60	34	20	401	622
	0	0	0	0	0	12	352	364
p	31	26	12	81	37	3	1,263	1,453
l..	198	134	53	373	145	59	4,037	4,999

3LE 30.—Distribution of Incident Pellagrins According to Frequency of Use of Local Corn-Meal

age	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
	1	0	3	3	1	0	14	22
/	1	0	0	1	0	3	8	13
	1	0	0	2	0	0	19	22
a	0	2	0	0	1	3	8	14
	0	0	0	0	0	1	14	15
p	0	1	0	2	0	0	20	23
l..	3	3	3	8	2	7	83	109

There is a suggestion of an inverse relation between the use of local corn-meal and the occurrence of new cases of pellagra in this population as a whole, those using it daily showing an incidence of new cases of 1.52 per cent., whereas those using it rarely or never show an incidence of 2.24 per cent. In village A, in which local corn-meal scarcely entered into the diet, the highest incidence of new cases was

TABLE 31.—Summarized Distribution According to Frequency of Use of Local Corn-Meal

Village	Total Individuals			Incident Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	25	141	461	1	4	17
W	56	125	391	1	1	11
P	28	107	1,226	1	2	19
Sa	58	135	429	0	3	11
A	0	0	364	0	0	15
Sp	31	144	1,278	0	3	20
Total	198	652	4,149	3	13	93

TABLE 32.—Incidence of Pellagra in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	4.00	2.84	3.69	3.51
W	1.79	0.80	2.81	2.27
P	3.57	1.87	1.55	1.62
Sa	0.00	2.22	2.56	2.25
A	....	....	4.12	4.12
Sp	0.00	2.08	1.56	1.58
Total.........	1.52	1.99	2.24	2.18

observed. In two villages, however, namely, I and P, the incidence was highest in the group using local corn-meal daily. Probably several conflicting factors disturb the relationships. In general we believe that people who use local corn daily are likely to be particular about their diet in other respects, and often are in better financial condition than the average of the population. These associated factors would doubtless operate to diminish the incidence of pellagra in this group. On the other hand, certain families, after one of their members has contracted pellagra, not only tend to restrict their use of shipped corn, but in some cases they tend to substitute local corn for it. As we shall see in a subsequent section of this report, the members of such families seem to be especially likely to develop the disease, and this may be a factor in the high incidence in those using this food daily in certain villages. In any event, it is clear that this study of the use of local corn has failed to reveal any consistent relation between it and pellagra.

ANY CORN-MEAL

Corn-meal was used by the vast majority of the population studied. Most of those who never used shipped corn-meal did use local corn-meal. It therefore seems desirable to examine the data concerning the use of any corn-meal. The records in respect to this foodstuff include 858 families present in the six villages at the time of our census in 1913, of which 137 contained one or more cases of pellagra. The distribution of the 858 total families and of the 137 pellagrin families in respect to the use of corn-meal is shown in Tables 33, 34, 35 and 36.

BLE 33.—Distribution of Total Families According to Frequency of Use of Any Corn-Meal

lage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	63	26	13	0	0	1	2	105
W	67	24	3	0	0	0	0	94
P	137	59	27	0	0	0	2	225
a	59	26	14	0	0	0	1	100
A	40	23	19	1	0	0	0	83
p	149	49	29	2	1	0	21	251
al..	515	207	105	3	1	1	26	858

BLE 34.—Families Containing One or More Cases of Pellagra, Distributed According to Frequency of Use of Any Corn-Meal

lage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	8	3	3	0	0	0	0	14
W	11	6	2	0	0	0	0	19
P	14	10	5	0	0	0	0	29
a	15	7	4	0	0	0	1	27
A	7	5	5	0	0	0	0	17
p	16	6	3	2	1	0	3	31
al..	71	37	22	2	1	0	4	137

Corn-meal was used by all but 26 of the 858 families, and by 515 of these families it was used daily. In one village, Sp, there were 21 families who avoided the use of corn-meal, probably as a prophylactic measure against pellagra. In every one of the six villages the existence of pellagra was relatively less frequent in the families using corn-meal daily than in those using it rarely. This is probably due to a tendency on the part of some pellagrin families to restrict their use of corn-meal. It certainly does not indicate any consistent positive correlation between use of corn-meal and presence of pellagra in these families.

TABLE 35.—SUMMARIZED DISTRIBUTION OF FAMILIES ACCORDING TO THE USE OF ANY CORN-MEAL

Village	Total Families			Pellagrin Families		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	63	26	16	8	3	3
W	67	24	3	11	6	2
P	137	59	29	14	10	5
Sa	59	26	15	15	7	5
A	40	24	19	7	5	5
Sp	149	52	50	16	9	6
Total	515	211	132	71	40	26

TABLE 36.—PELLAGRIN FAMILIES IN TOTAL FAMILIES IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	12.7	11.5	18.8	13.3
W	16.4	25.0	66.7	20.2
P	10.2	16.9	17.2	12.9
Sa	25.4	26.9	33.3	27.0
A	17.5	20.8	26.3	20.5
Sp	10.7	17.3	12.0	12.4
Total.........	13.8	19.0	19.7	16.0

These 858 families included 5,095 individuals, of whom 196 were pellagrins. Their distribution in respect to the use of corn-meal is shown in Tables 37, 38, 39 and 40.

It is evident that nearly everybody in these villages used corn-meal to some extent. Only 123 persons were members of families in which this foodstuff was not used and 97 of these persons were in one village, Sp. The inverse relation between the existence of pellagra and the use of corn is clearly shown in Table 40. In every village there were relatively more cases of pellagra in the population using this food rarely or never than in the group using it daily. Of

BLE 37.—DISTRIBUTION OF TOTAL INDIVIDUALS ACCORDING TO FREQUENCY OF USE OF ANY CORN-MEAL

lage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	381	141	70	0	0	2	6	600
W	415	128	17	0	0	0	0	560
P	850	377	147	0	0	0	11	1,385
Sa	367	183	77	0	0	0	9	636
A	212	152	86	4	0	0	0	454
Sp	910	278	159	9	7	0	97	1,460
al..	3,135	1,259	556	13	7	2	123	5,095

BLE 38.—DISTRIBUTION OF PELLAGRINS ACCORDING TO FREQUENCY OF USE OF ANY CORN-MEAL

lage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	12	3	5	0	0	0	0	25
W	14	8	3	0	0	0	0	38
P	18	12	8	0	0	0	1	38
Sa	20	12	5	0	0	0	0	27
A	12	7	8	0	0	0	5	46
Sp	22	9	6	3	1	0	0	20
al..	98	51	35	3	1	0	6	194

TABLE 39.—SUMMARIZED DISTRIBUTION ACCORDING TO FREQUENCY OF USE OF ANY CORN-MEAL

Village	Total Population			Individual Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	381	141	78	12	3	5
W	415	128	17	14	8	3
P	850	377	158	18	12	8
Sa	367	183	86	20	12	6
A	212	156	86	12	7	8
Sp	910	294	256	22	13	11
Total	3,135	1,279	681	98	55	41

the 123 persons recorded as never using corn-meal, six (or 4.9 per cent.) were pellagrins, a relative morbidity greater than that observed in persons using corn-meal daily. It should be noted, however, that this group is made up of persons who were not using corn-meal at the time of the census and had not used it for the preceding two years. Doubtless most if not all these persons had at some time used corn-meal. The information in regard to diet in these tables refers therefore to the diet at the time of observation, namely, 1912 and 1913, and not necessarily to the diet at the time when pellagra originated.

TABLE 40.—Pellagra Morbidity in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	3.15	2.13	6.41	3.33
W	3.37	6.25	17.65	3.46
P	2.12	3.18	5.06	2.74
Sa	5.45	6.56	6.98	5.97
A	5.66	4.49	9.30	5.95
Sp	2.42	4.42	4.30	3.15
Total.........	3.13	4.30	6.02	3.81

TABLE 41.—Distribution of Total Families According to Frequency of Use of Any Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	65	27	13	0	0	1	2	108
W	68	24	4	0	0	0	1	97
P	137	59	27	0	0	0	2	225
Sa	61	26	14	0	0	0	1	102
A	40	23	19	1	0	0	0	83
Sp	150	50	29	2	1	0	21	253
Total..	521	209	106	3	1	1	27	868

The use of any corn-meal by incident cases of pellagra would appear to be of particular interest. The total population of these six mill villages, for which we have available data for a study of this topic, includes 868 families, in 85 of which new cases of pellagra developed in 1912 and 1913. The distribution of these families in respect to the use of any corn-meal is shown in Tables 41, 42, 43 and 44.

BLE 42.—Distribution of Families in which New Cases of Pellagra Occurred in 1912 or 1913, According to Frequency of Use of Any Corn-Meal

age	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
[illegible]	10	4	2	0	0	0	0	16
V	7	1	1	0	0	0	1	10
[illegible]	11	4	5	0	0	0	0	20
a	6	4	2	0	0	0	0	12
[illegible]	3	4	3	0	0	0	0	10
p	10	4	1	0	0	0	2	17
l..	47	21	14	0	0	0	3	85

TABLE 43.—Summarized Distribution of Families According to Frequency of Use of Any Corn-Meal

Village	Total Families			Families with Incident Pellagra		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	65	27	16	10	4	2
W	68	24	5	7	1	2
P	137	59	29	11	4	5
Sa	61	26	15	6	4	2
A	40	24	19	3	4	3
Sp	150	53	50	10	4	3
Total	521	213	134	47	21	17

TABLE 44.—Families with Incident Pellagra in Total Families in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	15.4	14.8	12.5	14.8
W	10.3	4.2	40.0	10.3
P	8.0	6.8	17.2	8.9
Sa	9.8	15.4	13.3	11.8
A	7.5	16.7	15.8	12.0
Sp	6.7	7.5	6.0	6.7
Total.........	9.0	9.9	12.7	9.8

The incidence of new cases of pellagra in families shows no consistent relation to the frequency of use of corn-meal by these families. In four villages, W, P, Sa and A, and in the total families in the six villages, the families using corn-meal rarely or never developed new cases of pellagra relatively more frequently than those using this foodstuff daily, whereas in two villages, I and Sp, this relation was reversed. In the 27 families not using corn-meal during 1912 and 1913, there were three (or 11.1 per cent.) in which new cases of pellagra developed. This percentage is very similar to the analogous figures in the groups using corn-meal daily, habitually or rarely, and suggests that frequency of use of corn-meal in 1912 and 1913 had no direct relation to the development of new cases of pellagra in these families.

The 868 families just considered included 5,056 persons who were not pellagrins at the beginning of the year 1912. Of these 5,056 persons, 108 developed the disease during 1912 and 1913. The distribution of these persons according to the frequency of use of any corn-meal is shown in Tables 45, 46, 47 and 48.

TABLE 45.—Distribution of Individuals According to Frequency of Use of Any Corn-Meal

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	396	153	69	0	0	2	6	626
W	410	121	20	0	0	0	3	554
P	845	369	145	0	0	0	11	1,370
Sa	365	176	76	0	0	0	8	625
A	206	149	83	0	0	0	0	438
Sp	902	278	156	6	6	0	95	1,443
Total..	3,124	1,246	549	6	6	2	123	5,056

The incidence of new cases of pellagra was highest, in each of the six villages, among those persons using corn-meal rarely or never; and in the total population considered together, the incidence in this group was more than twice that of the group using corn-meal daily. The difference is more pronounced than that shown in the study of the families as units, and this means that families using little or no corn-meal not only developed new cases of pellagra more than the families using this food daily, but also developed multiple cases in the same family more frequently. The figures indicate very clearly that restriction or omission of corn-meal as an article of diet failed as

BLE 46.—Distribution of Incident Pellagrins According to Frequency of Use of Any Corn-Meal

llage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	14	4	4	0	0	0	0	22
W	6	1	3	0	0	0	1	11
P	13	4	6	0	0	0	0	23
Sa	6	5	4	0	0	0	0	15
A	6	4	5	0	0	0	0	15
Sp	12	4	3	0	0	0	3	22
al..	57	22	25	0	0	0	4	108.

TABLE 47.—Summarized Distribution According to Frequency of Use of Any Corn-Meal

Village	Total Individuals			Incident Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	396	153	77	14	4	4
W	410	121	23	6	1	4
P	845	369	156	13	4	6
Sa	365	176	84	6	5	4
A	206	149	83	6	4	5
Sp	902	290	251	12	4	6
Total	3,124	1,258	674	57	22	29

TABLE 48.—Incidence of Pellagra in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	3.54	2.61	5.19	3.51
W	1.46	0.83	17.39	1.99
P	1.54	1.08	3.85	1.68
Sa	1.64	2.84	4.76	2.40
A	2.91	2.68	6.02	3.42
Sp	1.33	1.38	2.39	1.52
Total.........	1.82	1.75	4.30	2.14

a prophylactic measure against pellagra in this population and suggest very strongly that it cannot be relied on for the control of pellagra.

The group of the population recorded as never using any corn-meal is of particular interest, and especially those families and the four persons in this group in whom pellagra developed in 1912 and 1913. One of these cases occurred in village W and the other three in village Sp, two of them in one family. The family in village W consisted of a man and wife, both about 65 years old, and three grown daughters. Corn-bread had been a staple article of diet until the summer of 1911, after which time it was no longer used. The youngest daughter, Case 78, developed pellagra in 1910 when she was 17 years old. The oldest daughter, Case 77, developed pellagra in the summer of 1911 when she was 27 years old. Both of these were pellagrins before the period of our observations. In June, 1912, about a year after the exclusion of corn-meal from the diet, the third sister, then aged 25, developed a typical erythema, and a diagnosis of pellagra was made. This recurred in July, 1913, without other symptoms. This case, 668, is regarded as incident in 1912, one year after the exclusion of corn-meal from the diet, and is therefore classed in the group of the population not using corn-meal. In the village Sp there are two families to be considered. One of these consisted of a mother, aged 41, and her son, aged 19. Corn-meal was not used, and our record clearly places this family in the class designated as never using this food. The record does not go into the matter in detail, and we do not know with certainty how long it had been excluded from the diet. The woman, Case 742, developed erythema for the first time in August, 1913, and this was accompanied by digestive disturbance and nervous symptoms. The remaining family consisted of a man and wife and three children. The wife, Case 25, developed pellagra in April, 1910, while residing at Columbia, S. C. She was then 38 years old. At that time she consulted one of the most eminent authorities on pellagra in this country and, at his advice, corn-meal was rigidly excluded from the diet of the whole family and none of it has been allowed in the house since 1910. The family moved to Spartanburg in the fall of 1911. The attack of pellagra recurred in the woman in 1911, 1912 and 1913. Early in June, 1912, two of the children, a girl aged 13 and a boy aged 6, developed typical erythema of the hands, and stomatitis. The boy also showed the eruption on his feet and had some diarrhea. In 1913 the boy remained free from symptoms of the disease, but it recurred in his sister with typical erythema, diarrhea and nervous excitability. These two children have been placed in the class not using corn-meal at the time of incidence of pellagra.

The theory that pellagra is caused by the excessive use of corn-meal is not supported by this study. Although every person in the population here considered probably ate corn-meal at some time in his life, there were found two cases of pellagra in which the use of

MILL VILLAGE I

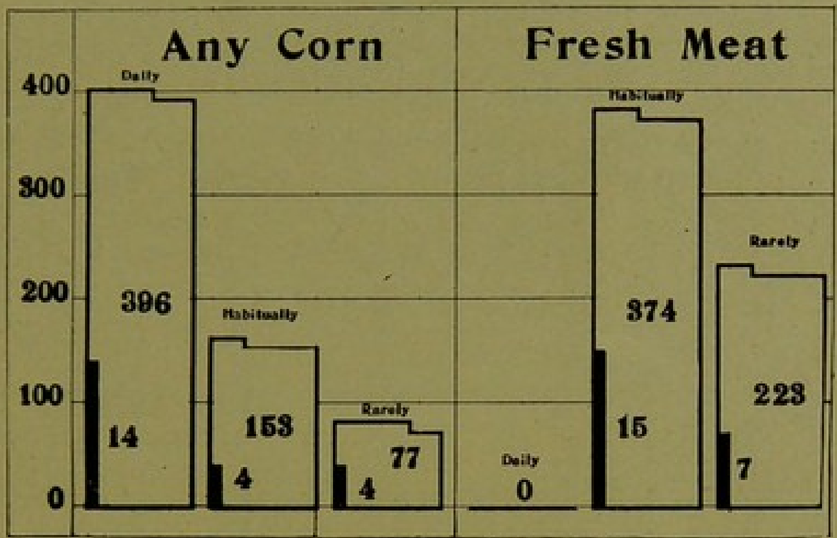


Fig. 9.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE W

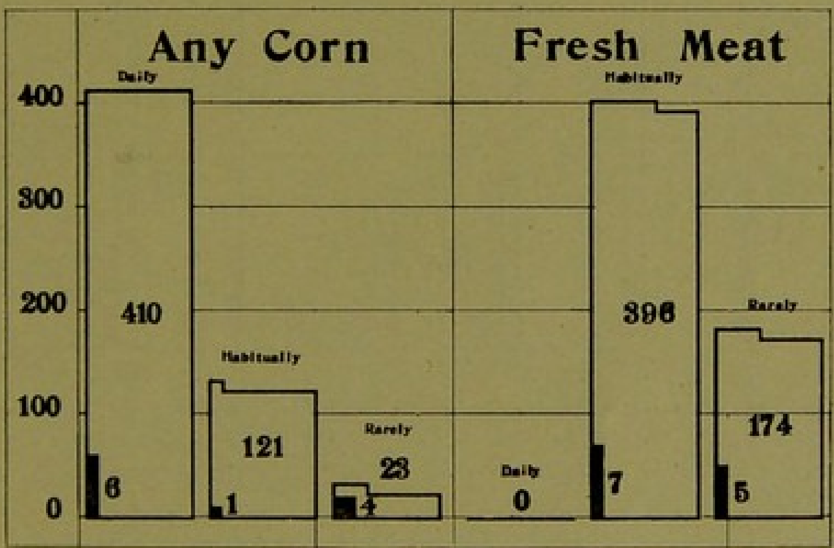


Fig. 10.—The area of each large white column indicattes the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

this foodstuff could be excluded with almost absolute certainty for a period of two years preceding the development of the first sign of the disease, and there were two other cases in which corn-meal had been excluded from the diet for a year previous to the development of the disease. The total persons in the population studied who have been classed as not using corn-meal amounted to only 123, and it may truly be said that non-pellagrins were placed in this group with much less careful scrutiny than were incident pellagrins. Of these 123 persons, four developed the disease in 1912 and 1913, an incidence of 3.25 per cent. This rate of incidence is greater than that observed among

MILL VILLAGE P

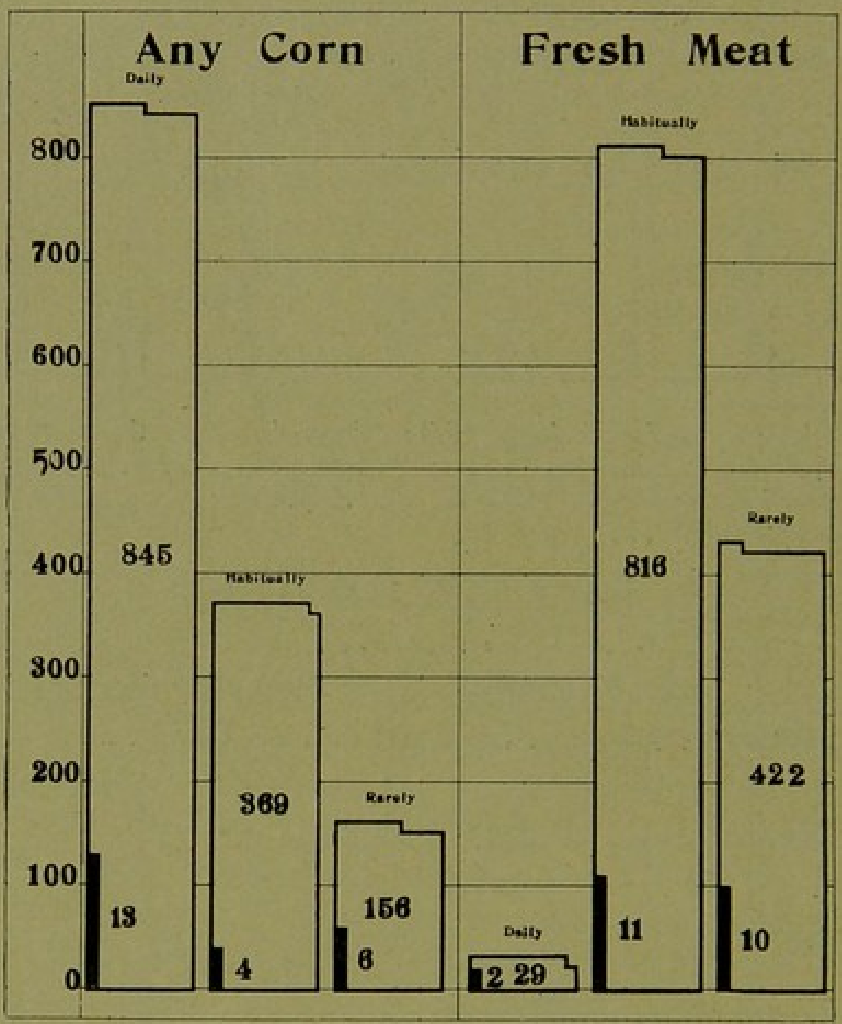


Fig. 11.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

those using corn-meal daily (1.82 per cent.) or habitually (1.75 per cent.). In this population, therefore, the occurrence of new cases of pellagra seems to bear an inverse relation to the frequency of use of corn-meal.

Without committing ourselves to a final opinion, we may offer some suggestions in explanation of these facts. In the first place it seems certain that corn-meal cannot rightly be regarded as the essential cause of pellagra. The high incidence in those using little corn-meal we believe to be due to their close association with previous pellagra patients. It is chiefly in those families already having one case of pellagra that the use of this food has been intentionally restricted.

MILL VILLAGE SA

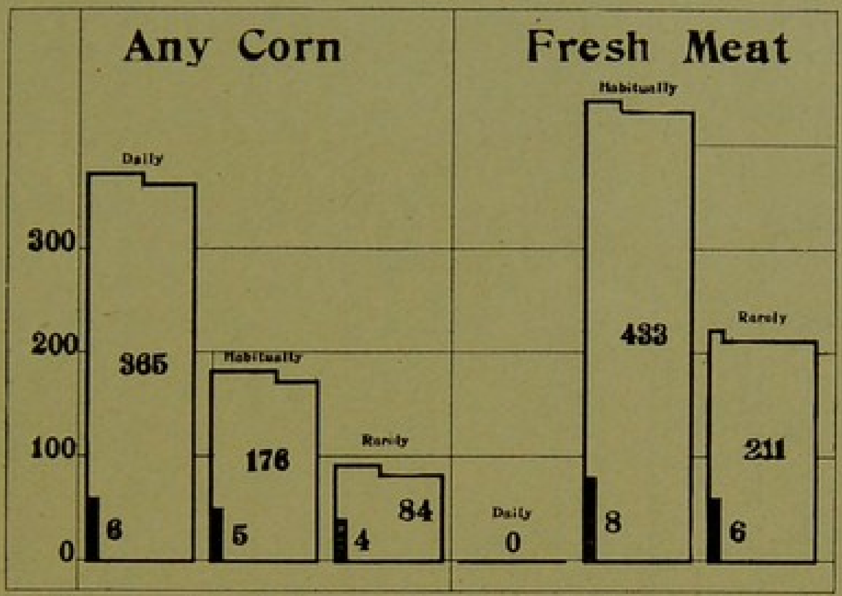


Fig. 12.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE A

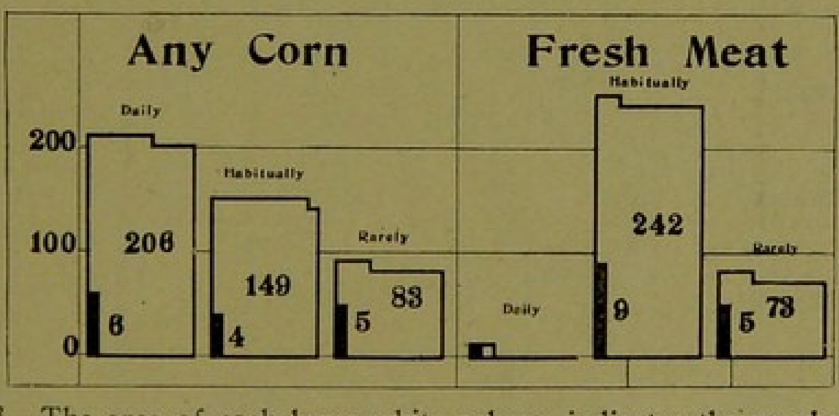


Fig. 13.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

This study has failed to reveal evidence of causal relationship of corn-meal to pellagra, and has shown that restriction of the use of corn-meal in the population studied has not proved effective as a prophylactic measure against pellagra.

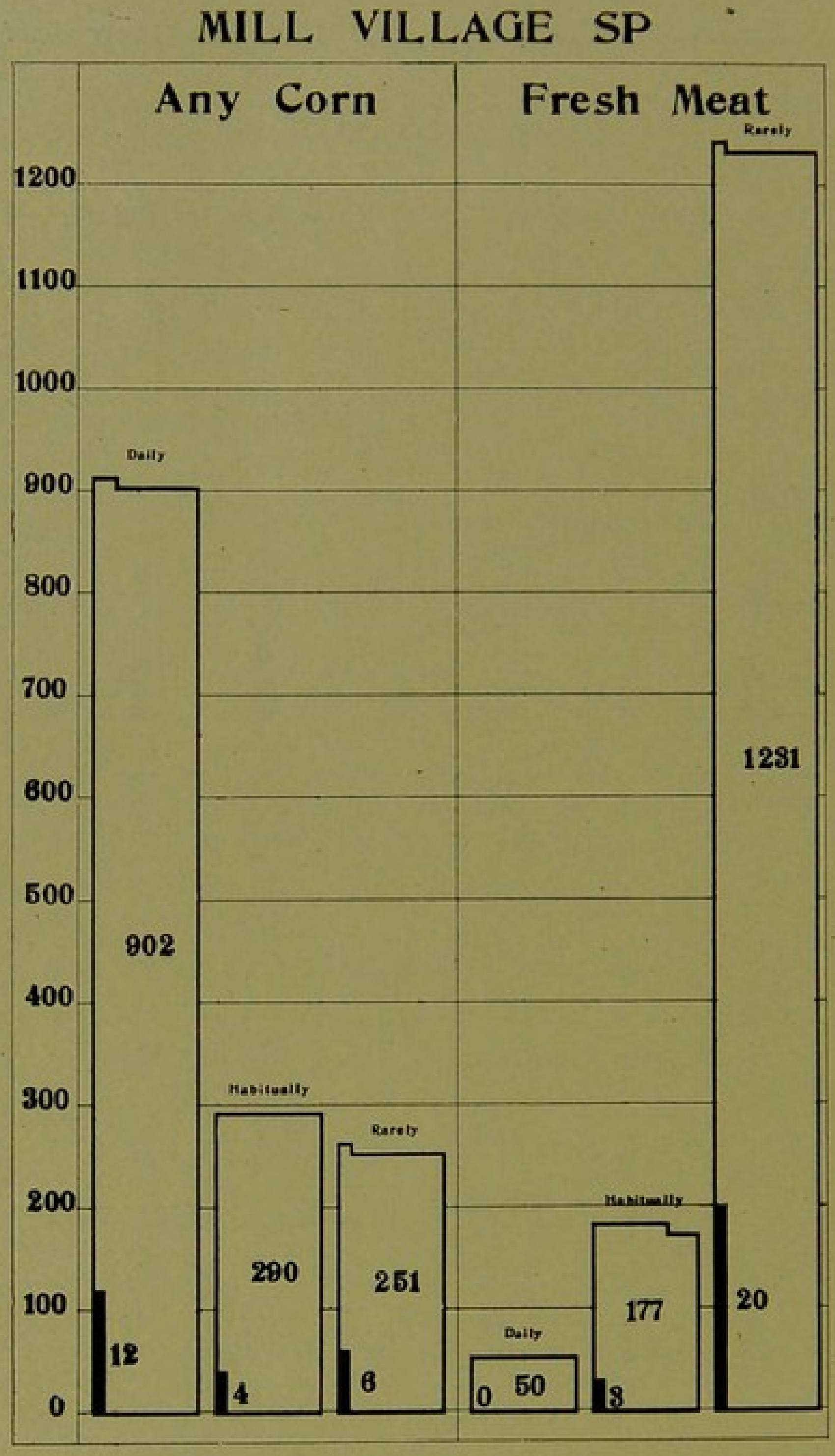


Fig. 14.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

FRESH MEAT

The recorded data in regard to the frequency of use of fresh meat by families present at the time of our census in these six mill villages relate to 861 families, of which 140 then contained one or more cases of pellagra. The distribution of these families according to frequency of use of this food is shown in Tables 49, 50, 51 and 52.

BLE 49.—Distribution of Total Families According to Frequency of Use of Fresh Meat

lage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
[	0	14	33	2	40	4	2	95
V	0	6	7	2	52	15	12	94
›	4	88	47	1	65	13	12	230
a	0	8	31	0	62	6	0	107
\	1	14	15	2	33	7	11	83
p	8	21	204	1	9	0	9	252
l..	13	151	337	8	261	45	46	861

ABLE 50.—Families Containing One or More Cases of Pellagra, Distributed According to Frequency of Use of Fresh Meat

age	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
	0	1	4	0	8	1	0	14
/	0	1	3	0	10	2	3	19
›	1	12	6	0	7	3	1	30
a	0	4	9	0	15	1	0	29
ι	1	4	4	0	8	0	0	17
p	1	1	26	1	2	0	0	31
1..	3	23	52	1	50	7	4	140

The daily use of fresh meat was rather uncommon in this population, only thirteen families falling in this group. Almost half the families (420) used this food habitually, part time daily or part time habitually, and about half of them (428) used it rarely or never. In two of the villages we failed to find any families in which fresh meat was used daily. The families containing cases of pellagra occur in all the groups and are relatively most numerous in the group using fresh meat daily and least numerous in the summarized group using this food rarely or never. In those families avoiding fresh meat altogether, only 4 out of a total of 46 had cases of pellagra, or 8.7 per cent., a lower percentage than in any other group.

TABLE 51.—SUMMARIZED DISTRIBUTION OF FAMILIES ACCORDING TO FREQUENCY OF USE OF FRESH MEAT

Village	Total Families			Pellagrin Families		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	0	56	39	0	9	5
W	0	60	34	0	11	8
P	4	154	72	1	19	10
Sa	0	70	37	0	19	10
A	1	49	33	1	12	4
Sp	8	31	213	1	4	26
Total	13	420	428	3	74	63

TABLE 52.—PELLAGRIN FAMILIES IN TOTAL FAMILIES IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	....	16.1	12.8	14.7
W	....	18.3	23.5	20.2
P	25.0	12.3	13.9	13.0
Sa	....	27.1	27.0	27.1
A	100.0	24.5	12.1	20.5
Sp	12.5	12.9	12.2	12.3
Total.........	23.1	17.6	14.7	16.3

The 861 families just considered included 5,133 persons, of whom 199 were pellagrins. The distribution of these persons according to the frequency of use of fresh meat in their families is shown in Tables 53, 54, 55 and 56.

It is evident that only a few (82) persons in this population used fresh meat daily, while 263 did not use it at all. About half the population (2,591 persons) used fresh meat as often as twice a week during part of the year at least, while the remaining population used this food less frequently. In certain mill villages, I, W, Sa and A, fresh meat could be had at local markets in the village only during the colder season of the year; during the summer the inhabitants were com-

BLE 53.—Distribution of Total Individuals According to Frequency of Use of Fresh Meat

llage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	102	182	13	233	28	11	569
W	0	43	43	16	339	70	64	575
P	29	550	281	4	403	73	71	1,411
Sa	0	62	183	0	375	32	0	652
A	2	88	75	23	163	32	67	450
Sp	51	115	1,198	2	60	0	50	1,476
al..	82	960	1,962	58	1,573	235	263	5,133

BLE 54.—Distribution of Pellagrins According to Frequency of Use of Fresh Meat

llage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	2	7	0	12	1	0	22
W	0	2	6	0	11	2	3	24
P	2	15	10	0	8	3	1	39
Sa	0	6	10	0	18	4	0	38
A	1	8	7	0	11	0	0	27
Sp	1	1	44	1	2	0	0	49
al..	4	34	84	1	62	10	4	199

TABLE 55.—Summarized Distribution According to Frequency of Use of Fresh Meat

Village	Total Population			Individual Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	0	348	221	0	14	8
W	0	398	177	0	13	11
P	29	957	425	2	23	14
Sa	0	437	215	0	24	14
A	2	274	174	1	19	7
Sp	51	177	1,248	1	4	44
Total	82	2,591	2,460	4	97	98

pelled to get their meat at more distant markets. In the large villages, P and Sp, the local markets sold fresh meat throughout the year. It was in these two villages that the lowest morbidity from pellagra was observed, namely, 2.76 and 3.32 per cent.

TABLE 56.—PELLAGRA MORBIDITY IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	....	4.02	3.62	3.87
W	....	3.27	6.21	4.17
P	6.90	2.41	3.29	2.76
Sa	....	5.49	6.51	5.83
A	50.00	6.93	4.02	6.00
Sp	1.96	2.26	3.53	3.32
Total.........	4.88	3.74	3.98	3.88

When we turn our attention to the morbidity in each of the dietary groups, the relation of pellagra to the use of fresh meat is much less evident. In one village, Sp, the morbidity increases progressively with the decrease in frequency of use of fresh meat, daily 1.96, habitually 2.26, rarely 3.53 per cent., but in the same village there were 50 persons who did not use this food at all and none of them had pellagra. In the other villages the correlation is even more confused, and in the total population of the six villages the pellagra morbidity is actually highest in the group of 82 persons who used fresh meat daily, namely, 4.88 per cent., while of the 263 persons who never used it, only 4 suffered from the disease (1.52 per cent.). The recorded data do not seem, therefore, to indicate any consistent correlation between the existence of pellagra and deficiency of fresh meat in the dietary of this population.

The population to be considered in relation to incident cases of pellagra included 884 families, in 85 of which new cases of pellagra developed in 1912 and 1913. The distribution of these families according to frequency of use of fresh meat is shown in Tables 57, 58, 59 and 60.

There is not a consistent correlation between the frequency of use of fresh meat and the origin of new cases of pellagra in these families. In two villages, Sa and Sp, the incidence is highest in the summarized group using fresh meat rarely, but in three villages, I, W and A, it is lowest in this group. In the total families the occurrence of new cases of pellagra seems to be correlated directly with the frequency of use of fresh meat. Even in those 56 families never

BLE 57.—Distribution of Total Families According to Frequency of Use of Fresh Meat

llage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	17	34	2	40	4	12	109
W	0	7	7	2	53	16	12	97
P	4	88	47	1	65	13	12	230
Sa	0	9	31	0	63	6	0	109
A	1	15	15	2	33	7	11	84
Sp	8	22	206	1	9	0	9	255
tal..	13	158	340	8	263	46	56	884

BLE 58.—Distribution of Families in which New Cases of Pellagra Occurred in 1912 or 1913, According to Frequency of Use of Fresh Meat

llage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	4	5	0	6	1	0	16
W	0	2	1	0	6	1	1	11
P	1	7	6	0	4	2	0	20
Sa	0	2	4	0	5	0	0	11
A	1	5	2	0	2	0	0	10
Sp	0	1	15	1	0	0	0	17
tal..	2	21	33	1	23	4	1	85

TABLE 59.—Summarized Distribution of Families According to Frequency of Use of Fresh Meat

Village	Total Families			Families with Incident Pellagra		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	0	59	50	0	10	6
W	0	62	35	0	8	3
P	4	154	72	1	11	8
Sa	0	72	37	0	7	4
A	1	50	33	1	7	2
Sp	8	32	215	0	2	15
Total	13	429	442	2	45	38

using fresh meat, there was only one in which an incident case of pellagra appeared, or 1.8 per cent., a very much lower rate of incidence than was observed in any other group.

In the 884 families just considered, there were 4,853 persons, of whom 109 contracted pellagra in 1912 and 1913. The distribution of these persons according to the frequency of use of fresh meat in their families is shown in Tables 61, 62, 63 and 64.

TABLE 60.—Families with Incident Pellagra in Total Families in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	....	16.9	12.0	14.7
W	....	12.9	8.6	11.3
P	25.0	7.1	11.1	8.7
Sa	....	9.7	10.8	10.1
A	100.0	14.0	6.1	11.9
Sp	0.0	6.3	7.0	6.7
Total.........	15.4	10.5	8.6	9.6

TABLE 61.—Distribution of Individuals According to Frequency of Use of Fresh Meat

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	131	184	13	230	28	11	597
W	0	45	38	16	335	74	62	570
P	29	464	280	4	348	72	70	1,267
Sa	0	65	179	0	368	32	0	644
A	2	88	73	0	154	0	0	317
Sp	50	117	1,181	2	58	0	50	1,458
Total..	81	910	1,935	35	1,493	206	193	4,853

New cases of pellagra developed in all the groups, and there is no consistent correlation between the incidence of these cases and the frequency of use of fresh meat. Of the 81 persons in families using this food daily, 3 acquired pellagra during the two years, a higher incidence (3.70 per cent.) than was observed in any other group. In the 193 persons who did not use fresh meat at all, only 1 new case of pellagra was observed, an incidence of 0.52 per cent., much lower than in any other group. In fact, in the village in which this one case

TABLE 62.—Distribution of Incident Pellagrins According to Frequency of Use of Fresh Meat

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	6	6	0	9	1	0	22
W	0	2	1	0	5	3	1	12
P	2	7	8	0	4	2	0	23
Sa	0	3	6	0	5	0	0	14
A	1	7	5	0	2	0	0	15
Sp	0	2	20	1	0	0	0	23
Total..	3	27	46	1	25	6	1	109

TABLE 63.—Summarized Distribution According to Frequency of Use of Fresh Meat

Village	Total Population			Incident Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	0	374	223	0	15	7
W	0	396	174	0	7	5
P	29	816	422	2	11	10
Sa	0	433	211	0	8	6
A	2	242	73	1	9	5
Sp	50	177	1,231	0	3	20
Total	81	2,438	2,334	3	53	53

TABLE 64.—Incidence of Pellagra in Each of the Summarized Groups, Per Cent.

Village	Daily	*Habitually*	*Rarely*	Total
I	....	4.01	3.14	3.69
W	....	1.77	2.87	2.11
P	6.90	1.35	2.37	1.82
Sa	....	1.85	2.84	2.17
A	50.00	3.72	6.85	4.73
Sp	0.00	1.69	1.62	1.58
Total.........	3.70	2.17	2.27	2.25

occurred there were 62 persons who did not use fresh meat, so that the incidence for that village alone was only 1.61 per cent. for this group. One finds here no support for the idea that deficiency of fresh meat in the diet is a cause of pellagra. On the contrary, it would appear quite certain that in the population here studied those avoiding fresh meat contracted this disease least.

TABLE 65.—Distribution of Total Families According to Frequency of Use of Canned Goods

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	2	17	58	0	0	0	10	87
W	3	27	48	1	0	0	12	91
P	4	58	136	0	0	1	27	226
Sa	1	21	75	1	0	0	8	106
A	3	21	54	0	0	0	3	81
Sp	3	15	178	0	0	0	54	250
Total..	16	159	549	2	0	1	114	841

TABLE 66.—Families Containing One or More Cases of Pellagra Distributed According to Frequency of Use of Canned Goods

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	4	9	0	0	0	0	13
W	0	1	12	1	0	0	3	17
P	0	9	16	0	0	1	5	31
Sa	0	6	20	1	0	0	2	29
A	0	3	14	0	0	0	0	17
Sp	0	0	24	0	0	0	7	31
Total..	0	23	95	2	0	1	17	138

CANNED GOODS

The data in regard to the use of canned goods (tinned foods) include 841 families present at the time of census, 138 of which contained one or more cases of pellagra at that time. The distribution of these families according to frequency of use of tinned foods is shown in Tables 65, 66, 67 and 68.

There is evidently no consistent positive correlation between the frequency of use of canned goods and the existence of cases of pellagra in these families. In fact the indication, if anything, would appear to be the reverse. The 16 families using this kind of food daily had no pellagra, while, of the 114 families avoiding canned goods altogether, no less than seventeen (14.9 per cent.), contained one or more cases of the disease.

TABLE 67.—SUMMARIZED DISTRIBUTION OF FAMILIES ACCORDING TO FREQUENCY OF USE OF CANNED GOODS

Village	Total Families			Pellagrin Families		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	2	17	68	0	4	9
W	3	28	60	0	2	15
P	4	58	164	0	9	22
Sa	1	22	83	0	7	22
A	3	21	57	0	3	14
Sp	3	15	232	0	0	31
Total	16	161	664	0	25	113

TABLE 68.—PELLAGRIN FAMILIES IN TOTAL FAMILIES IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	0.0	23.5	13.2	14.9
W	0.0	7.1	25.0	18.7
P	0.0	15.5	13.4	13.7
Sa	0.0	31.8	26.5	27.4
A	0.0	14.3	24.6	21.0
Sp	0.0	0.0	13.4	12.4
Total.........	0.0	15.5	17.0	16.4

The 841 families just considered contained 4,966 persons, of whom 192 were pellagrins. The distribution of these persons according to the frequency of use of tinned foods in their families is shown in Tables 69, 70, 71 and 72.

Evidence of correlation between the existence of pellagra in a family and the frequency of use of canned goods is not to be found in these tables. The 89 persons using canned foods daily had no pellagra. In the 643 persons who avoided such foods, 18, or 2.80 per cent., were pellagrins.

TABLE 69.—DISTRIBUTION OF TOTAL INDIVIDUALS ACCORDING TO FREQUENCY OF USE
CANNED GOODS

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	9	111	337	0	0	0	60	517
W	12	168	292	3	0	0	71	546
P	24	416	788	0	0	5	148	1,381
Sa	2	141	462	5	0	0	32	642
A	20	114	286	0	0	0	11	431
Sp	22	88	1,018	0	0	0	321	1,449
Total..	89	1,038	3,183	8	0	5	643	4,966

TABLE 70.—DISTRIBUTION OF PELLAGRINS ACCORDING TO FREQUENCY OF USE OF CANN
GOODS

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	5	14	0	0	0	0	19
W	0	1	17	1	0	0	3	22
P	0	12	21	0	0	1	6	40
Sa	0	9	25	2	0	0	2	38
A	0	4	22	0	0	0	0	26
Sp	0	0	40	0	0	0	7	47
Total..	0	31	139	3	0	1	18	192

TABLE 71.—SUMMARIZED DISTRIBUTION ACCORDING TO FREQUENCY OF USE OF CANNED GOODS

Village	Total Population			Individual Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	9	111	397	0	5	14
W	12	171	363	0	2	20
P	24	416	941	0	12	28
Sa	2	146	494	0	11	27
A	20	114	297	0	4	22
Sp	22	88	1,339	0	0	47
Total	89	1,046	3,831	0	34	158

For the study of the occurrence of new cases of pellagra in relation to the use of canned goods, we have data on 853 families, in 85 of which one or more new cases of the disease developed in 1912 or 1913. The distribution of these families in respect to frequency of use of tinned foods is shown in Tables 73, 74, 75 and 76.

TABLE 72.—PELLAGRA MORBIDITY IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	0	4.55	3.53	3.68
W	0	1.17	5.51	4.03
P	0	2.88	2.98	2.90
Sa	0	7.53	5.47	5.92
A	0	3.51	7.41	6.03
Sp	0	0.00	3.51	3.24
Total.........	0	3.25	4.12	3.87

BLE 73.—DISTRIBUTION OF TOTAL FAMILIES ACCORDING TO FREQUENCY OF USE OF CANNED GOODS

lage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	2	17	61	0	1	0	10	91
V	3	27	50	1	0	0	13	94
P	4	58	136	0	0	1	27	226
a	1	22	76	1	1	0	8	109
A	3	21	54	0	0	0	3	81
p	3	15	180	0	0	0	54	252
al..	16	160	557	2	2	1	115	853

The occurrence of new cases of pellagra in a family does not appear to have been influenced in any consistent way by the frequency with which the family used canned goods. The 16 families using canned goods daily had no new cases of the disease during the two years. Of the 115 families avoiding the use of these foods, 8 (7 per cent.), had new cases of pellagra during 1912 or 1913.

The 853 families just considered included 4,874 persons, of whom 109 persons contracted pellagra in 1912 or 1913. The distribution of these persons according to frequency of use of tinned foods is shown in Tables 77, 78, 79 and 80.

TABLE 74.—DISTRIBUTION OF FAMILIES IN WHICH NEW CASES OF PELLAGRA OCCURRED IN 1912 OR 1913, ACCORDING TO FREQUENCY OF USE OF CANNED GOODS

Village	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	2	12	0	1	0	0	15
W	0	0	9	1	0	0	1	11
P	0	8	10	0	0	1	1	20
Sa	0	2	8	1	1	0	0	12
A	0	2	8	0	0	0	0	10
Sp	0	0	11	0	0	0	6	17
Total..	0	14	58	2	2	1	8	85

TABLE 75.—SUMMARIZED DISTRIBUTION OF FAMILIES ACCORDING TO FREQUENCY OF USE OF CANNED GOODS

Village	Total Families			Families with Incident Pellagra		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	2	18	71	0	3	12
W	3	28	63	0	1	10
P	4	58	164	0	8	12
Sa	1	24	84	0	4	8
A	3	21	57	0	2	8
Sp	3	15	234	0	0	17
Total	16	164	673	0	18	67

TABLE 76.—FAMILIES WITH INCIDENT PELLAGRA IN TOTAL FAMILIES IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	0	16.7	16.9	16.5
W	0	3.6	15.9	11.7
P	0	13.8	7.3	8.8
Sa	0	16.7	9.5	11.0
A	0	9.5	14.0	12.3
Sp	0	0.0	7.3	6.7
Total.........	0	11.0	10.0	10.0

TABLE 77.—Distribution of Individuals According to Frequency of Use of Canned Goods

illage	Daily	Habitually	Rarely	Part Time			Never	Total
				Dailv	Habitually	Rarelv		
I	9	108	367	0	3	0	60	547
W	12	168	291	3	0	0	71	545
P	24	352	778	0	0	5	144	1,303
Sa	2	140	452	5	7	0	32	638
A	20	112	277	0	0	0	0	409
Sp	22	88	1,002	0	0	0	320	1,432
tal..	89	968	3,167	8	10	5	627	4,874

ABLE 78.—Distribution of Incident Pellagrins According to Frequency of Use of Canned Goods

illage	Daily	Habitually	Rarely	Part Time			Never	Total
				Daily	Habitually	Rarely		
I	0	2	18	0	1	0	0	21
W	0	0	11	1	0	0	1	13
P	0	9	11	0	0	1	2	23
Sa	0	2	9	2	1	0	0	14
A	0	2	13	0	0	0	0	15
Sp	0	0	17	0	0	0	6	23
tal..	0	15	79	3	2	1	9	109

TABLE 79.—Summarized Distribution According to Frequency of Use of Canned Goods

Village	Total Individuals			Incident Pellagrins		
	Daily	*Habitually*	*Rarely*	Daily	*Habitually*	*Rarely*
I	9	111	427	0	3	18
W	12	171	362	0	1	12
P	24	352	927	0	9	14
Sa	2	152	484	0	5	9
A	20	112	277	0	2	13
Sp	22	88	1,322	0	0	23
Total	89	986	3,799	0	20	89

TABLE 80.—INCIDENCE OF PELLAGRA IN EACH OF THE SUMMARIZED GROUPS, PER CENT.

Village	Daily	*Habitually*	*Rarely*	Total
I	0	2.73	4.22	3.84
W	0	5.85	3.31	2.39
P	0	2.56	1.51	1.77
Sa	0	3.29	1.86	2.19
A	0	1.79	4.69	3.67
Sp	0	0.00	1.74	1.61
Total.........	0	2.03	2.34	2.24

There is no evident consistent correlation discovered here between the use of canned goods and the development of new cases of pellagra. The 89 persons in families using these foods daily remained free from pellagra. Of the 627 persons who avoided altogether the use of canned goods, 9, or 1.44 per cent., developed the disease in the course of the two years 1912 and 1913. There is no significant difference in incidence of pellagra between the groups using these foods habitually and the groups using them rarely. This study has failed therefore to discover any evidence that the use of canned goods causes pellagra, and suggests that these foods had no part in the causation of this disease in this particular population.

MILL VILLAGE I

Fig. 15.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE W

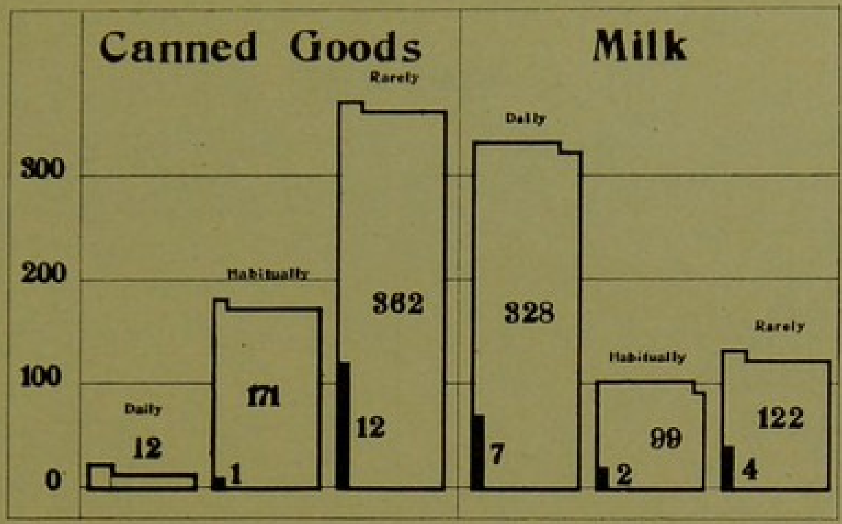


Fig. 16.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE P

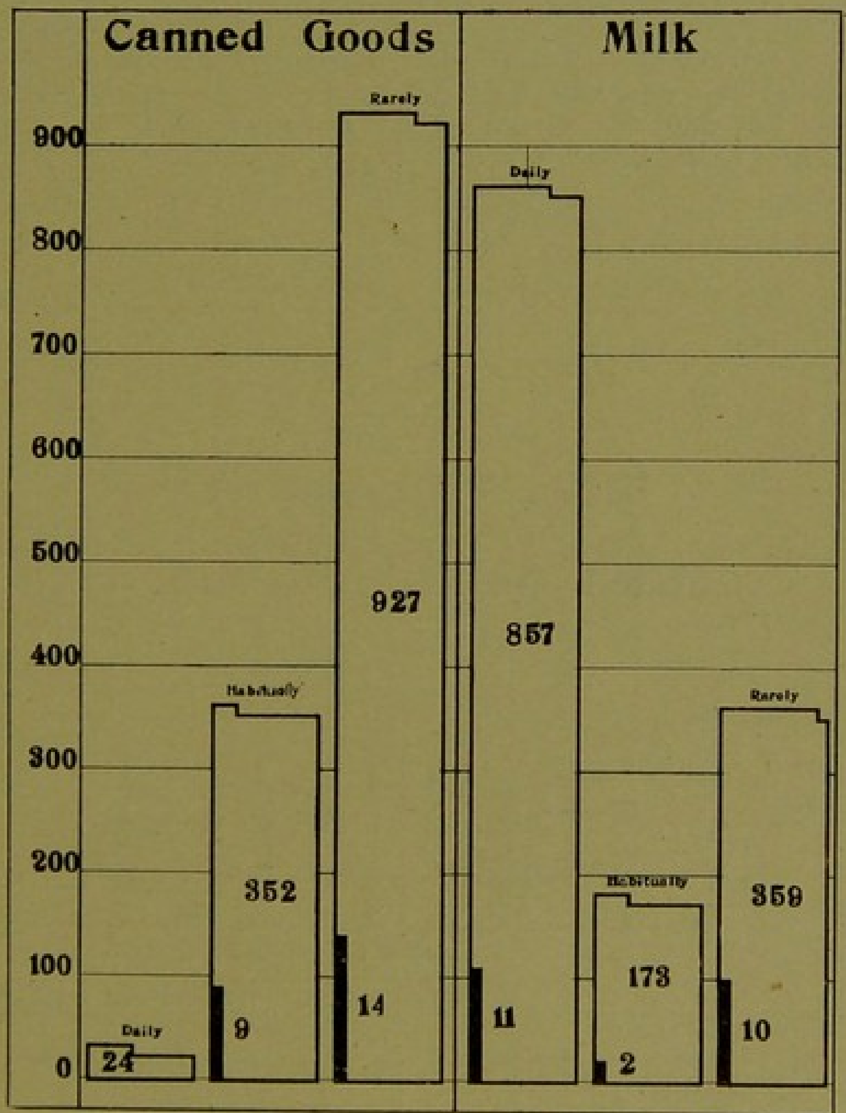


Fig. 17.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE SA

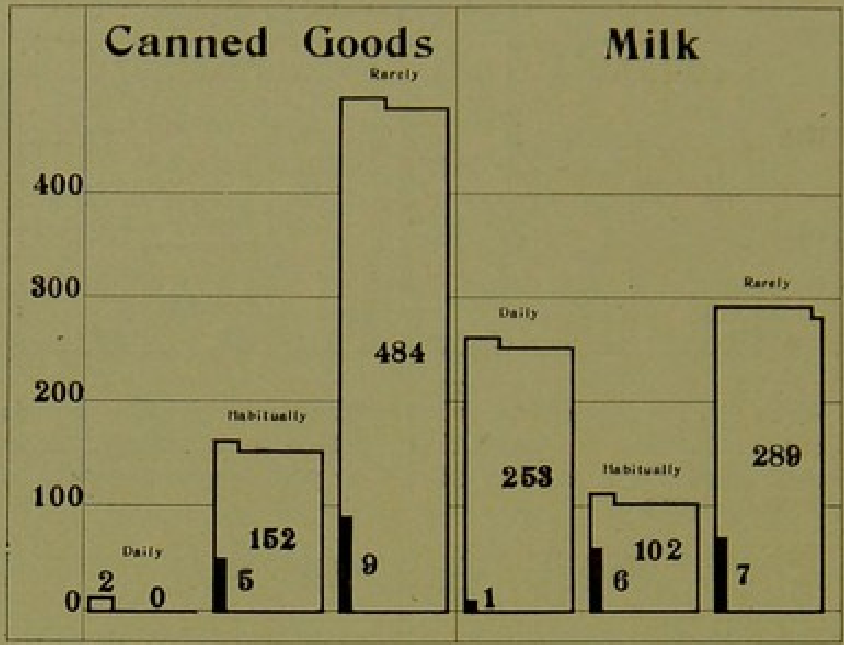


Fig. 18.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE A

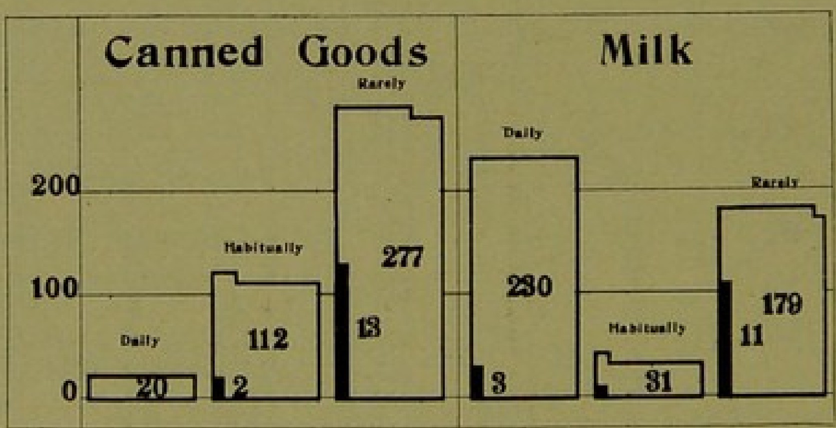


Fig. 19.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

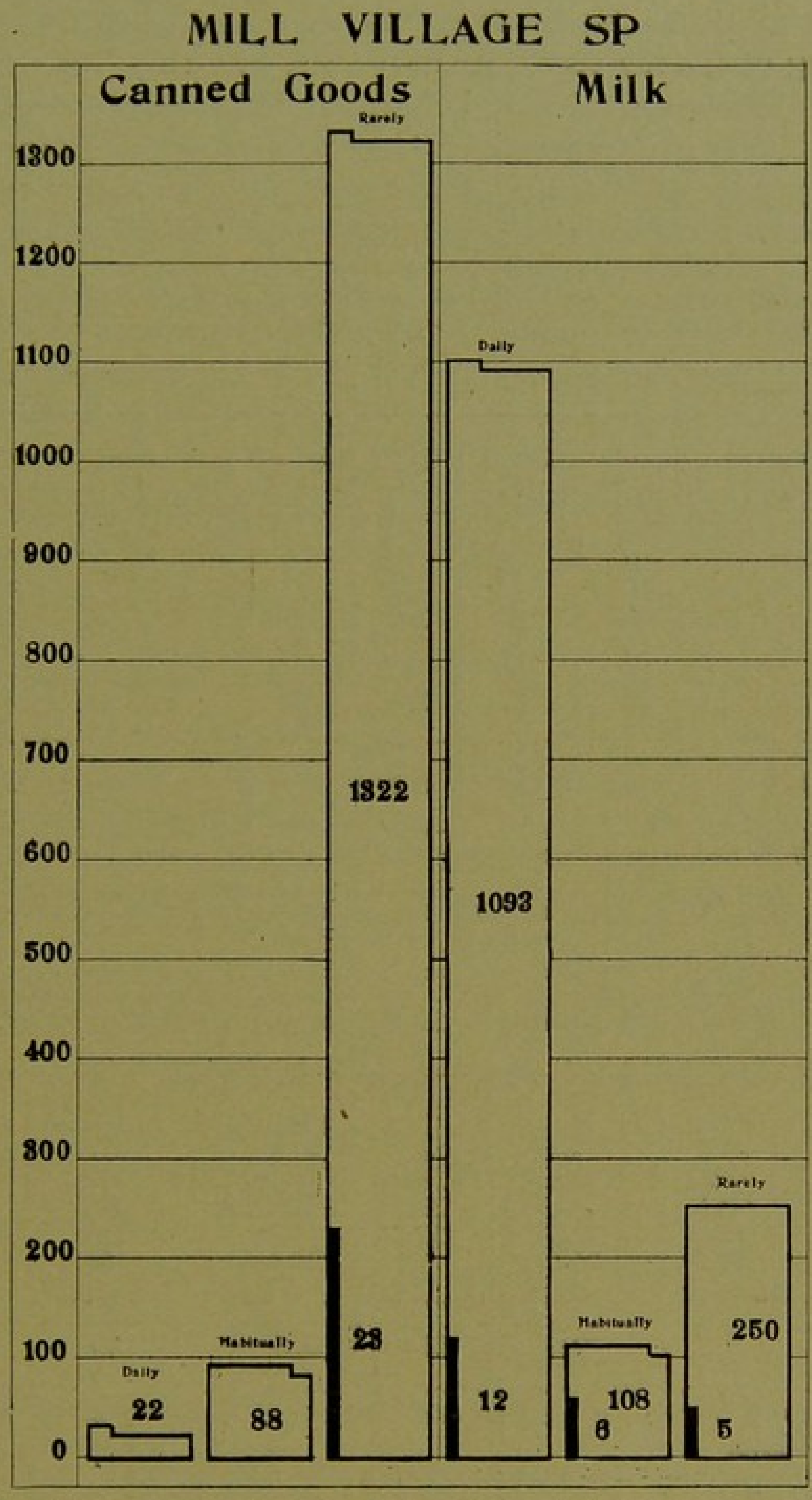


Fig. 20.—The area of each large white column indicates the number of non-pellagrin individuals using the food daily, *habitually* or *rarely*. The included black column indicates the portion of the respective group which contracted pellagra in 1912 or 1913.

MILK

Of the six mill villages used for the detailed study of the foods, only one, Sp, had a market dairy. In the other five villages the families using milk daily kept their own cows, as a rule. In only a few instances was milk purchased daily from neighboring families. Those who used milk less frequently did not possess cows. In many families using milk daily, this food was taken as a beverage in the form of buttermilk. Drinking of sweet milk was very exceptional.

TABLE 81.—Distribution of Families According to Frequency of Use of Milk

Village	Total Families					Pellagrin Families			
	Daily	Habitually	Rarely	Never	Total	Daily	Habitually	Rarely	Never
I	63	21	10	2	96	9	3	0	2
W	53	17	8	14	92	7	5	1	6
P	137	32	40*	21	230	16	6	5*	4
Sa	46	16	18	27	107	13	5	4	7
A	39	7†	13	24	83	6	3†	4	4
Sp	187	18	29	22	256	20	3	2	6
Total..	525	111	118	110	864	71	25	16	29

* Includes one family using milk part time rarely. † Includes one family using milk part time habitually.

TABLE 82.—Pellagrin Families in Total Families in Each of the Groups, Per Cent.

Village	Daily	Habitually	Rarely	Never	Rarely or Never*	Total
I	14.3	14.3	0.0	100.0	16.7	14.6
W	13.2	29.4	12.5	42.9	31.8	20.7
P	11.7	18.8	12.5	19.0	14.8	13.5
Sa	28.3	31.3	22.2	25.9	24.4	27.1
A	15.4	42.9	30.8	16.7	21.6	20.5
Sp	10.7	16.7	6.9	27.3	15.7	12.1
Total	13.5	22.5	13.6	26.4	19.7	16.3

* This group corresponds to the one designated as *Rarely* in the preceding summary tables.

The recorded data concerning the population present at the time of our census relate to 864 families, in 141 of which one or more cases of pellagra existed at the time. The distribution of these families in respect to the frequency of use of milk is shown in Tables 81 and 82. Only one family used milk part time habitually; one, part time rarely, and none part time daily. These groups are therefore not given separate consideration in the tables.

Milk was used daily by considerably more than half the total families; and in only two of the villages, Sa and A, was this food daily used by less than half the population. The groups using milk habitually, rarely and never are well represented, each including more than 100 families. Table 82 (of percentages) suggests that pellagra was, on the whole, somewhat less common in families using milk daily. Furthermore, the 110 families avoiding altogether the use of milk included 29, or 26.4 per cent., in which pellagra existed, a figure distinctly above the average for the total families considered.

TABLE 83.—Distribution According to Frequency of Use of Milk

Total Populattion					Individual Pellagrins				
Daily	Habitually	Rarely	Never	Total	Daily	Habitually	Rarely	Never	Total
371	127	53	13	564	11	5	0	4	20
327	102	55	69	553	9	7	1	7	24
865	177	233*	134	1,409	19	6	7†	8	40
268	103	126	159	656	16	7	7	8	38
236	40‡	46	129	451	9	6§	4	8	27
1,104	104	144	115	1,467	25	7	6	8	46
3,171	653	657	619	5,100	89	38	25	43	195

ludes five persons using milk part time rarely. † Includes one person using milk part time ‡ Includes eight persons using milk part time habitually. § Includes one person using milk e habitually.

TABLE 84.—Pellagra Morbidity in Each of the Groups, Per Cent.

Village	Daily	Habitually	Rarely	Never	Rarely or Never*	Total
I	2.96	3.94	0.00	3.08	6.06	3.55
W	2.75	6.86	1.82	10.14	6.45	4.34
P	2.20	3.39	3.00	5.97	4.09	2.84
Sa	5.97	6.80	5.56	5.03	5.26	5.79
A	3.81	15.00	8.70	6.20	6.86	5.99
Sp	2.26	6.73	4.17	6.96	5.41	3.14
Total	2.81	5.82	3.81	6.95	5.33	3.82

* This group corresponds to the one designated as *Rarely* in the preceding summary tables.

The 864 families just considered included 5,100 persons, of whom 195 were pellagrins at the time of our census. Inasmuch as the four groups using milk daily, habitually, rarely and never each contain more than 600 individuals, while the other groups are very small, it seems best to present the figures in four groups (Tables 83 and 84).

The correlation between frequency of use of milk and freedom from pellagra is not definitely consistent; but, in five of the villages, those avoiding the use of milk altogether had relatively more pellagra than those using this food daily. The figures for the total population also show a marked difference, 2.81 per cent. of those using milk daily being pellagrins against 6.95 per cent. of those never using milk. It would appear, therefore, that pellagrins used milk somewhat less frequently, on the whole, than the population which was free from this disease.

For the study of the relation of milk in the diet to the origin of new cases of pellagra, we have records of 877 families of which 86 developed one or more incident cases of the disease in 1912 or 1913. There were no families in the groups "Part Time Daily" and "Part Time Habitually," and only one family of five persons in the group "Part Time Rarely." It therefore seems unnecessary to present the usual detailed tables of the seven groups. In Tables 85 and 86 the one family of five persons using milk part time rarely has been classed with those using milk rarely. One new case of pellagra developed in this family.

TABLE 85.—Distribution of Families According to Frequency of Use of Milk

Village	Total Families					Families with Incident Pellagra			
	Daily	Habitually	Rarely	Never	Total	Daily	Habitually	Rarely	Never
I	63	21	11	5	100	8	3	1	4
W	54	18	9	14	95	5	2	1	3
P	137	32	40*	23	232	10	2	2*	6
Sa	46	16	19	28	109	1	5	2	4
A	39	6	13	25	83	3	1	1	5
Sp	188	19	29	22	258	9	4	2	2
Total..	527	112	121	117	877	36	17	9	24

* Includes one family using milk rarely for part of the year only.

In Table 86 the group designated "Rarely or Never" is strictly comparable with the summarized group designated as *Rarely* in the presentation of data concerning other foods. There is a fairly consistent correlation shown in this table, indicating that the families in which milk was not used were the ones in which new cases of pellagra most commonly appeared, while, on the other hand, those families using this food daily developed new cases the most infrequently. This difference would appear to have some significance.

The 877 families just considered included 5,067 persons free from pellagra at the beginning of 1912. Of these 5,067 persons, 110 contracted the disease during 1912 and 1913. One family of five persons used milk rarely for part of the year only. All the other persons fell strictly within the groups shown in Tables 87 and 88.

TABLE 86.—Families with Incident Pellagra in Total Families in Each of the Groups, Per Cent.

Village	Daily	Habitually	Rarely	Never	Rarely or Never	Total
I	12.7	14.3	9.1	80.0	31.3	16.0
W	9.3	11.1	11.1	21.4	17.4	11.6
P	7.3	6.3	5.0	26.1	12.7	8.6
Sa	2.2	31.3	10.5	14.3	12.8	11.0
A	7.7	16.7	7.7	20.0	15.8	12.0
Sp	4.8	21.1	6.9	9.1	7.8	6.6
Total	6.8	15.2	7.4	20.5	13.9	9.8

TABLE 87.—Distribution According to Frequency of Use of Milk

	Total Individuals					Incident Pellagrins				
	Daily	Habitually	Rarely	Never	Total	Daily	Habitually	Rarely	Never	Total
I	369	127	56	42	594	9	5	1	7	22
W	328	99	57	65	549	7	2	1	3	13
P	857	173	228*	131	1,389	11	2	2†	8	23
S	253	102	127	162	644	1	6	2	5	14
A	230	31	43	136	440	3	1	1	10	15
S	1,093	108	141	109	1,451	12	6	3	2	23
ota	3,130	640	652	645	5,067	43	22	10	35	110

* udes five persons using milk part time rarely. † Includes one person using milk part time re

TABLE 88.—Incidence of Pellagra in Each of the Groups, Per Cent.

Village	Daily	Habitually	Rarely	Never	Rarely or Never	Total
I	2.44	3.94	1.79	16.67	8.16	3.70
W	2.13	2.02	1.75	4.62	3.28	2.37
P	1.28	1.16	0.88	6.11	2.79	1.66
Sa	0.40	5.88	1.57	3.09	2.42	2.17
A	1.30	3.23	2.33	7.35	6.15	3.41
Sp	1.09	5.56	2.13	1.84	2.00	1.59
Total	1.37	3.44	1.53	5.43	3.47	2.17

It is evident that in the whole population those persons using milk daily contracted pellagra the least. Of the 3,130 persons in this group, only 43 acquired the disease during the two years. In the whole population also, it is clear that those avoiding the use of milk suffered most from the development of new cases of pellagra. The incidence of the disease in the latter group, 5.43 per cent., is nearly four times that in the former, 1.37 per cent. In every one of the six villages the group using milk daily showed a lower incidence than the average for that village, and those never using milk showed a higher incidence than the average. The correlation is quite inconsistent in the groups using milk habitually and rarely. The tendency toward correlation between the occurrence of new cases of pellagra and the deficiency of milk in the diet is nevertheless distinctly evident, on the whole, and suggests that the use of milk (including buttermilk) as a food has some value in the prevention of pellagra.

TABLE 89.—Distribution of Families According to Frequency of Use of Eggs

Village	Total Families					Pellagrin Families			
	Daily	Habitually	Rarely	Never	Total	Daily	Habitually	Rarely	Never
I	37	42	13	0	92	3	6	2	0
W	14	52	23	6	95	3	7	8	1
P	35	125	55	9	224	3	17	5	1
Sa	26	46	31	3	106	10	9	9	1
A	13	35*	30	5	83	1	8*	8	0
Sp	28	90	129	5	252	2	14	14	1
Total..	153	390	281	28	852	22	61	46	4

* Includes one family using eggs part time habitually.

EGGS

The recorded data concerning the use of eggs relate to 852 families present in the six villages at the time of our census, of which 133 contained one or more pellagrins. The distribution of these families according to the frequency of use of eggs is shown in Tables 89 and 90.

The tabulated data show very clearly that there was no significant variation in existence of pellagra in families correlated with a difference in frequency of use of eggs. The percentage of families with pellagra in the different groups is remarkably uniform.

The 852 families contained 5,068 persons, of whom 186 were pellagrins at the time of our census. The distribution of these persons according to frequency of use of eggs in their families, is shown in Tables 91 and 92.

TABLE 90.—Pellagrin Families in Total Families in Each of the Groups, Per Cent.

Village	Daily	Habitually	Rarely	Never	Rarely or Never	Total
I	8.1	14.3	15.4	....	15.4	12.0
W	21.4	13.5	34.8	16.7	31.0	20.0
P	8.6	13.6	9.1	11.1	9.4	11.6
Sa	38.5	19.6	29.0	33.3	29.4	27.4
A	7.7	22.9	26.7	0.0	22.9	20.5
Sp	7.1	15.6	10.9	20.0	11.2	12.3
Total	14.4	15.6	16.4	14.3	16.2	15.6

TABLE 91.—Distribution According to Frequency of Use of Eggs

Total Population					Individual Pellagrins				
Daily	Habitually	Rarely	Never	Total	Daily	Habitually	Rarely	Never	Total
225	253	64	0	542	3	9	4	0	16
75	317	144	32	568	5	8	10	1	24
198	786	337	62	1,383	3	22	8	1	34
157	267	209	19	652	15	9	13	1	38
65	187*	169	28	449	1	16†	10	0	27
151	505	789	29	1,474	3	15	27	2	47
871	2,315	1,712	170	5,068	30	79	72	5	186

ludes eight persons using eggs part time habitually. † Includes four persons using eggs
e habitually.

TABLE 92.—Pellagra Morbidity in Each of the Groups, Per Cent.

Village	Daily	Habitually	Rarely	Never	Rarely or Never	Total
I	1.33	3.56	6.25	....	6.25	2.95
W	6.67	2.52	6.94	3.13	6.25	4.23
P	1.52	2.80	2.37	1.61	2.26	2.46
Sa	9.55	3.37	6.22	5.26	6.14	5.83
A	1.54	8.56	5.99	0.00	5.13	6.01
Sp	1.99	2.97	3.42	6.90	3.55	3.19
Total	3.44	3.41	4.21	2.94	4.09	3.67

It is evident from the tables that no consistent correlation has been discovered between the distribution of cases of pellagra and the frequency of use of eggs.

In regard to the relation between use of eggs and the origin of new cases of pellagra, we have data on 861 families, of which 77 developed one or more new cases in 1912 or 1913. The distribution according to frequency of use of eggs is shown in Tables 93 and 94.

TABLE 93.—Distribution of Families According to Frequency of Use of Eggs

Village	Total Families					Families with Incident Pellagra			
	Daily	Habitually	Rarely	Never	Total	Daily	Habitually	Rarely	Never
I	38	43	13	0	94	3	7	2	0
W	15	53	24	6	98	2	5	4	0
P	37	125	55	9	226	5	9	3	0
Sa	27	47	31	3	108	4	2	5	1
A	13	34	30	6	83	0	5	4	1
Sp	28	90	129	5	252	1	8	5	1
Total..	158	392	282	29	861	15	36	23	3

TABLE 94.—Families with Incident Pellagra in Total Families in Each of the Groups, Per Cent.

Village	Daily	Habitually	Rarely	Never	Rarely or Never	Total
I	7.9	16.3	15.4	....	15.4	12.8
W	13.3	9.4	16.7	0.0	13.3	11.2
P	13.5	7.2	5.5	0.0	4.7	7.5
Sa	14.8	4.3	16.1	33.3	17.6	11.1
A	0.0	14.7	13.3	16.7	13.9	12.0
Sp	3.6	8.9	3.9	20.0	4.5	6.0
Total	9.5	9.2	8.2	10.3	8.4	8.9

There is no evidence of any relationship between the use of eggs by a family and the development of a new case of pellagra in that family.

The 861 families just considered included 4,724 persons free from pellagra at the beginning of 1912. Of these 4,724 persons, 99 contracted the disease during 1912 and 1913. The distribution of these persons according to frequency of use of eggs in their families is shown in Tables 95 and 96

In these tables it again appears that pellagra originated with almost equal frequency in all the groups, and there is no evidence that its origin was influenced at all by the presence or absence of eggs in the diet. The high incidence, 3.43 per cent., in the 175 persons never using eggs does not appear worthy of much consideration because of the small number of persons concerned and the irregularity of the figures for the different villages.

TABLE 95.—Distribution According to Frequency of Use of Eggs

Total Families					Incident Pellagrins				
Daily	Habitually	Rarely	Never	Total	Daily	Habitually	Rarely	Never	Total
235	256	64	0	555	4	9	4	0	17
15	80	140	31	266	2	7	4	0	13
210	774	333	61	1,378	5	10	4	0	19
153	266	202	19	640	5	2	6	1	14
64	174	163	36	437	0	7	4	4	15
149	499	772	28	1,448	1	9	10	1	21
826	2,049	1,674	175	4,724	17	44	32	6	99

TABLE 96.—Incident Pellagrins in Total Population in Each Group, Per Cent.

Village	Daily	Habitually	Rarely	Never	Rarely or Never	Total
I	1.70	3.52	6.25	....	6.25	3.06
W	13.33	8.75	2.86	0.00	2.34	4.89
P	2.38	1.29	1.20	0.00	1.02	1.38
Sa	3.27	0.75	2.97	5.26	3.17	2.19
A	0.00	4.02	2.45	11.11	4.02	3.43
Sp	0.67	1.80	1.30	3.57	1.38	1.45
Total	2.06	2.15	1.91	3.43	2.06	2.10

THE RELATION BETWEEN LOCATION OF A DOMICILE OF AN INCIDENT CASE OF PELLAGRA AND THE DOMICILE OF AN ANTECEDENT CASE

The data accumulated by the house-to-house census in the various mill villages, and our records of the cases of pellagra there, permit us to examine the geographical relationship of the houses in which pellagra has developed to houses in which a case of the disease already existed. We have chosen to divide the non-pellagrin population of

MILL VILLAGE I

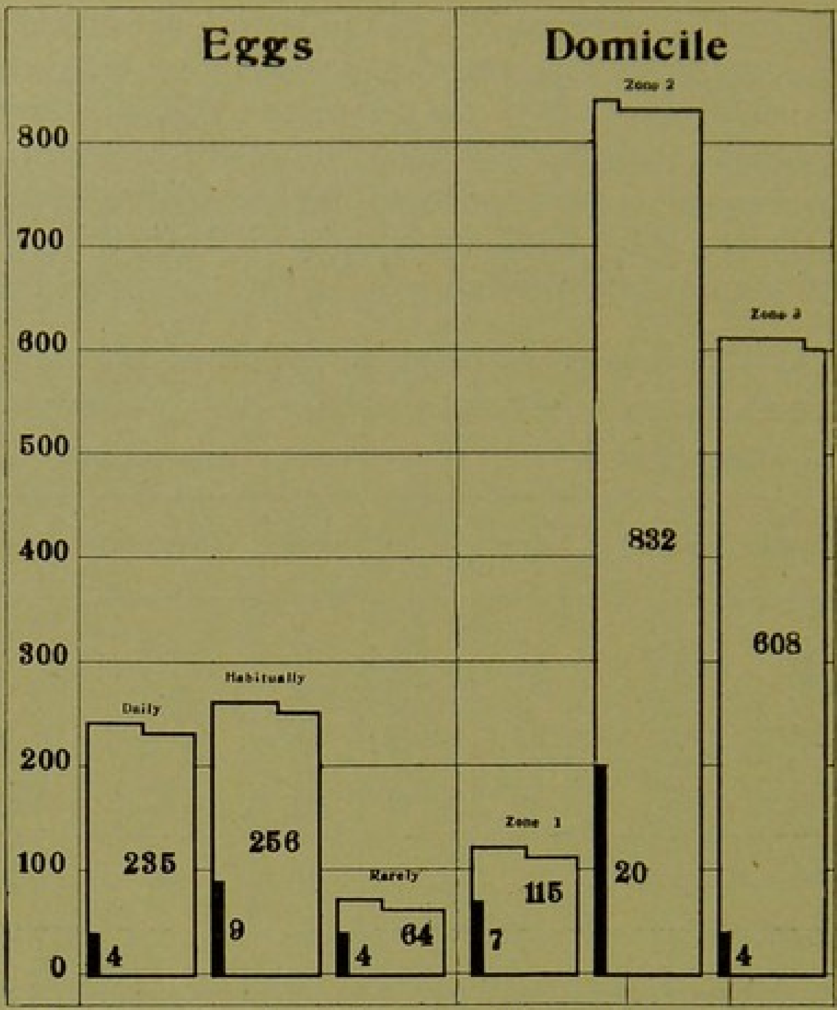


Fig. 21.—The area of each of the three white columns at the left indicates the number of non-pellagrin individuals using eggs daily, *habitually* and *rarely*. The three columns at the right indicate in the same way the number of non-pellagrin individuals living in each of the three domiciliary zones. The included black column indicates in each instance the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE W

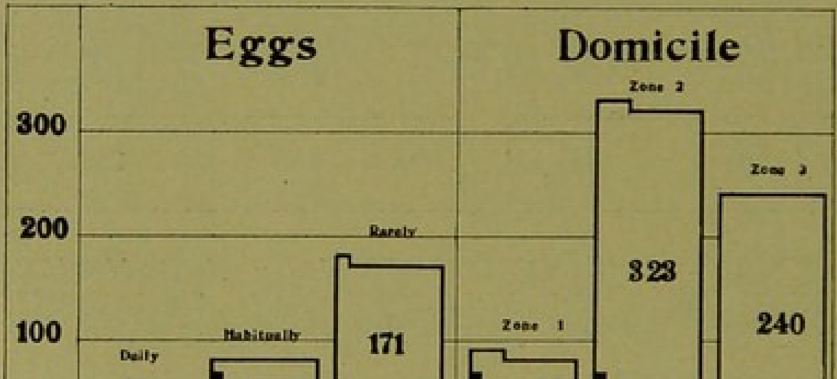


Fig. 22.—The area of each of the three white columns at the left indicates the number of non-pellagrin individuals using eggs daily, *habitually* and *rarely*. The three columns at the right indicate in the same way the number of non-pellagrin individuals living in each of the three domiciliary zones. The included black column indicates in each instance the portion of the respective group which contracted pellagra in 1912 or 1913.

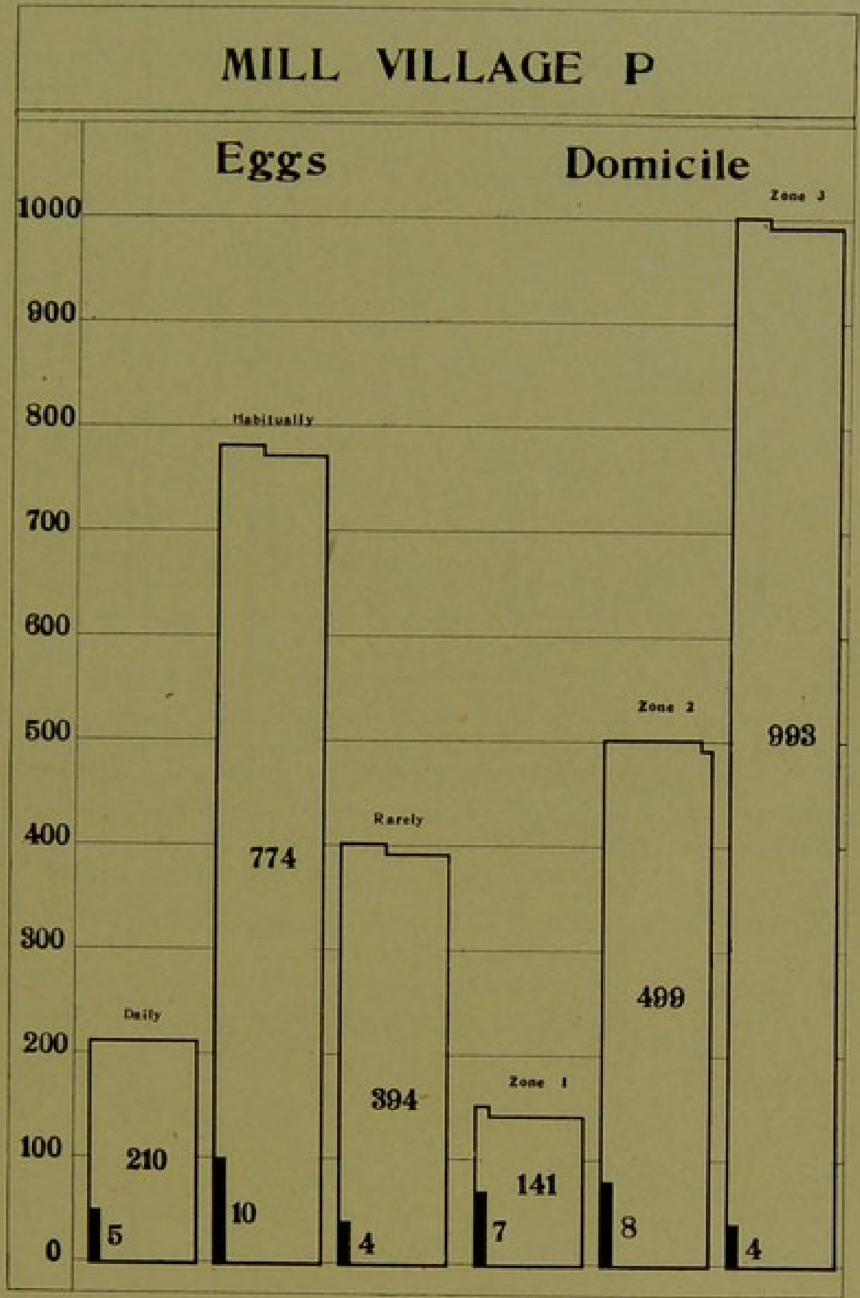


Fig. 23.—The area of each of the three white columns at the left indicates the number of non-pellagrin individuals using eggs daily, *habitually* and *rarely*. The three columns at the right indicate in the same way the number of non-pellagrin individuals living in each of the three domiciliary zones. The included black column indicates in each instance the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE SA

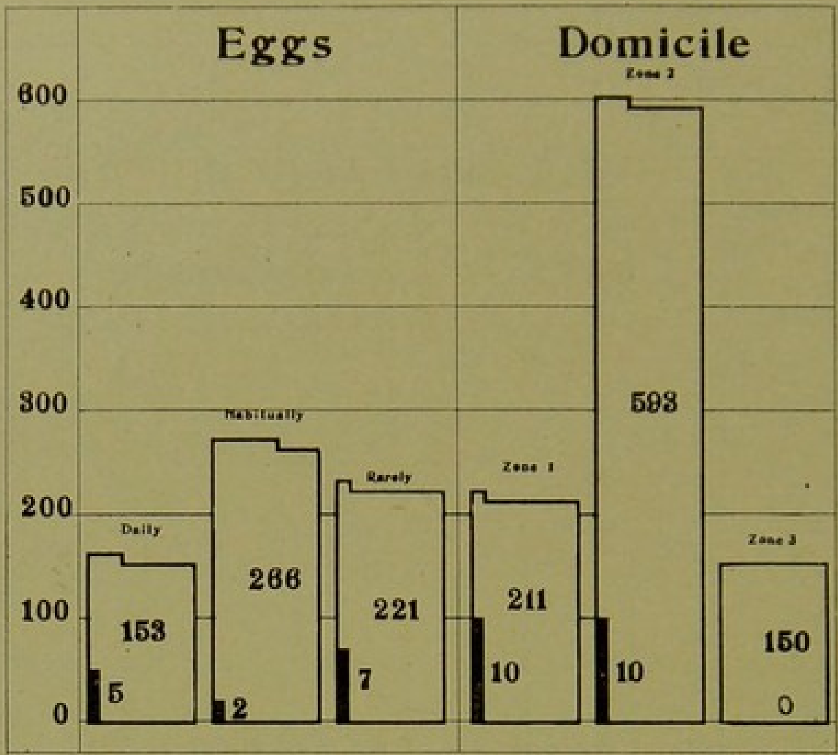


Fig. 24.—The area of each of the three white columns at the left indicates the number of non-pellagrin individuals using eggs daily, *habitually* and *rarely*. The three columns at the right indicate in the same way the number of non-pellagrin individuals living in each of the three domiciliary zones. The included black column indicates in each instance the portion of the respective group which contracted pellagra in 1912 or 1913.

MILL VILLAGE A

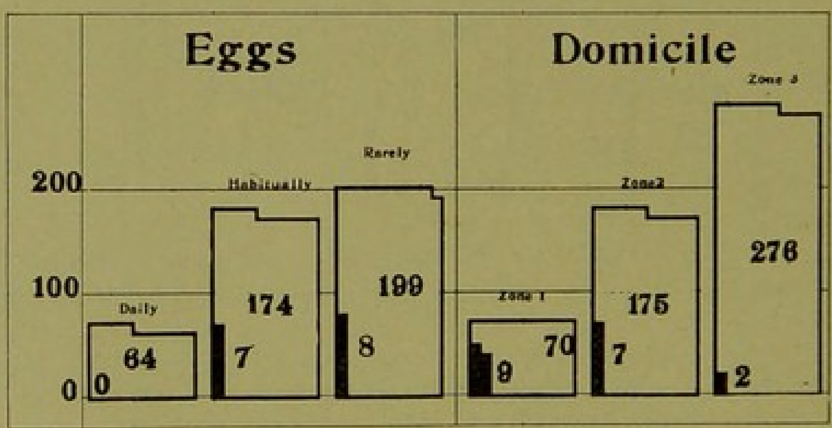


Fig. 25.—The area of each of the three white columns at the left indicates the number of non-pellagrin individuals using eggs daily, *habitually* and *rarely*. The three columns at the right indicate in the same way the number of non-pellagrin individuals living in each of the three domiciliary zones. The included black column indicates in each instance the portion of the respective group which contracted pellagra in 1912 or 1913.

each village into three parts or zones in respect to domicile: first zone, those persons free from pellagra living in the same building in which a patient with pellagra resided during 1912 or the first part of 1913; second zone, those persons, not included in the first zone, who resided in a house adjacent to the house of a pellagrin; third zone, those persons living in houses at distances greater than next door to the domicile of a pellagrin. The second zone included the houses

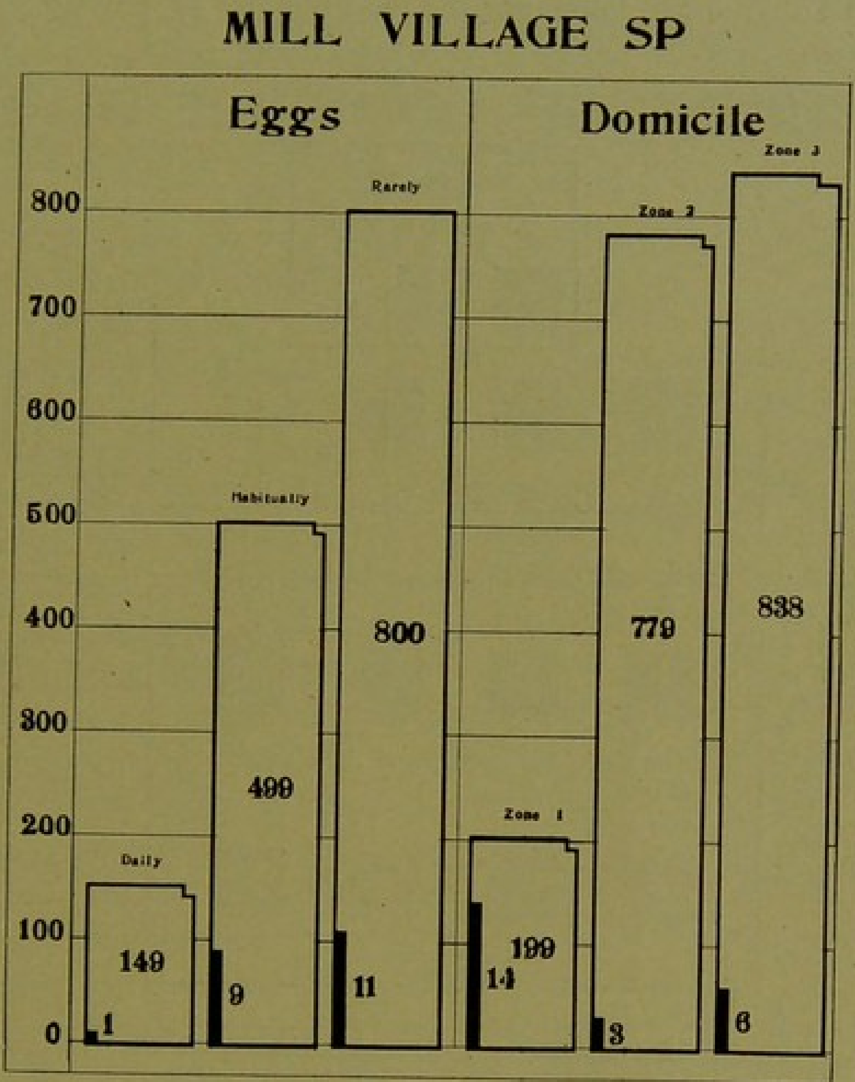


Fig. 26.—The area of each of the three white columns at the left indicates the number of non-pellagrin individuals using eggs daily, *habitually* and *rarely*. The three columns at the right indicate in the same way the number of non-pellagrin individuals living in each of the three domiciliary zones. The included black column indicates in each instance the portion of the respective group which contracted pellagra in 1912 or 1913.

at either side, directly in front, across the street, and directly behind, provided the intervening space was not greater than that of the ordinary mill-village lot (about 100 feet) and also the four houses adjacent on diagonals from the original house. The scheme of the study may be quickly grasped by reference to Figure 27. Each house containing a patient with pellagra during 1912 or early in 1913, whether the patient moved in there or the case originated there, was considered in turn as the center of such a diagram, and the total persons free from pellagra at the beginning of exposure ascertained for each case as far as our records show them. By adding together the totals for each zone we were then able to ascertain the total number of non-pellagrin population living in the same house with a pellagrin and the total number of cases of pellagra known to develop in this population during 1912 and 1913; in the same way the total number of instances in which

SCHEME OF DOMICILE STUDY

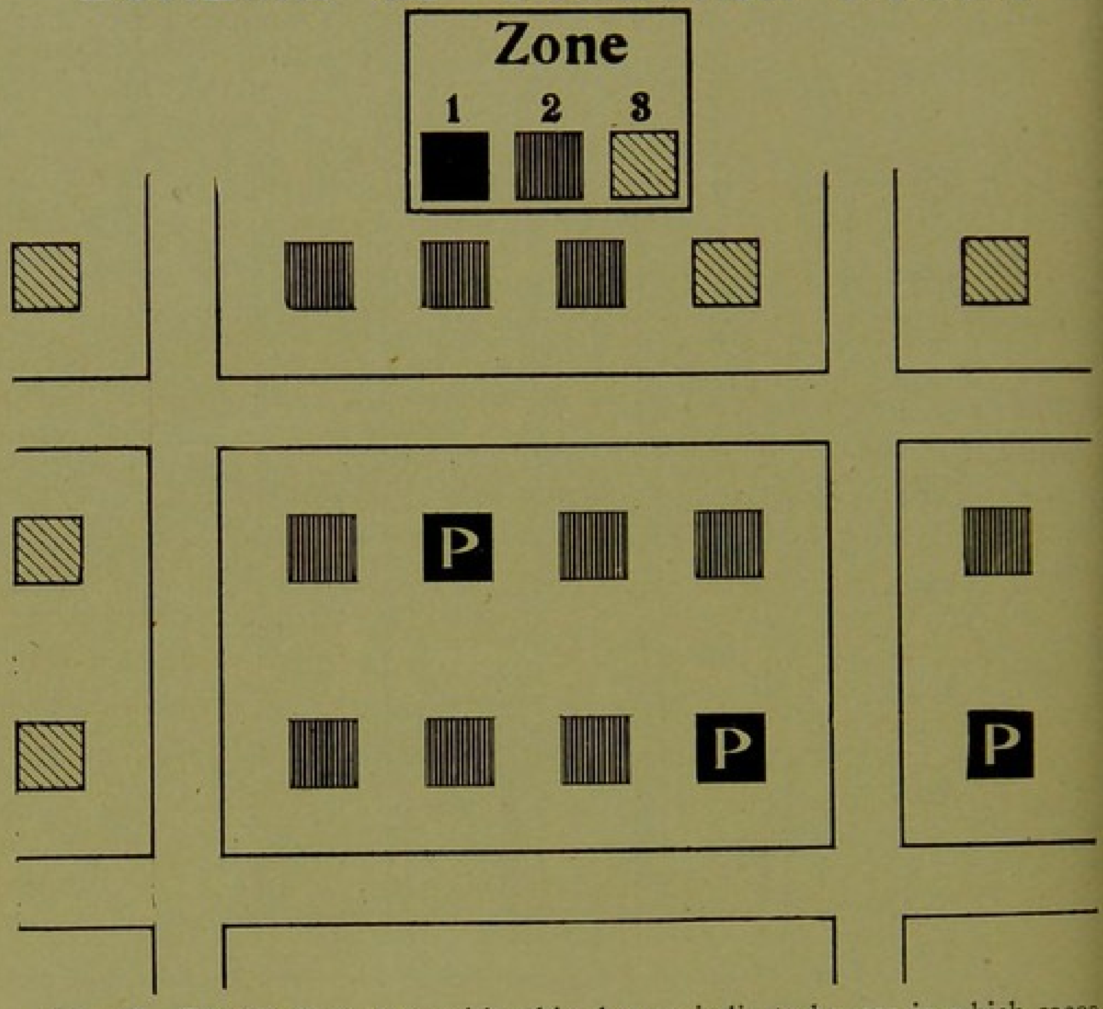


Fig. 27.—The black squares with white letters indicate houses in which cases of pellagra already existed. These houses belong to Zone 1. Houses situated next door belong to Zone 2. All houses situated farther away belong to Zone 3.

a person free from the disease had been domiciled next door to a case of pellagra and total number of instances in which pellagra had arisen under these circumstances; and in the same way for the third zone, we were able to ascertain the number of persons living at a greater distance than next door from a case of pellagra and the total instances in which pellagra had developed during 1912 and 1913 in this population.

Certain difficulties presented themselves from time to time in making this statistical study. It was essential that our knowledge of the cases and of the population employed should be very complete. We therefore limited the antecedent cases to be used to known pellagrins and we excluded from this study those pellagrins who had shown no symptoms of the disease for two years. It was also decided to omit from consideration mere visitors, provided the duration of the visit were less than two weeks. Furthermore, we did not consider as antecedent cases those pellagrins who had moved into the village or had developed symptoms of the disease for the first time within a period of three months preceding the time of our census and search for cases.

Certain arbitrary rules had to be adopted also in regard to the exposed population. Zone 1 included all non-pellagrins known to have lived in the same house with an antecedent case, as defined above, for a period of at least two weeks during 1912 or 1913. Cases of pellagra developing in this zone were considered as incident cases possibly secondary to the antecedent case only when the disease developed after an interval of at least two weeks from the beginning of the domiciliary relationship and within three months in summer or six months in the colder season after the termination of such relationship. Zone 2 included the non-pellagrins living in a house next door to an antecedent case. Those persons who lived next door to several houses in which pellagra existed were considered in relation to each of these houses in turn and added to the population of Zone 2 each time. The population of Zone 2 does not, therefore, mean the number of different persons living next door to a pellagrin, but it designates the number of instances in which a non-pellagrin lived next door to a house containing a pellagrin for a period of at least two weeks during the years selected. Incident cases of pellagra developing in Zone 2 were regarded as possibly secondary to the antecedent case only when symptoms of the disease developed not earlier than two weeks from the beginning of the supposed exposure and not later than from three to six months after its termination. Cases developing in Zone 2 next door to two or more houses containing antecedent cases were credited as secondary to each such case, so that the incident cases in Zone 2 represent not the actual number of persons developing the disease in this zone but the number of instances in which this relationship was followed by the development of incident pellagra. As explained above, the persons who did not contract the disease were treated in a similar way in compiling the statistics. Finally, Zone 3 included all the population living for a period of at least three months in spring and summer or six months in the colder season in houses farther removed than next door from any known case of pellagra;

and any case of pellagra developing in such persons, or in any one not falling within Zone 1 or Zone 2, according to our arbitrary rules, was credited to Zone 3. New cases of pellagra definitely recorded as such, concerning which our information was too incomplete to warrant a final placing in one of these zones, have been temporarily placed in Zone 3. Obviously, it would sometimes happen that a person would first be in Zone 3 and later come to be included in one of the other zones because of change of residence on his part or because a pellagrin would appear next door to him or in his own household. It seemed necessary to adopt such arbitrary rules and to adhere to them throughout this statistical study. Our purpose, of course, was to ascertain whether the proximity of residence to cases of pellagra would show any correlation to the incidence of the disease in these mill villages.

TABLE 97.—Domicile Relationship, Village I, Zone 1

Antecedent Case Present Between October, 1911, and June, 1913			Other Members of the Household			
Case	House	Residence Period	Adults	Children	Total	Incident Pellagrins
514	39	Dec., 1911-May, 1912	17	5	22	1
114	41	Apr., 1911-July, 1913	4	1	5	0
145	44	Jan., 1912 - July, 1913	3	3	6	2
148 } 149 }	40	1910-July, 1913	3	3	6	1
337	617	Apr. '12-Mar. 31, '13	2	3	5	0
592	617	Mar. 31, '13-July, '13	2	3	5	0
280	611	Feb., 1913-July, 1913	1	1	2	0
330	66	Jan., 1911 - July, 1913 Pellagra developed July, 1912	3	4	7	0
164	59	Mar., 1910-July, 1913	1	4	5	0
153 } 154 }	54	Nov., 1911 - July, 1913	2	2	4	1
150	48	July, 1912-Sept., 1912	12	2	14	1
Total for this portion of the table.....			50	31	81	6

The method of procedure in this study may be illustrated by a sample portion of the original tabulations, from which the data concerning exact location of each house have been purposely omitted (Tables 97, 98 and 99). These fragments of our detailed tables indicate the method employed in compiling the data. It is impossible to print here the complete tabulations because of their extent. The summary of these data is shown in Table 100.

TABLE 98.—Domicile Relationship, Village I, Zone 2

...ecedent Case Present Between ...tober, 1911, and June, 1913		Population Resident in Adjacent Houses				
House	Residence Period	Residence Period	Adults	Children	Total	Incident Pella-grins
39	Dec., 1911-May, 1912	Dec., 1911-July, 1913	2	1	3	0
		May, 1912-Sept. 10, 1912	2	1	3	0
		May, 1911-July, 1913	3	2	5	0
		Feb., 1909-July, 1913	2	3	5	0
		Total	9	7	16	0
41	Apr., 1911 - July, 1913	Apr. 1908-July, 1913	2	1	3	0
		Feb., 1913-July, 1913	3	0	3	0
		Antecedent Pellagra in Household	..	..	..	..
		Nov., '11 - July, 1913	2	4	6	0
		Jan., 1910-July, 1913	3	1	4	0
		Feb., 1909-July, 1913	2	3	5	0
		Oct., 1912-July, 1913	5	3	8	0
		Total	17	12	29	0
44	Jan., 1912-July, 1913	Mar., '12 - Feb., 1913	4	4	8	0
		Jan. 1911-July, 1913	3	5	8	2
		Mar., '13-July, 1913	4	0	4	0
		Feb., 1913-July, 1913	3	0	3	0
		Dec., 1912-July, 1913	3	4	7	0
		Aug., '12-Mar., 1913	5	5	10	0
		June, '13,-July, 1913	2	0	2	0
		Antecedent Pellagra in Household	..	..	..	..
		Apr., 1913-July, 1913	2	2	4	0
		Mar., '13-July, 1913	2	0	2	0
		Apr., 1913-July, 1913	2	1	3	0
		Dec., '11-Mar., 1913	3	0	3	0
		July, '12-Mar., 1913	5	4	9	0
		Total	38	25	63	2
40	1910-July, 1913	*Antecedent Pellagra in Household*	..	..	..	..
		Jan., 1911-July, 1913	4	4	8	1
		Dec., 1912-July, 1913	2	5	7	1
		Mar., '13-July, 1913	4	0	4	0
		Feb., 1913-July, 1913	3	0	3	0
		Apr., 1913-July, 1913	2	2	4	0
		Mar., '13-July, 1913	2	0	2	0
		Apr., 1913-July, 1913	2	1	3	0
		Mar., '13-Apr., 1913	2	2	4	1
		1910-Feb., 1913	5	4	9	0
		Total	26	18	44	3
...otal for this portion of the table		....	90	62	152	5

The result of this compilation of data in regard to location of domicile is very striking. Of the 819 non-pellagrin individuals who lived in the house in which pellagra existed at the time, 54 acquired the disease during 1912 and 1913. Of the 3,201 instances in which non-pellagrin individuals lived next door to a house in which pellagra was present, the disease developed in this exposed population in 55 instances during 1912 and 1913. Of the 3,105 persons who lived in houses farther away than next door to a pellagrin, 16 contracted the disease during the two years. The respective percentages are 6.59

TABLE 99.—Domicile Relationship, Village 1, Zone 3

Residence Period	Adults	Children	Total	Incident Pellagrins	Excluded from Zone 3 by Presence of Pellagra in Same or Adjacent House
Jan., 1913 - July, 1913	12	1	13	0	1911 to Aug., 1912.
May, 1911-July, 1913	3	2	5	0	1911 to Aug., 1912.
April, 1913-July, 1913	4	2	6	0	July, 12, '12, to Sept., 1912.
Nov., 1911-July, 1913	5	0	5	0	July, 12, '12, to Sept., 1912.
Oct., 1910 - July, 1913	2	1	3	0	July, 12, '12, to Sept., 1912.
Dec., 1911-July, 1913	2	1	3	0	1911 to March, 1912.
Feb., 1913 - July, 1913	2	2	4	0	1911 to March, 1912.
1909-July, 1913	2	3	5	0	1911 to March, 1912; July, 1912, to July, 1913.
Nov., 1911-Dec., 1912	2	1	3	0	....
Jan., 1913 - July, 1913	2	4	6	0	....
Jan., 1913 - May, 1913	2	1	3	0	....
May, 1913 - July, 1913	2	1	3	0	....
Apr., 1908 - July, 1913	2	0	2	0	June, 1912, to July, 1913.
Nov., 1909-July, 1913	3	4	7	2	July, 1912, to July, 1913.
Feb., 1910-July, 1913	4	0	4	0	1911 to March, 1912; June, 1912, to July, 1913.
Apr., 1908-July, 1913	2	1	3	0	1911 to March, 1912; June, 1912, to July, 1913.
Apr., 1911-July, 1913	5	0	5	0	June, 1912, to July, 1913.
Jan., 1912 - Jan. 1913	3	0	3	0	July, 1912, to July, 1913.
Nov., 1911-July, 1913	2	4	6	0	....
Nov., 1911-Sept., 1912	2	4	6	0	....
Apr., 1913 - July, 1913	2	1	3	0	....
Total for this portion of the table	65	33	98	2	

for Zone 1, 1.72 for Zone 2 and 0.52 for Zone 3. As far as these mill villages are concerned it is clearly evident that a high degree of correlation existed between proximity of domicile to an existing case of pellagra and the origin of new cases in the population of such a domicile. In other words, the new cases of the disease developed almost exclusively in small foci, within which one or more old cases of the disease already existed.

The figures presented above have been subjected to a critical scrutiny with especial attention to the accuracy and the completeness

TABLE 100.—INCIDENCE OF PELLAGRA IN THE POPULATION OF DIFFERENT ZONES ACCORDING TO LOCATION OF DOMICILE IN RELATION TO DOMICILE OF AN ANTECEDENT PELLAGRIN

Village	Zone 1			Zone 2			Zone 3		
	Instances of Exposure	Incident Pellagrins	Incidence Per Cent.	Instances of Exposure	Incident Pellagrins	Incidence Per Cent.	Instances of Exposure	Incident Pellagrins	Incidence Per Cent.
I	115	7	6.09	832	20	2.40	608	4	0.66
W	83	7	8.43	323	7	2.17	240	0	0.00
P	141	7	4.96	499	8	1.60	993	4	0.40
Sa	211	10	4.74	593	10	1.69	150	0	0.00
A	70	9	12.86	175	7	4.00	276	2	0.72
Sp	199	14	7.04	779	3	0.38	838	6	0.72
Total	819	54	6.59	3,201	55	1.72	3,105	16	0.52

of our records and to the possibility of association with other cases of pellagra besides the antecedent cases here considered. In regard to Zone 1, this scrutiny has shown a high degree of accuracy and completeness. In many instances the household in which an old case of pellagra existed had been examined and detailed record of it made previous to the development of the secondary cases. The development of new cases presented opportunity to verify and extend the records already made. In Zone 2, the cases have not, on the whole, been so completely studied and in some of these the location of previous residences is incompletely known and, in some instances, the possibility of close association with other pellagrins by visits is clearly indicated by the records. In Zone 3 there are only 16 incident cases and they will be considered briefly in order.

Patients 152 and 157, at village I, were father and son. They had been living in the same house for three years, during which time no patient with pellagra had resided in the immediate vicinity. The nearest case was at a distance of five houses, in the village. Both of these persons developed pellagra about the same time, in June, 1912. The father of the older patient, grandfather of the boy, is said to have pellagra. He lives at a distance of about a mile in the country. We have no further information in regard to him. The wife and mother in this family has been in poor health for some years, but there is no definite history and no evidence of pellagra in her. The two cases have been placed in Zone 3. As far as relation of domicile is concerned, one cannot be considered secondary to the other. A third case in village I is Patient 153, a little girl aged 5. Her family had lived in the village part of the time ever since her birth. During the spring and summer of 1911 they lived on a farm some distance from the village and moved to the present residence the last of November, 1911. The little girl suffered from diarrhea since early in the spring of 1912 and developed the erythema in March, 1912. We have not been able to obtain information concerning the associations at the farm. The case therefore falls in Zone 3. The fourth case in village I is Case 280, a woman aged 28, living in a house removed from cases of pellagra by one intervening house. Her father-in-law, Patient 316, died of pellagra in August, 1911, in the house next door but one from the house in which this patient was living. In Case 280, erythema developed for the first time in July, 1912. Evidence of living next door to a pellagrin is absent in this case and it is therefore placed in Zone 3.

In village W there are no cases in the third zone to be considered.

In village P there are four cases in Zone 3. Case 54 was in a boy aged 12, who developed pellagra for the first time in May, 1912.

He had lived in the same house in this village since March 6, 1912, having come from Lee County, Va. There was no recognized case of pellagra among the persons living in any of the adjacent houses at this time. In a house next door but one, there was a little girl who had suffered from pellagra for about a year. In the spring of 1912 three cases of pellagra in children originated in this immediate vicinity; one in the younger sister of this original case, one in a girl aged 10, who lived next door, and one in this boy we are now considering, Case 54. The three families lived in adjacent houses, the house in which the 10-year-old girl lived being between the house of the original case and this Case 54. These three children all developed pellagra about the same time and it is therefore impossible to regard the case of this boy as secondary to that in the girl living next door to him. He has been placed in the third zone. In Case 630, a girl aged 8, pellagra developed for the first time in July, 1912, while the patient was living in a house in Zone 3. Her mother, Patient 299, died of pellagra in June, 1911. The child lived with her mother in the same house in which the child developed the disease later. Her mother, however, was taken from this house shortly before she died, to her father's house, grandfather of Patient 630, a short distance away in the same village, where she died. The grandfather developed pellagra during 1911. The evidence of close association between the child, its mother and grandfather, is, of course, very clear; but inasmuch as the domicile in which the erythema developed is further away than next door from the grandfather's house and the mother was removed from this domicile about a year before the child developed the disease, the case is placed in Zone 3. Patient 640 was a woman aged 27 who had been living in the same house since 1910. She developed pellagra for the first time in June, 1913. The house is next door but one to a house containing two cases of the disease which developed in 1912. In the same house where this woman lived there was a boy, Patient 521, who had pellagra in the summer of 1911. He had lived in this house since 1908 and moved away in September, 1911. Patient 557 was, of course, associated with this boy in the same house during 1911, but inasmuch as the record shows that she developed her erythema in June, 1913, nearly two years after the other patient had left, she is placed in Zone 3. Patient 634 was a woman aged 35. She developed erythema for the first time the latter part of July, 1913. She had been living in the same house since February, 1912, and there was no case of pellagra within a radius of four houses. Previous to February, 1912, she had lived on the other side of the river near her father's house. The exact location of her residence there has not been ascertained. Her father, Patient 300, developed pellagra in 1911 and died of pellagra in August, 1912. The evidence of association between these two cases has not been definitely ascertained, but even if it were fully known, the domicile in Case 634 would, nevertheless, remain in Zone 3. This woman died of pellagra, Sept. 23, 1913.

In village Sa we find no cases of pellagra which developed in houses at a greater distance than next door from a previous case.

In village A, two persons developed the erythema for the first time while living in houses which did not contain a case of pellagra and which were not adjacent to such houses. One of these, Patient 594, was a woman aged 30, who had lived in her present residence since October, 1912. She developed erythema for the first time in June, 1913. Her residence previous to October, 1912, had not been definitely ascertained. During the winter of 1912 and 1913, that is, from November, 1912, to January, 1913, Patient 570 lived in the same house. Patient 570 is believed to have developed erythema for the first time in June, 1913, after leaving this house, but her sister states that she had suffered from pellagra also during the summer of 1912. The exact information in regard to this point is lacking. As we do not know with certainty of any association in the household or of any next-door relationship to a previous case, we have placed Case 594 in the third zone.

Case 579 was in a boy aged 4. He had been living in his present residence since December, 1912, and developed erythema for the first time in June, 1913. During this interval, from December to June, there was no recognized case in the same house or in any of the adjacent houses, excepting one. In this one exceptional house, three cases of pellagra developed in 1913, one on May 1, one on June 19 and one on June 25. Two of these cases were in young children. In our study of relation of domicile we decided not to consider a case as a center of origin unless the patient had resided in this particular village previous to April, 1913. It is therefore impossible to include this case, 579, in our Zone 2. This child, however, played with the other children a large part of the time, and there is no question that association with other pellagrin children in the immediate neighborhood was very close.

In the village Sp there are six cases to consider. Patient 747 was a woman aged 44 who had been living in her present residence since 1907. She was observed to have pellagrous erythema in October, 1913. She refused to give us information concerning her history, except to say that she had been ailing for three years. There was no antecedent case of pellagra within a radius of four houses and, in the absence of more complete information, this case has been credited to Zone 3. Case 748 was in a woman aged 44, who was living directly across the street from Case 747. She had been in this house since 1906. Erythema developed for the first time in August, 1913. This patient was also very reluctant in giving her history. It is perhaps justifiable to consider her as a case developed next door to Case 747, but in the absence of more complete information we have placed her in Zone 3. Patient 548, a girl aged 5, had been living in her present residence since September, 1913. The nearest antecedent case of pellagra was three doors away. The little girl developed erythema for the first time about June 1, 1913. Her parents both worked in the mill, and she played with the neighbors' children most of the time. We were unable to find that she actually lived in the house with a case of pellagra or in a house next door to such a case. Patient 718, a woman aged 42, had been living in her present residence since April, 1912, and she developed erythema for the first time in May, 1913. Her previous residence had been across the street from a case of pellagra. Her residence in 1913 was an apartment house in which there were no other cases of the disease. The association in the previous house was too remote to come within the limits which we have set for ourselves in this study. She has been placed, therefore, in Zone 3.

This brief examination of the cases originating in a house farther away than next door from an antecedent case of pellagra shows that in most of the instances there is evidence of previous close association with cases of pellagra or that our information is too incomplete to warrant a final opinion in regard to this question. It serves to strengthen rather than weaken the indication shown by the tabulated figures. We are forced to conclude that the origin of pellagra in persons living at a distance from previous cases of the disease in these particular mill villages was relatively very uncommon in 1912 and 1913.

DISCUSSION OF FOODS AND OF LOCATION OF DOMICILE AS ETIOLOGICAL FACTORS IN PELLAGRA

The preceding pages have presented the data concerning the use of particular foods and concerning the location of domicile in relation to pellagra, obtained by an intensive study of the inhabitants of six mill villages. It remains to discuss these facts presented and their bearing on the problem of the causation of pellagra.

In the first place the data do not support the theory that pellagra is an intoxication, the recurrent manifestations of which are due to the continued use of maize. The simple fact is that the portion of the population rarely or never using shipped corn contained a relative excess of pellagrins as compared with those using this food daily. Of those persons using shipped corn daily, 3.02 per cent. were pellagrins; of those using it habitually, 3.92 per cent., of those using it rarely or never, 5.49 per cent. The relation to local corn-meal was somewhat similar. Of those persons using it daily, 2.99 per cent. were pellagrins; of those using it habitually, 3.90 per cent.; of those using it rarely or never, 3.83 per cent. The study of corn-meal, both kinds considered together, gave an even more emphatic result. Of those persons using it daily, 3.13 per cent. were pellagrins; of those using it habitually, 4.30, and of those using it rarely or never, 6.02 per cent. were pellagrins. It would seem justifiable to dismiss at once the idea that continued use of maize was the important factor in producing the symptoms of pellagra in the population of these villages.

A precisely similar conclusion may be drawn concerning the supposed toxic influence of canned foods as a primary factor in the causation of the symptoms of pellagra. Of the 89 persons using canned foods daily, none were pellagrins; of those using these foods habitually, 3.25 per cent. were pellagrins; of those using them rarely or never, 4.12 per cent. were pellagrins.

So far as we are aware, no one has yet ascribed the causation of pellagra to the use of fresh meat, milk or eggs, and we do not perceive any reason for giving them any consideration as direct causes of this disease.

In the second place it is necessary to examine the food data from the point of view of those who regard deficiency in total amount or in the quantity of particular elements of the food as the real cause of the symptoms and lesions of pellagra. The data presented in the preceding pages have little bearing on the theory that pellagra is the direct result of a general deficiency in diet. Our observation of pellagra in apparently well-nourished growing children, however, as well as in apparently well-nourished adults, have made this conception appear unworthy of consideration. The theory that a deficiency in some special dietary constituent may cause pellagra seems worthy of much more attention, especially because of the brilliant success attained in the prophylaxis of beriberi by measures based on a similar theory of causation in that disease. In general the dietary in these villages showed considerable variety. Most of the families possessed small gardens, and fresh vegetables were everywhere used in season. The data concerning the use of fresh meat, milk and eggs would appear to have a particular bearing on this question, because these foods might be supposed to contain the particular substance or substances, a lack of which would be assumed to cause the signs and symptoms of pellagra. Of the 82 persons in families using fresh meat daily, four were pellagrins, 4.88 per cent.; of the 2,591 persons in families using this food habitually, 3.74 per cent.; of the 2,460 persons in families using this food rarely or never, 3.98 per cent. were pellagrins. Most significant of all, perhaps, was the fact that of the 263 persons never using fresh meat, only 4, or 1.52 per cent., were pellagrins, a figure considerably below the average morbidity for the whole population considered, namely, 3.88 per cent. Evidently the fresh meat used in these villages cannot be regarded as the essential pellagra-preventing food.

The data concerning the use of milk do show evidence of a relation of this food to pellagra. Of the 3,171 persons in families using milk daily, 89, or 2.81 per cent., were pellagrins, while of the 619 persons avoiding the use of milk, 43, or 6.95 per cent. were pellagrins. An analogous apparent effect of milk in preventing the development of new cases of pellagra was also evident in the study of the incident cases. We do not regard deficiency of milk in the diet as the cause of pellagra, however, because pellagra existed in many families in which milk was used daily and we have records of many cases of pellagra in persons who habitually drank sweet milk or buttermilk, and of several who drank buttermilk daily. Furthermore, it is well known that milk and milk products, although valuable dietary elements for adult man, are not absolutely essential for his nutrition. A further reason for refusing to accept deficiency in milk as the essential cause of pellagra is its complete failure to account for the focal distribution of the incident cases so clearly brought out in the domiciliary study. Nevertheless, as far as these data are concerned, milk, including buttermilk, stands out prominently as the one dietary element which seems to have had any influence at all on the prevention of pellagra, and the number of persons included in each of the groups using this food daily, habitually, rarely and never is sufficiently large to give some weight to the evidence.

The use of eggs exerted no apparent influence on the existence of pellagra and only an uncertain influence on the origin of new cases. The pellagra morbidity in the 170 persons avoiding the use of eggs was only 2.94 per cent., while the average for the total population considered in this relation was 3.67. Of the population considered in relation to the incidence of pellagra, 175 persons never used eggs. Of these, 6, or 3.43 per cent., contracted the disease, an incidence somewhat above the average, 2.10 per cent., for the total population considered. The small number of persons in this group (175), and the great irregularity of the figures in the different villages, render the average figure, 3.43 per cent., very unreliable as an indication of the value of eggs in preventing pellagra. We are inclined to ascribe no importance whatever to this article of diet.

The omission or restriction of the use of corn-meal does show a slight associated increase in pellagra. For example, the 123 persons who avoided the use of corn-meal altogether included 6 pellagrins, a morbidity of 4.88 per cent., as against an average of 3.81 per cent. in the total population considered. Similarly, of the population considered in relation to incident cases, 123 persons avoided the use of corn-meal and four of these contracted pellagra, an incidence of 3.25 per cent., as against an incidence of 2.14 per cent. for the whole 5,056 persons considered. We do not believe that omission of maize from the diet has contributed essentially to the increase of pellagra. The real explanation seems to be that some of those persons who already had the disease have restricted their use of maize and in some cases other members of their families have done the same. As has been shown in the domiciliary study, those persons closely associated with preexisting cases of pellagra contracted the disease most frequently. The slightly higher incidence among those taking little or no corn-meal is probably to be explained, therefore, by a relatively closer association of these persons with previous cases of the disease; an association which tended to produce two results, namely, restriction in the use of corn-meal and also a higher incidence of pellagra.

In the third place we wish to consider the bearing of the facts presented on the theory that pellagra is an infectious disease. The relationships discovered in the domiciliary study seem to us to be conclusive evidence of the correctness of this view. It is evident that, so far as was observed in the population of these mill villages in 1912 and 1913, the location of one's domicile in the same house with, or next door to a pellagrin, or farther away, had a greater and more definite relation to the subsequent development of pellagra than did the use or avoidance of any of the foods to which attention has been given. The observations indicate very clearly that pellagra actually spread in these villages from a preexisting case as a center, and that it spread readily only within a very small area surrounding such a preexisting case.

In order to present in a graphic manner the apparent relation of these dietary elements and of location of domicile to the origin of new cases of pellagra we have constructed a series of charts to illustrate the data in regard to incident cases, showing by actual area of each column the number of persons in families using each of the foods daily, habitually and rarely (including never) in each of the mill villages. These charts (Figs. 3 to 26, inclusive) show at a glance the relative number of the population in each of the frequency groups in respect to each of the seven foods studied and, in a precisely similar way, the population in each of the three domiciliary zones in the same village. In each of the large columns a smaller black column at the lower left corner indicates the actual number of that group which contracted pellagra during 1912 and 1913. The variation in the size of the different dietary and domiciliary groups in the different villages is shown very clearly.

Figure 28 shows the incidence of new cases per ten thousand in the total population in the six villages using each of the foods daily, habitually and rarely (including never). The *higher* incidence of pellagra in those who rarely or never used corn-meal, the *higher* incidence in those who did use fresh meat daily, the *absence* of incident cases among those using canned foods daily, and the *lower* incidence among

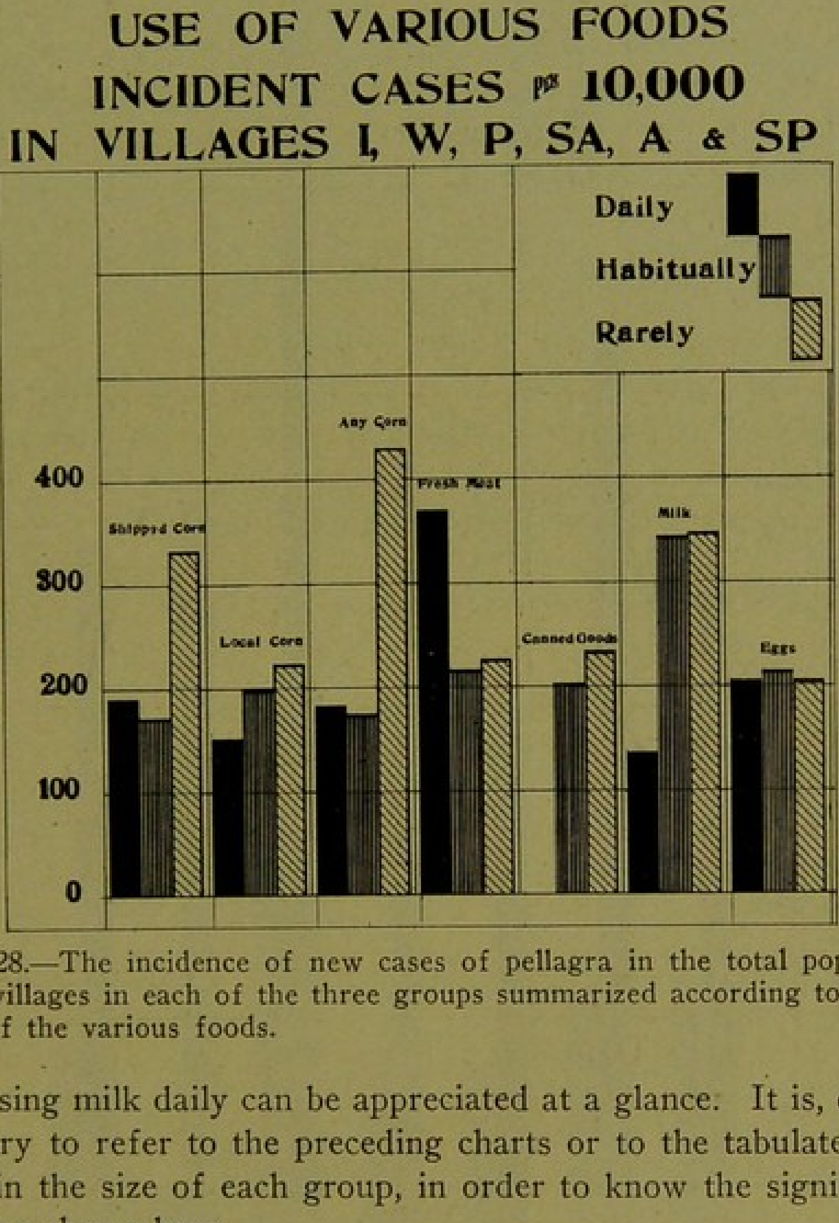


Fig. 28.—The incidence of new cases of pellagra in the total population of the six villages in each of the three groups summarized according to frequency of use of the various foods.

those using milk daily can be appreciated at a glance. It is, of course, necessary to refer to the preceding charts or to the tabulated data to ascertain the size of each group, in order to know the significance of the ratios shown here.

Figure 29 shows in a similar way the incidence rate per ten thousand in each of the three domiciliary zones for each of the six mill villages and, at the right under "Av.," for the total population considered together. This distribution of incident cases can be accounted for, in our opinion, only by the conception that pellagra is an infectious disease spreading from a preexisting case as a center. Further-

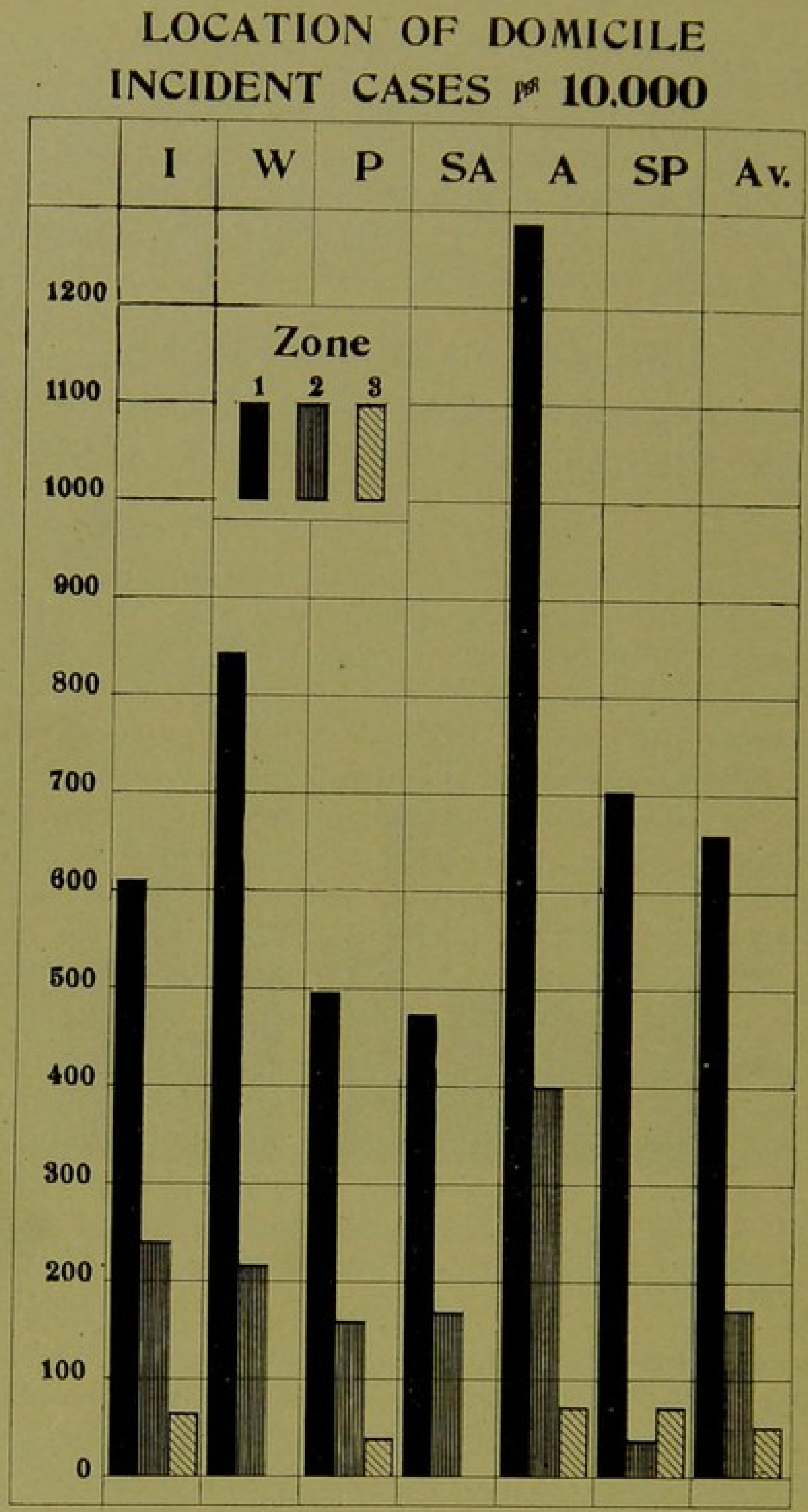


Fig. 29.—The black columns indicate the incidence of new cases of pellagra among persons living in the same house with a preexisting case. The columns striped vertically indicate the incidence in the population living next door. The columns striped obliquely indicate the incidence in the population living within the respective village, but farther away than next door from a preexisting case of pellagra.

more, it seems in general not to be very readily transmitted even to those in the same house, and its spread to those at a greater distance is very much less common. It should be remembered that nearly two years elapsed while the new cases on which this chart is based were originating.

Summary

1. Pellagra spread from a preexisting case as a center in the six villages here studied.

2. It was transmitted to new victims only through very short distances and chiefly to those immediately associated in the home with a preexisting case of the disease.

3. Frequent use of corn-meal as an article of diet was not a factor in the causation of pellagra in these villages.

4. There was discovered no evidence that canned goods have anything to do with the causation of pellagra.

5. Frequent use, even daily use, of fresh meats and of eggs afforded no relative protection from pellagra in these villages.

6. The daily use of milk seemed to diminish to some extent the danger of contracting pellagra in these mill villages in 1912 and 1913, although its use did not fully insure against the development of the disease.

IV

THE RELATION OF METHODS OF DISPOSAL OF SEWAGE TO THE SPREAD OF PELLAGRA *

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INTRODUCTION

In analyzing the data collected in 1912 we were struck by the inequalities in the distribution of pellagra in the townships of the county in which our studies were undertaken. This rate ranged from no cases to 71 cases per ten thousand of population. A further analysis, based on the distribution of the population in rural, urban and mill-village communities showed that in rural communities the incidence rate was 16 per ten thousand of population; in the city of Spartanburg, exclusive of the mill-village section, it was 29 per ten thousand, while in the mill-village communities it averaged 104 per ten thousand.

One of the features of our epidemiological work in 1912 was the investigation of methods of disposal of human wastes. In certain sections of the city of Spartanburg a water-carriage system was in use. In the rural districts the white farmers usually had the unscreened surface privy. Privies were but seldom found on the premises of negro tenants on the farms. In the cotton-mill villages, about twenty-eight in number, in which pellagra prevailed much more extensively than elsewhere, two types of privy were in use. The usual type was an unscreened wooden outhouse where the excreta were deposited on the ground. In a few mill-villages the privy type was an unscreened wooden outhouse provided with metal containers for the reception of fecal matter. In some of the villages scavengers cleaned the privies at weekly intervals; in others at less frequent intervals or irregularly. These villages were laid out in streets, the dwelling-houses were but short distances apart and the privies neces-

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sarily in close proximity to the dwelling-houses. No effort was made to screen these privies; flies and other insects had free access to the collections of excreta.

In a series of 243 cases of pellagra investigated in 1912, the following methods of disposal were found to be in use.

In 5 per cent. (11 of the cases) a modern water-carriage system was used.

In 20 per cent. (51 of the cases) the unscreened wooden outhouses were equipped with metal receptacles.

In 60 per cent. (152 of the cases) the privy was an unscreened wooden outhouse, the feces being deposited on the ground.

In 12 per cent. (29 of the cases) there were no privies.

The average sanitary index of the privies used by these 243 pellagrins was 16 per cent., computed in accordance with the methods adopted by the Rockefeller Sanitary Commission. The existing sanitary conditions were summarized as follows:

The most insanitary condition found in the county is the absence of properly constructed privies. Outside of a part of the city of Spartanburg, which is supplied by a water-carriage sewage system, there is no effective provision in the county for the proper disposal of human excreta. A second striking insanitary condition is the almost complete absence of effective screening of dwellings. These two conditions present a situation highly favorable to the transmission of disease organisms eliminated in the excreta, both by direct contamination of food and persons and by insects. This situation is naturally aggravated in the mill villages and small towns by the greater congestion of houses.

As a result of these, as well as other observations, the members of the commission were impressed with the possibility that insanitary methods of disposal of human wastes might be an important factor in the spread of pellagra.

In the course of our investigations during 1913 it was determined that this feature should receive special attention. The principal point which we endeavored to ascertain was whether the endemic foci of the disease were more common in those communities and in those sections of cities in which the methods of disposal of human wastes were insanitary. In order to ascertain these facts we made a careful study of the exact distribution of the cases of pellagra, including a history of its distribution in the past. By personal visits to pellagrins and their relatives it has been possible for us to secure definite information as to the exact residence of pellagrins. We have endeavored to locate precisely all houses occupied by them from the inception of the disease up to the present time. The information relative to residence, as well as to other pertinent facts, has been transferred to our pellagra "house card," a copy of which we show. These "house cards" have been filed by locality and from them we have constructed spot-maps showing the exact location of the cases of pellagra of which we have record.

HOUSE CARD *

House No. *190.* Township, *Spartanburg. Whitney.*
Location, *Whitney Mills No. 101.*

Pellagrous History Date, *July, 1913.*

No.		First Erythema (Place, Date)
86.	Here from *Jan. 22, 1912,* to *early in 1913.*	*July, 1911. Clifton No. 2. H. No. 191.*
87.	Here from *Jan. 22, 1912,* to *early in 1913.*	*June, 1912. Here.*
88.	Here from *Jan. 22, 1912,* to *early in 1913.*	*June, 1912. Here.*
89.	Here from *Jan. 22, 1912,* to *early in 1913.*	*June, 1912. Here.*

Notes—*86 = mother; 87 = son; 88 = daughter; 89 = daughter.*
Apparent house of origin for Cases *Nos. 87, 88, 89.*
House: Construction—*Frame.* Screened, *no.*
Sanitary Condition—Good, poor, *fair.*
Water Supply—Well: *dug, with bucket. Deep.* Surface contamination, *no.*
Disposal of Excreta—Privy type: A, B, C, D, *E,* F. Distance from house, *twenty yards.*
Method of Ultimate Disposal—*Scavenger.*
General Sanitary Condition—*Poor.*

* Data relating to the particular house (House No. 190) are set in italics.

In all the mill-villages in Spartanburg County unscreened surface privies were in use and, in order that possible contrasts in the prevalence of pellagra might be shown, for the purpose of this study, it was necessary to extend our investigations to industrial communities elsewhere in the state in which water-carriage systems of sewage disposal had been installed. Through the state health authorities we learned that four cotton-mill villages in the state had adopted such methods of disposal. In two of these villages, one situated in Greenville, S. C., and the other in Union, S. C., the water-carriage sewer systems had been installed less than a year. The third was the Newry mill-village in Oconee County in the western part of the state, in which a water-carriage system of sewage disposal was installed about twenty years ago. The fourth village was the Republic mill-village in Chester County, situated in the northern part of the state, in which a water-carriage system was installed about three years ago. We have investigated the sanitary condition and prevalence of pellagra in the Newry mill-village and the Republic mill-village. As the water-carriage system of disposal had been in use in the other two villages for only a few months, their investigation was left to the future.

This study has enabled us, first, to compare the prevalence of pellagra in sewered and unsewered portions of the city of Spartanburg, and second, to make a similar comparison of two entirely sewered villages with a large number of villages where unscreened surface privies were in use.

THE SPREAD OF PELLAGRA IN THE CITY OF SPARTANBURG AND ITS RELATION TO VARIOUS METHODS OF DISPOSAL OF HUMAN WASTES

We have record of a total of 268 cases of pellagra in the city of Spartanburg (204 white and 64 colored). This includes not only the pellagrins living there in 1913 but also all known cases which have occurred. Of these 268 cases, 168 are known to have originated in the city.

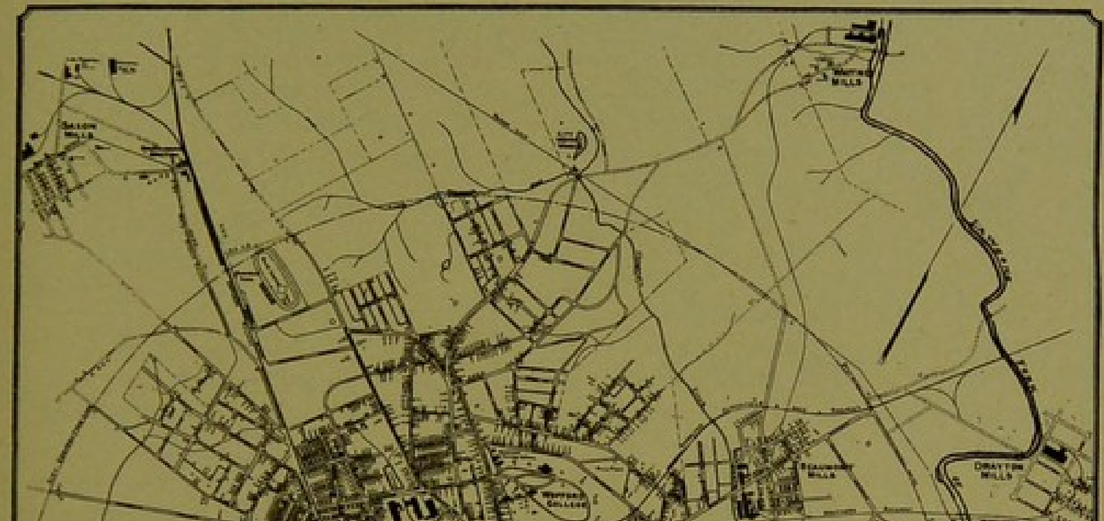

Fig. 1.—Map of Spartanburg, S. C., showing plan of city.

Figure 1 is a reproduction of the plan of the city, the black portion in the center indicating the location of the business section. It will be noted that there are three mill-villages within and two just beyond the city limits. The largest cotton-mill is situated in the northwestern quadrant, the next largest in the northeastern, and the smallest in the southwestern quadrant.

Figure 2 shows the geographical distribution of pellagra in the city of Spartanburg together with the distribution of the sewer mains. It is clearly evident from this map that practically all the active foci of the disease were in the sections of the city in which unscreened surface privies were used. Two active foci of the disease existed in the southeastern quadrant of the city. One of these foci was in a sewered district but none of the pellagrous houses had sewer connections. The other was in a negro settlement and all the privies in this vicinity were of the unscreened surface type.

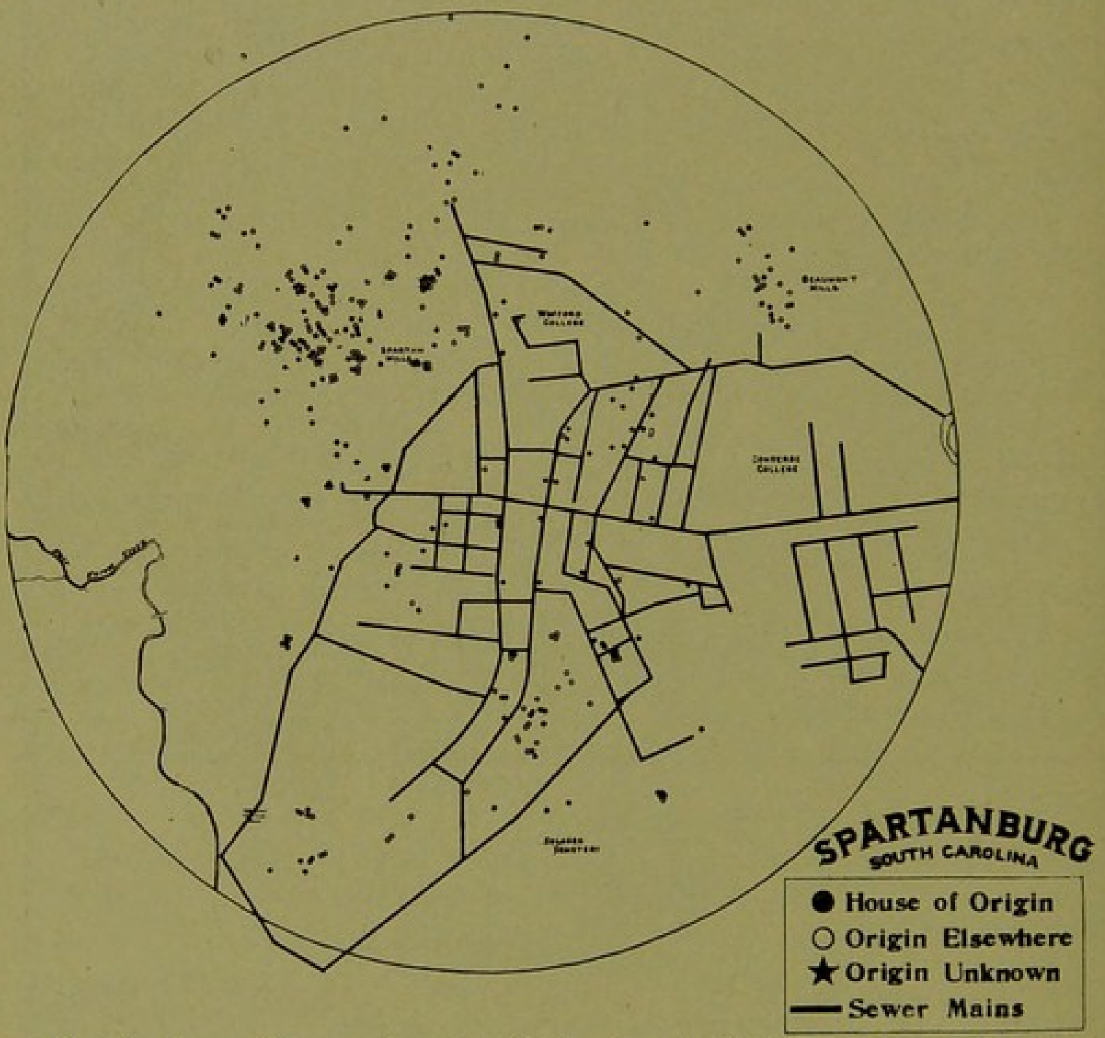

Fig. 2.—Map of Spartanburg, S. C., showing distribution of cases of pellagra in the city and distribution of sewer mains. Note that 168 of these cases originated in the city and that the largest number of cases occurred in the northwestern quadrant.

Of the total 268 cases of which we have record in the city of Spartanburg, we have investigated methods of disposal of excreta in 241 instances. In 230 cases, or 95 per cent. of the total investigated, the method of sewage disposal was the unscreened surface privy. In eleven instances, or 5 per cent. of the total, a water-carriage system of disposal was in use. A detailed examination of the records of these eleven cases has shown the following facts:

Patient 12 was a white woman, aged 40, married, whose residence had not changed since 1907. She contracted pellagra in 1911 and had mild recurrences in 1912 and 1913. She lived on one of the better residential streets; her circumstances were comfortable, and her only occupation was housework. The house was not screened. She gave no history of association with pellagrins, except visits to two persons suffering with pellagra. Our records, however, show that in a house immediately in rear of hers, Patient 496, a colored female, died of pellagra, July 12, 1910, and that during 1911, Patient 379, a colored female, lived directly across the street from her. The houses of these two colored pellagrins had the usual unscreened surface privies.

Patient 19, a white man, aged 20, contracted pellagra in the spring of 1911. His residence remained the same from 1905 to the fall of 1912. His home was in the best residential section of the city and the house was effectively screened. He was a college student and his circumstances were comfortable. His general health was good until the summer of 1909, when he contracted malaria in a saw-mill camp in South Carolina, near Augusta, Ga. Since that time his health has not been good. In 1910 he again spent five months (January to June) in a lumber-camp near the Georgia state line in South Carolina. This patient had severe recurrences during 1912 and 1913. No cases of pellagra have been located in the vicinity of his home in Spartanburg and there is no history of association with pellagrins.

Patient 24, a white man, aged 61, contracted pellagra in May, 1912. His residence had remained the same for several years. His home was situated in a good residential section but was not screened. He had been engaged in clerical work since 1881; his health had been good, and his circumstances appeared to be comfortable. He gave no history of association with pellagrins and we were not able to locate any cases in the vicinity of his residence. The disease recurred in 1913 and he died in the fall of 1913.

Patient 40, a white woman, aged 63, contracted pellagra in February, 1912. She had not changed residence for two years except for prolonged visits to relatives in South Carolina. Her home was situated in the business section of the city and, though it was screened, the screening was not effective. Two visits were made to this home by members of the commission. We found the screens raised, swarms of flies present and the general sanitary conditions very unsatisfactory. The patient's economic circumstances were poor and her occupation was housework. Patient 342, a white woman, who was a chronic pellagrin, lived with her during August, September and October, 1911. This patient (No. 40) died of pellagra, Aug. 10, 1912, having first shown symptoms in February, 1912.

Patient 57, a white woman, aged 43, first showed symptoms of pellagra on June 27, 1912. She lived in the best residential section of the city and had been living there since 1910. Her home was effectively screened and her husband well-to-do. She apparently had had some gastric disorder for a number of years. Her only occupation was the supervision of her housework. There was no history of association with pellagrins and no pellagrins lived in the immediate vicinity. There was no definite recurrence during 1913.

Patient 59, a white woman, aged 38, contracted pellagra in March, 1909, three months after confinement. Her home was in one of the best residential sections of the city and she had been living there since 1907. Her house was screened in part and her circumstances were those of comfort. There was no history of pellagra in her family and she gave no history of association with pellagrins. She had slight recurrences in 1910, 1911, 1912 and 1913.

Patient 208, a white man, aged 59, developed pellagra in December, 1909, and severe symptoms persisted until September, 1910. He had completely recovered from the attack in November, 1910, since which time his health had been good. The house of origin for this case was situated in one of the better residential sections and he lived there from 1907 to early in 1912. His circumstances were those of comfort and his health prior to the development of pellagra had been good. No pellagrins have been located as living in the immediate vicinity of the house of origin for this case. For several years it had been the patient's custom to make visits from time to time to relatives in certain country districts in the county. One of his sisters died of pellagra in 1907 and another died of pellagra in 1910. Both were living in Spartanburg county and were well-to-do. His health has been excellent since November, 1910.

Patient 233, a white woman, married, contracted pellagra in May, 1910, in a house located in the best residential section of the city. She lived in this house from August, 1908, to March, 1911, and it was not screened. Her husband was well-to-do and she had enjoyed good health prior to the development of pellagra. Symptoms recurred in 1911, but there was no recurrence in 1912 and 1913. We have no record of pellagrins living in her immediate vicinity during 1909 and 1910. Her father-in-law (Case 321) died of pellagra in September, 1910, at his home in an unsewered portion of the city of Spartanburg and she had visited him there frequently during his illness.

Patient 426, a white woman, single, died of pellagra in 1902. Her father was well-to-do. Prior to the development of pellagra her health is said to have been good. She had been living in the same house for many years. As the condition was not recognized as pellagra until several years after her death the history is very incomplete. Evidence of association with other cases of pellagra is wholly lacking.

Patient 541, a white woman, aged 21, married, first showed erythema in April, 1913, though she gave history of ill health since November, 1912. She had lived since 1909 in a good residential section and the house was screened in part. Her circumstances were those of comfort and her health had been good prior to November, 1912. The nearest case of pellagra was a white man, Patient 5, who contracted pellagra in 1911 and died of it in 1912 in a house directly across the street. His house was provided with an unscreened surface privy. This woman, Patient 541, made a visit of three weeks' duration, during the summer of 1912, to relatives in a southern state on the gulf coast where surface privies were in use. There was no history of association with pellagrins.

Patient 755, a white man, aged 32, druggist, contracted pellagra in the spring of 1913 and died of it in August, 1913. During 1913 he lived in the best residential section of the city and was well-to-do. The history of this case is very incomplete and we have no data concerning association with pellagrins.

Of the eleven patients, three (Cases 12, 233 and 541) gave a history of living or visiting in the same house or next door to pellagrins using surface privies; another (Case 40) lived under very insanitary conditions in the same house with a pellagrin; and a sixth (Case 208) had two sisters who were pellagrins, one dying before he developed the disease and the other dying the following year. Two, Patients 24 and 755, were men engaged in occupations bringing them constantly into contact with the general public. In the other four cases, (Nos. 19, 57, 59 and 426) we have been unable to learn of any relationship whatever to antecedent pellagra.

THE SPREAD OF PELLAGRA IN UNSEWERED MILL-VILLAGES IN SPARTANBURG COUNTY

Our records show that pellagra occurred and has originated in all the mill-villages in Spartanburg County. In all these villages unscreened privies were in use. In some, the fecal material was collected in pails; in the majority, however, it was deposited on the ground. Many of these mills were situated but a few miles distant from one another and for a number of reasons there was a tendency for certain elements of their population to move, with great frequency, from one mill to another. This element of the population—generally termed "floating"—varied from about 15 per cent. to even more than 33 per cent. Cases of pellagra commonly occurred in this floating element and frequently it was necessary for us to trace pellagrins from mill-village to mill-village before finally locating them.

Six of these villages were selected for intensive studies and by house-to-house visitations all existing cases of pellagra were accurately located. The incidence rate for 1912 and 1913 was higher in

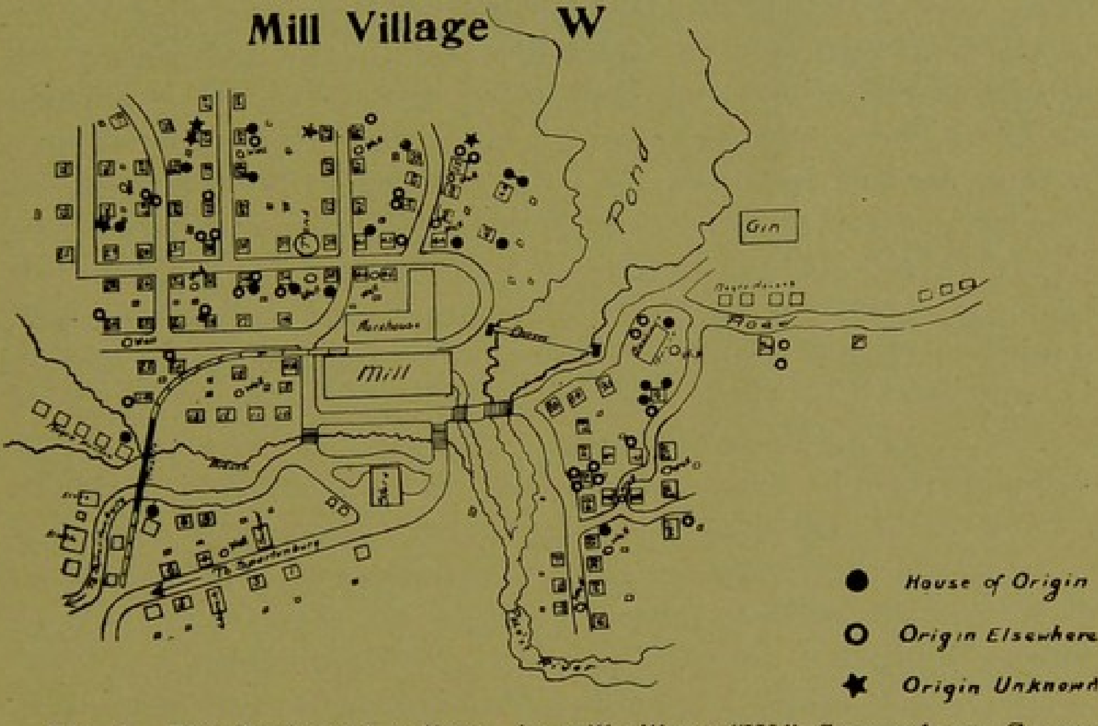

Fig. 3.—Distribution of pellagra in mill-village "W," Spartanburg County. Unscreened surface privies are shown as small blocks in the rear of dwelling-houses. Note that twenty cases of pellagra have originated in this village.

some villages than in others, but incident cases occurred in every village during 1912 and 1913. It was observed that in several of these villages incident cases of pellagra would be quite numerous one season and relatively few the next, or *vice versa*.

Spot-maps have been constructed of these mill-villages showing the distribution of pellagra. Figure 3 is a reproduction of the plan of village *"W"* showing the distribution of the disease, and this is a fair example of conditions in all these villages. It will be noted from this map that at least twenty cases of pellagra have originated in this village.

HISTORY AND SPREAD OF PELLAGRA IN MILL-VILLAGES IN WHICH WATER-CARRIAGE SYSTEMS OF DISPOSAL OF SEWAGE HAVE BEEN INSTALLED

Newry Mill-Village

This village is located in Oconee County in the northwestern part of South Carolina. It was built about twenty years ago, its first president being Captain Courtenay of Charleston. Captain Courtenay installed a water-carriage system of sewage disposal before the mill-village dwellings were occupied and this system has been continuously in use to the present time. The closets have been grouped (from four to eight in each group) in detached houses convenient to a group of dwelling-houses, rather than as individual closets in each dwelling-house. One of these privies has been assigned to each dwelling and the tenant held responsible for its proper care. The annual cost for repairs and upkeep has amounted to but little. The total population was 750. The operatives employed in the mill were recruited from the same sections and from the same elements of the population, as were operatives in mills elsewhere in the state. They were accustomed to eat the same foods as were eaten by the inhabitants of other mill-villages throughout the state. The company store was selling about a bushel of shipped (western) corn-meal to each family per month. The only respect in which their dietary habits possibly differed from those of some of the mill-villages in the state, lay in the fact that fresh meat could be obtained throughout the year from a local market. In some of the mill-villages in Spartanburg County fresh meat was not on sale in the village during the hot summer months. In others, however, where pellagra prevailed extensively, fresh meat could be obtained throughout the year from the mill-village market.

The Newry village is almost surrounded by permanent streams, and the eggs and larvae of *Simulium* were observed in abundance. The only demonstrable difference between this mill-village and (with three exceptions) those elsewhere in the state lay in the fact that a water-carriage system of sewage disposal was used there, while the method employed elsewhere was the unscreened surface or pail privy. With these facts in mind it is of interest to study the history of pellagra in this village.

In August, 1911, a woman showing active pellagrous skin lesions came into the village from Georgia. She departed the same day on the advice of the local physician and has since died.

In the spring of 1908, a family which had been resident in the village for several years, purchased a home near the railway (at Courtenay Station) about one mile away. They lived there until December, 1911. A woman with pellagra resided next door during the period of their residence at Courtenay Station. In June, 1909, the mother (Case 2064) contracted pellagra. In December, 1911, they returned to the Newry mill-village and were still there in October, 1913. The family consisted of six adults and one child. No other case of pellagra was observed in the family and this one case had recurrences in 1910, 1911, 1912 and 1913.

Another woman (Case 2060), one of the four patients now resident in the village, gave a rather indefinite history of pellagrous symptoms as far back as 1910. The family had been extremely migratory and it was difficult to determine with certainty exactly where and when the disease developed. She first lived in the village for two months in the winter of 1910 and it is possible that she was at that time pellagrous. The first positive history of the disease began in the spring of 1912, when a frank erythematous rash appeared. At that time she was living on a farm some ten miles north of the village. She returned to Newry in November, 1912, and lived there until the last of February, 1913. She was then away until June, 1913, when she returned to the village and was still there in September, 1913.

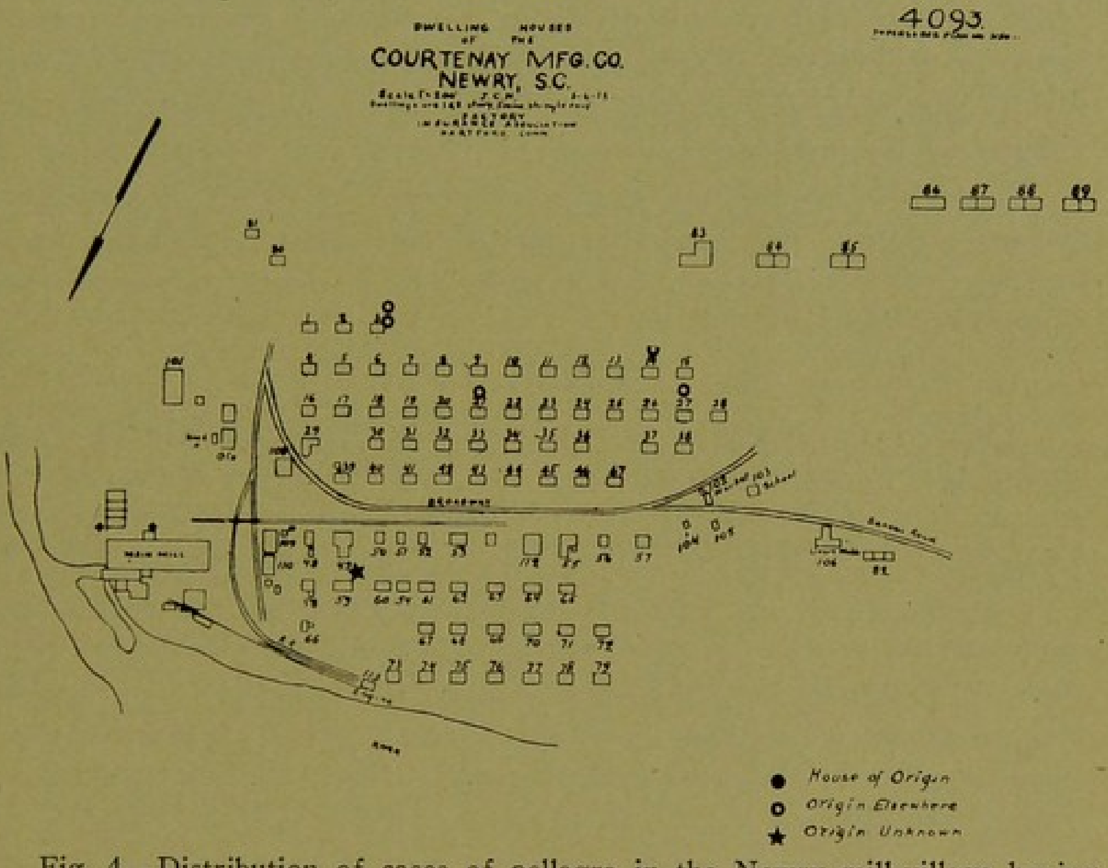

Fig. 4.—Distribution of cases of pellagra in the Newry mill-village having a water-carriage system for disposal of sewage. Note that all patients with one possible exception contracted pellagra before moving into the village.

Patient 2061, who had been a pellagrin since 1910 and had had a recurrence each succeeding year, first moved to the village in November, 1912, and still lived there in September, 1913. Her 10-year-old son (Case 2062) had pellagra, but he likewise developed the disease early in 1912 before coming to the village.

Case 2063, that of a young woman who died of pellagra in Newry, Aug. 17, 1913, offers the only instance of possible origin in this mill-village, inasmuch as she moved there late in the fall of 1912 (exact date not known) and apparently did not have any erythema prior to Aug. 3, 1913, two weeks before death. She was under treatment by the local physician for persistent diarrhea from June 6, 1913, and gave a history of stomatitis, diarrhea and general poor health the previous year, while living at another village in a house within a few doors of at least two other cases of pellagra. It seems highly probable that she was a pellagrin in 1912 before coming to Newry.

The history of pellagra in this village may be summarized by saying that five pellagrous patients have been observed, all of whom, with one possible exception, were suffering with pellagra on arrival in the village. No case of pellagra clearly originating in the village has been found. Figure 4 indicates the distribution of pellagra at the Newry mill-village.

As a control study we investigated the prevalence of pellagra in a mill-village on the outskirts of Seneca, S. C., about four miles distant from Newry mill. The methods of disposal of human wastes in this village were exactly similar to those observed in mill-villages in Spartanburg County (unscreened surface privies). We were shown active cases of pellagra originating in this village. The history of pellagra in this village as given us by the local practitioners indicated that it had prevailed here to much the same extent as in the mill-villages in Spartanburg County.

Oconee County had not so large a number of cotton-mills as Spartanburg County, nor were the mills in such close proximity one to another. For this reason the "floating" or transient population was appreciably smaller.

Republic Mill

This mill is situated at Great Falls, Chester County, in the north central part of South Carolina. It was built in 1910 and was put into operation in June of that year. There were ninety-two houses in the village and its population was between 475 and 500. Before building the village, Mr. R. S. Mebane, president of the mill, made a special study of the problem of the proper sanitation of mill-villages, especially with reference to the water-supply and sewerage. In building the village he constructed a complete sewer system, connected with every house, and placed in each house a kitchen sink and flush closet. The system differed from that at Newry Mill in that the closets were placed in the houses instead of being grouped outside. This mill-village was visited for two days in September, 1913, and as complete a study made of the pellagra situation as was possible in that time. Dr. J. B. McKeown, the resident physician, kindly gave practically the entire two days to assist in the inquiry. Notes were secured of six cases of pellagra concerned in the history of the village during the three years of its existence.

The first patient, a woman, aged 30, had lived in the village only four months. She was at about term with her fourth child. She had no erythema when seen and said she had never noticed any. When seen by us she had a very bad stomatitis and glossitis and had suffered with persistent diarrhea for the past nine months. She had lost considerable weight and had suffered recently with severe burning of feet. While, in the absence of any skin manifestation, it was not considered possible to make an absolutely positive diagnosis, we agreed with Dr. McKeown in considering hers a very probable case of pellagra. There was no question, however, but that her symptoms antedated her coming to Republic Mill.

A second case, not now in the village, was reported by Dr. McKeown as having moved there in January, 1913. The patient first came to his attention in April, 1913, when she was confined. About three weeks later he was again called and found her with all the symptoms of an active attack of pellagra — diarrhea, nervous symptoms, bad stomatitis, and a symmetrical erythema on the backs of her hands. She left the village the following June. In November we received a letter from Dr. L. S. Hay of Rock Hill, a former physician of the case, saying that she had been a pellagrin under his care the previous year before coming to Republic Mill.

The third patient was a woman who had been a pellagrin since the spring of 1909 and had lived in Republic Mill for the past two years. She had had no active symptoms of the disease during the period of her residence in the village.

The fourth case was that of a boy aged 8, who came to the village in March, 1913. When seen he showed no evidence of the disease except a symmetrical scaliness and pigmentation of the backs of the hands. In the spring of 1913 he had an erythema of hands and feet and an attack of sore mouth. He was seen by Dr. McKeown at that time and the case diagnosed as pellagra. According to his father's statement he had suffered an exactly similar attack, though rather more severe, in March of the previous year (1912) before coming to Republic.

The fifth case was that of a boy, aged 6, who, according to Dr. McKeown's statement, presented a typical erythematous rash of both hands and feet and was suffering from diarrhea and sore mouth and tongue during the summer of 1912. The erythema had appeared in June, 1912, and he had come to the village the preceding January. His mother stated that he had a somewhat similar rash the previous year (1911) before coming to Republic, which she thought was "poison oak." She said that she "broke out" the same way on her hands, face and neck about six years ago and that her mouth got sore. She also stated that her father was said to have died of pellagra. The woman was of a very low order of intelligence and her statements were not considered very reliable. A diagnosis in her case was not possible and the time of appearance of the boy's first symptoms could not be determined positively. The case must be considered as possibly originating at Republic Mill, but there was a fair probability that the boy was pellagrous prior to coming to the village.

The sixth patient, a colored woman, aged 35, did not live in the village proper, but in a cabin about one fourth of a mile distant. This was a typical case, but the patient had been living there only a short while and her symptoms clearly antedated her present residence.

Of the total six cases which could be discovered in the three years history of the village, only one could possibly have arisen there and in that case the evidence seemed to point to probable origin elsewhere. Figure 5 shows the distribution of pellagra in this village. Two of the cases cited above are not shown on this map because the patients lived beyond the limits of the village.

One significant fact in these two villages was the difficulty encountered in finding cases of pellagra even by careful search, whereas in all other villages studied, a few moments' inquiry was all that was necessary to locate many cases of pellagra, well known to the population at large.

The second striking feature, of course, was that, with two doubtful exceptions, each of the eleven patients affected with the disease who could be found in these two water-sewered villages had been pellagrins prior to coming to the respective villages. It appears, therefore, that while cases of pellagra had been introduced into these villages from time to time during their history of twenty and of three years, respectively, no case of the disease could be shown definitely to have originated in these villages and only two could possibly have done so.

With reference to Republic Mill, the point arises whether three years is not perhaps too short a time for pellagra to show itself in a newly constructed village. That this is not true is demonstrated in the case of a mill-village in Spartanburg County which was built in 1911 and went into operation in April, 1912. During the following year five known cases of pellagra moved into the village. Two chil-

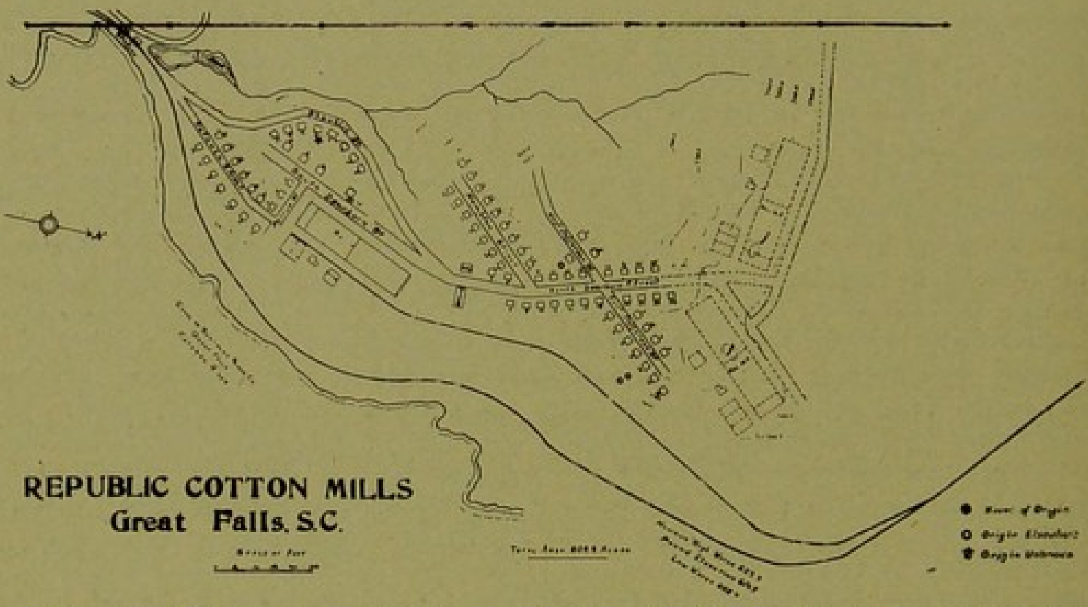

Fig. 5.—Distribution of pellagra in the Republic mill-village. Note that with one possible exception all pellagrins contracted the disease elsewhere and moved into the village with pellagra.

dren (Cases 546 and 585) who in July, 1912, moved into the house next door to one of these imported cases, developed typical pellagrous symptoms in May and June, respectively, the following year (1913). There were very clear histories of the absence of any previous manifestations of the disease. A third patient (No. 745), a boy of 7 years, developed pellagra in March, 1913. There was no history of a previous attack. The immediate connection with a previous case of pellagra appeared to be the boy's grandfather, who was a pellagrin and had visited the family during the previous winter. The development of these three cases within little over a year after the newly built village was first occupied would argue strongly that the apparent freedom of Republic mill-village from pellagra cannot be explained by the assumption that a period of three years is not sufficient time for the disease to manifest itself in a new locality.

Each of the villages here cited is still under observation, and it is our intention to follow them for at least another year, both in order to determine the presence or absence of pellagra and to ascertain, if possible, any factors other than the presence of water-carriage systems of sewage disposal which may differentiate them from those villages showing a high prevalence of pellagra.

THE SPREAD OF PELLAGRA IN UNSEWERED RURAL COMMUNITIES

We have referred to inequalities in the distribution of pellagra in Spartanburg County and have cited the fact that our records showed an incidence rate of sixteen per ten thousand of population in rural communities, against 104 per ten thousand in mill-village communities.

So far as disposal of excreta is concerned the only important difference between these two elements of the population was the fact that unscreened surface privies were always found in mill-village communities, while in rural communities, not infrequently, there was no visible method of disposal. The absence of privies applied more particularly to the colored tenant farmers. Where privies were found in rural communities they were practically always of the unscreened surface type.

The most important contrast between rural and mill-village communities appears to be density and congestion of population. There were isolated instances in rural communities in Spartanburg County where foci of pellagra appeared to exist and we made an extensive study of one such district. In this farming district covering an area 2 miles square, there was a total population of approximately 260 persons, 100 white and 160 colored. We secured records of a total of eleven cases of pellagra occurring in this population since 1906, four cases in the white population and seven cases in the colored. The incidence rate for pellagra in this rural community was 423 per ten thousand of population while the incidence rate for the rural population of the county as a whole was only 16 per ten thousand of population. In this district a history of close association between previously existing and new cases was demonstrable. There was a general tendency for active foci of pellagra in rural communities to occur in townships in which mill-villages were located and the focus mentioned above occurred within about 2 miles of a mill-village community where pellagra was endemic.

The methods of disposal of human wastes in the county in which our studies were undertaken are typical of those in use throughout the southern states where pellagra prevails so extensively. Recent statistical reports of the Rockefeller Sanitary Commission[1] indicate quite clearly the sanitary conditions existing in the Southern states at the present time. Of 189,510 homes inspected in rural communities it was found that 95,735 had no privy. The sanitary index for the total number investigated was only 5.8 per cent.

THE PREVALENCE OF PELLAGRA IN INSTITUTIONS WITH WATER-CARRIAGE METHODS OF DISPOSAL OF SEWAGE

The prevalence of pellagra in institutions for the insane, having water-carriage systems of disposal of sewage, is of particular importance in the discussion of any possible relationship between the spread of pellagra and methods of disposal of human excreta. We have been unable to obtain any definite information relative to the actual incidence rate of pellagra in asylums in the southern states. The disease is endemic in these states and cases of pellagrous insanity are being admitted to these institutions at frequent intervals. Very frequently symptoms of the disease are observed within a short time after admission and even though there be no suspicion or definite evidence of the disease on admission, it is impossible, from the histories obtainable, to arrive at any definite conclusion as to where the person contracted pellagra. It is a fact, however, that, not infrequently, patients show active symptoms of the disease for the first time, several years after commitment.

So far as we have been able to ascertain, there is probably only one institution for the insane in this country in which a severe epidemic of pellagra has occurred and in which there appeared to be no question that practically all the patients contracted the disease in the institution. We refer to an epidemic of pellagra at the Peoria State Hospital at Peoria, Ill.[2] Two of the members of this commission took part in an investigation of this epidemic and it was studied most thoroughly by the Pellagra Commission of the State of Illinois. Dr. George A. Zeller, superintendent of this institution, recalls very distinctly that cases of pellagra occurred in the Peoria Hospital as early as 1907 and has records of such cases, though they were not, at that time, recognized as such. In 1909, however, there was a sharp outbreak of pellagra in the institution involving more than 8 per cent. of the inmates (177 cases). Table 1 shows the total number of incident cases for each year from 1909 to 1913 inclusive. All cases for 1909 are tabulated as incident cases because accurate records were not available prior to that time. The mortality rates in

1. Fourth Annual Report, The Rockefeller Sanitary Commission.
2. Report of the Pellagra Commission of the State of Illinois, November, 1911, Springfield, Ill., 1912.

this epidemic were very high, particularly so during the year 1909 (50 per cent.). The severe outbreak of pellagra in 1909, with the sharp decline in succeeding years, is most interesting.

TABLE 1.—Incident Cases of Pellagra at the Peoria State Hospital, Peoria, Ill.

Year	1909	1910	1911	1912	1913	1914 (to March 15)
Cases	177	67	14	0	0	0

The institution had a most excellent water-carriage system of disposal of sewage and it is not possible to attribute the 1909 epidemic

TABLE 2.—Pellagra Arising in the Wards of the Peoria State Hospital

Ward	Type of Patient	Habits*	Sex †	Population	No. of Cases of Pellagra	Incidence Per Cent.
ary *A*	Infirm chronic...	±	♀	60	10	16.6
....	Staff house......	....	....	....	....	....
....	Chronic	±	♀	50	7	14.0
....	Demented	—	♀	62	19	30.6
....	Epileptic	+	♀	60	7	11.7
....	Acute and chronic	+	♀	52	2	4.0
ary *B*	Infirm chronic...	±	♂	60	3	5.0
....	Acute and chronic	+	♂	52	2	4.0
....	Demented	—	♂	52	13	25.0
....	Demented	—	♂	62	4	6.4
....	Epileptic	+	♂	58	8	13.8
....	Demented workers	+	♂	110	8	7.3
....	Demented	±	♂	110	9	8.2
....	Demented	±	♂	110	8	7.3
....	Irritable dements	+	♂	110	7	6.4
....	Irritable dements	±	♀	110	14	12.8
....	Irritable dements	+	♀	110	7	6.4
....	Feeble dements...	±	♀	110	6	5.5
....	Infirm old	+	♀	110	23	20.8
dormitory..	Quiet workers....	+	♀	...	2	
Col. *B*.......	Tuberculous	±	♀	57	12	21.0
Col. *C*.......	Tuberculous	±	♂	57	5	8.8
ward	Workers	+	♂	140	4	2.9
tic ward....	Workers	+	♀	64	1	1.5

he sign + indicates that patients are all cleanly in habits; ± indicates that some are cleanly any are not; — indicates that all patients are uncleanly. In this column ♂ stands for male for female.

to improper methods of disposal of human excreta. It is to be remembered, however, that in many infectious diseases of intestinal origin, dependent mainly for their spread on faulty methods of disposal of human excreta, intimate association and contact may also be important factors. With this in mind, there are some suggestive facts which may be cited in connection with this epidemic.

The wards of this institution were constructed on the pavilion plan. Twelve of the pavilions had capacity for 60 patients. Eight pavilions housed 110 patients each; the supply ward had 140 patients and the domestic ward, 64. In assigning patients to wards an effort was made to distribute them according to cleanliness of habits. Through the courtesy of Dr. H. D. Singer, director of the Illinois Psychopathic Institute, Dr. George A. Zeller, member of the State Board of Administration and Dr. E. Z. Levitin of the Medical Staff of the Peoria State Hospital, we have secured information[3] covering the distribution of 181 cases of pellagra arising in the early stage of the epidemic at Peoria. Table 2 shows the distribution of cases in the different wards and each case has been charted in the ward of apparent origin.

It will be noted from this table that, except for Wards 8 *C* and 3 *B*, there was a distinctly greater tendency for pellagra to spread in wards housing untidy patients (3 *A* and 2 *B*) than in those housing patients of cleanly habits. It is also evident that the patients in 8 *C*, which shows a high rate of incidence, were of advanced age and infirm.

Omitting the two cases which occurred in the south dormitory, for which population figures are not at hand, there remain 179 pellagrins. The distribution of these cases according to cleanliness of habits is shown in Table 3.

TABLE 3.—Distribution of Pellagra in Wards of the Peoria State Hospital According to Cleanliness of Habits

Character of Inmates	Population	No. of Pellagrins	Incidence Per Cent.
All cleanly habits	866	69	8.0
Mixed: some cleanly habits and many uncleanly	724	74	10.2
All uncleanly habits	176	36	20.5
Total	1,766	179	10.1

The incidence rate of pellagra in the untidy wards was 20.5 per cent., two and a half times greater than in wards housing patients with cleanly habits, in which it was 8 per cent.

The food for the inmates was distributed from a central kitchen. One of the early and severe cases in the institution was that of a woman employed in the central kitchen. She had a very severe attack of pellagra during the summer of 1908 while working in the kitchen and her symptoms became so severe as to necessitate her admission to the hospital.

3. Personal communication, March, 1914.

In August, 1909, Dr. Zeller, the superintendent of the institution, decided to establish in the hospital proper, male and female pellagra wards. In the fall of 1909 practically all the pellagrins in the institution were transferred to these wards, a graduate nurse was assigned to each ward and daily notes were made on the cases. During the summer of 1910, the pellagrins were still segregated and as new cases of the disease arose they were transferred to hospital. Dr. E. Z. Levitin of the hospital staff informed us recently (March, 1914)[4] that segregation was practiced until the fall of 1911, when the patients were so few that the practice was discontinued. He states further that, except for one chronic pellagrin, there are at the present time (March, 1914) no active cases of pellagra in the institution. This segregation and practical isolation of pellagrins may possibly have been a factor in the remarkably rapid disappearance of pellagra from this institution. The death-rate among pellagrins in this institution was also remarkably high, thus diminishing the number of hypothetical sources of infection.

DISCUSSION

This study shows inequalities in the geographical distribution of pellagra in Spartanburg County. Furthermore, in those communities and elements of the population in which methods of disposal of human excreta were similar, its distribution was still unequal. In the section in which our studies were undertaken, congestion of population, general sanitary conditions being equal, appeared to be an important factor in producing higher incidence rates. Thus we found that, where the population was congested in Spartanburg County, as was the case in mill-village communities, the pellagra morbidity per ten thousand of population was six and a half times greater than in rural communities where the population was sparse. (Rural rate per ten thousand was 16, mill-village rate per ten thousand was 104.)

In the city of Spartanburg there was a distinct tendency for the endemic foci of the disease to be confined to those sections of the city in which unscreened surface privies were in use. Information given us by physicians practicing elsewhere in the South indicates that the distribution of the disease, in at least some other southern cities, coincides, so far as methods of sewage disposal are concerned, with its distribution in the city of Spartanburg. It is our intention, during 1914, to study the distribution of the disease in a number of cities and industrial communities, with particular reference to methods of disposal of sewage.

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4. Personal communication.

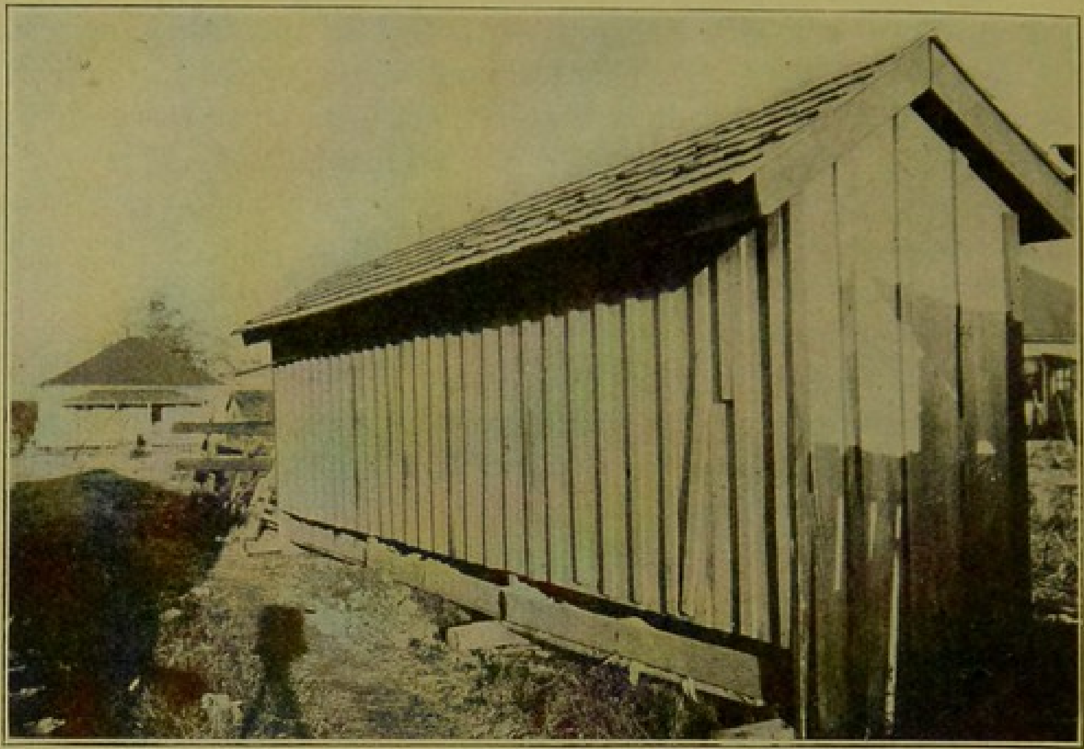

Fig. 6.—Type of unscreened trough privy formerly in use in Spartan mill-village.

Fig. 7.—General view of unscreened trough privies formerly in use in Spartan mill-village.

Pellagra prevailed and originated in all the mill-village communities in Spartanburg County and in all these communities the methods of disposal of excreta were unscreened surface privies. We investigated the history of pellagra in two mill villages elsewhere in the state in which the only striking contrast was the fact that a complete water-carriage system of disposal of sewage had been installed. In these

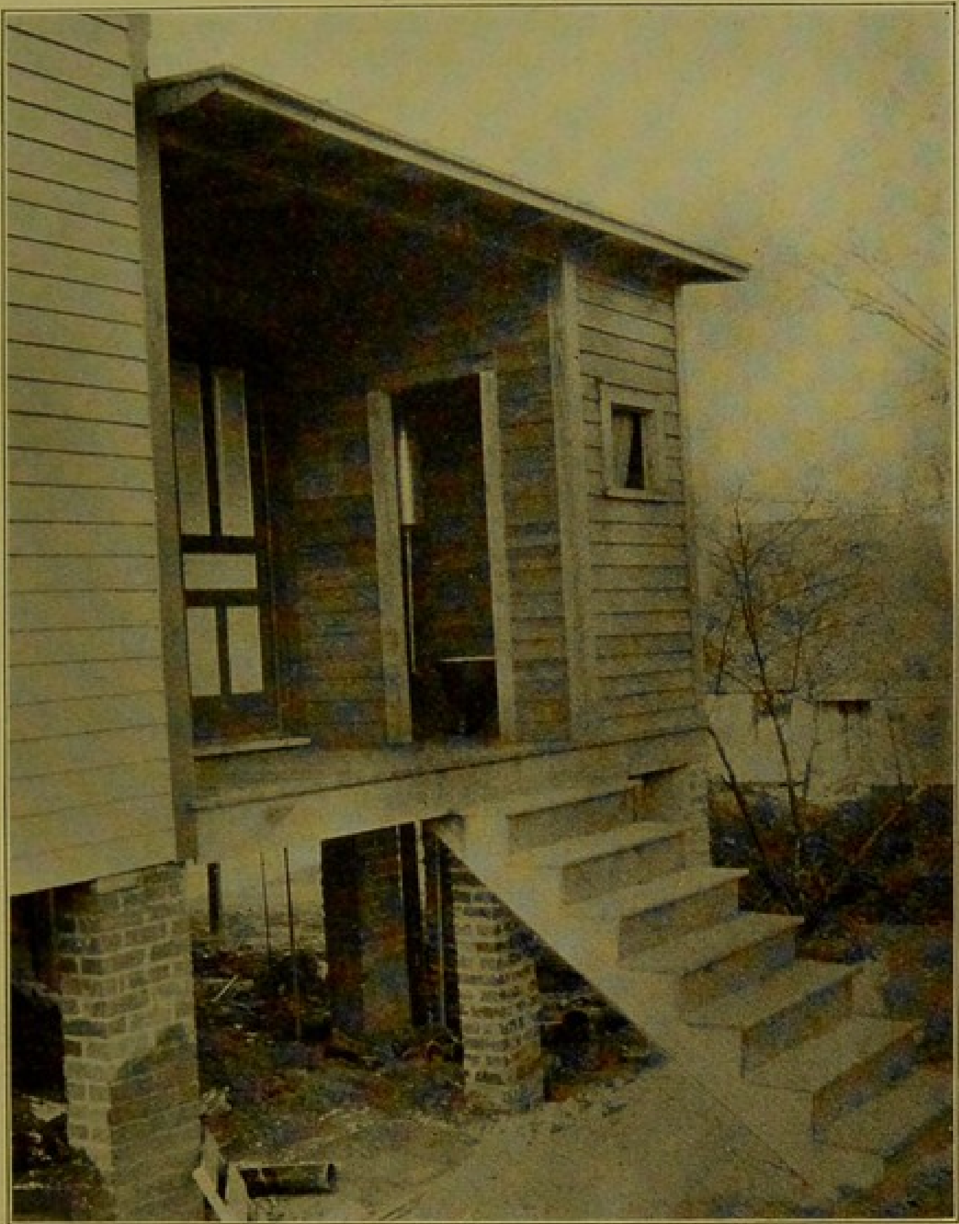

Fig. 8.—Type of water-closet recently installed in Spartan mill-village.

villages we found that, notwithstanding the fact that pellagrins moved in from time to time, thus far, there had been no tendency for pellagra to originate or to spread in these communities. These observations appear to us to be somewhat striking and strongly suggest the possibility of a direct relationship between the spread of pellagra and faulty methods of disposal of human excreta.

There is a wide-spread movement under way at the present time in the southern states toward the improvement of methods of disposal of human excreta. Many towns and cities as well as industrial communities in which pellagra is endemic are either improving their types of surface privies or putting in modern water-carriage systems of disposal. It is in such communities that most important information can be obtained, either confirming or refuting these observations. Superficial studies and general impressions will not suffice. If any information of value is to result, the local health officers and physicians in communities, in which improved methods of disposal are being installed, must necessarily know the history of the prevalence and distribution of pellagra prior to the installation of improved methods.

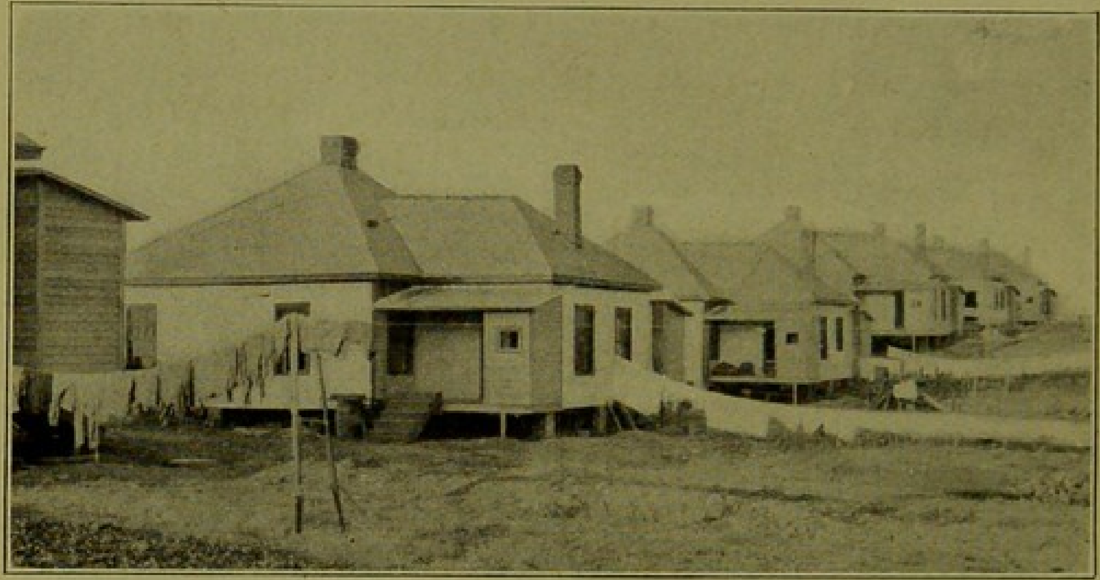

Fig. 9.—Rear view of a row of houses showing type of construction adopted in installation of water-carriage system of disposal of sewage in Spartan mill-village. The closet is on the back porch.

They must also necessarily keep accurate records, for at least three or four years, of the prevalence of the disease subsequent to the installation of improved sanitary methods.

One community exists in Spartanburg in which a water-carriage system of disposal has been substituted for unscreened surface privies. Reference to Figure 2 (the distribution of pellagra in the city of Spartanburg and its relation to methods of disposal of sewage) shows that the disease has prevailed most extensively in the northwestern quadrant of the city. In this quadrant is located one of the largest cotton-mills in the county. About 300 of the dwelling houses in this section are the property of this mill, and during the summer of 1913 the president of the mill, Mr. W. S. Montgomery, decided to install individual water-closets in each dwelling. Up to the present, pellagra has been excessively prevalent in this section and the method of disposal of human wastes has been the unscreened trough system (Figs 6 and 7). The installation of a water-carriage system was begun in the fall of 1913 and is being pushed to completion. On Feb. 1, 1914, 123 installations had been completed and connected with the sewer mains. The type of construction adopted is shown in Figures 8 and 9. A special non-freezing type of closet has been installed, as the fixtures are exposed to sudden and sharp changes in temperature.

We have studied the prevalence of pellagra in this village during 1912 and 1913 and each case has been carefully located. We know that at least eighty cases of pellagra have originated in the northwestern section of the city during the past six years. It is our intention to observe carefully the behavior of the disease with respect to the development of new cases during 1914 and for two or three years thereafter.

In presenting these facts at this time, we hope that similar studies may be undertaken in communities elsewhere in the Southern states where pellagra is endemic and where contrasts in methods of disposal of human excreta present themselves.

SUMMARY

1. Pellagra morbidity was higher in congested communities using surface privies than in more sparsely settled districts in which similar methods for the disposal of excreta were employed.

2. In the city of Spartanburg the endemic foci of pellagra were located in the districts in which surface privies were in use.

3. In cotton-mill villages equipped with surface privies pellagra was found to be endemic and new cases of the disease arose there year after year.

4. In two cotton-mill villages completely equipped with water-carriage systems of sewage disposal it was impossible to find cases of pellagra which had certainly originated there, although some cases which had originated elsewhere were present.

5. There is some evidence that pellagra spreads in hospitals for the insane more readily in the wards housing untidy patients.

6. This study indicates that methods of disposal of human wastes may prove to be a determining factor in the spread of pellagra in certain communities and it suggests a possible method of prophylaxis, which is now being tested in a practical way.

Twentieth Street and Second Avenue.

V

FURTHER OBSERVATIONS ON THE BLOOD-COUNT IN PELLAGRA *

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In a previous article[1] one of us summarized the more important changes that occur in the blood-count in pellagra. In the present communication we desire to record briefly our observations on another series of pellagrins, all of whom resided in, or adjacent to, Spartanburg County, South Carolina, in which locality the Thompson-McFadden Pellagra Commission has been investigating the disease. The data included in this report were obtained from patients examined during the summer and early fall months of 1913, when many new cases of pellagra were seen, as well as a large number of patients who had had one or more attacks of the disease. The information derived from this study confirms and amplifies the work of the commission carried on along the same lines in 1912. In the investigations of 1913 more particular attention was given to the relationship (if any) existing between the total leukocyte and differential counts, especially in the primary acute attacks of the disease. It was our main intention, however, to examine a fairly large and representative series of cases from the standpoint of the differential count, even in the absence of the correlated total leukocyte count. A few confirmatory observations were also made on the hemoglobin percentage and number of red corpuscles. The actual technic employed was essentially the same as detailed in the former paper, and was such as to insure consistent results with a minimal error.

In the accompanying table the differential leukocyte count is given on a series of forty-six pellagrins, together with the total leukocyte count when this was made, and also a few remarks with regard to the incidence of the attack, its nature (whether mild or severe), and the probable duration of the attack. Inspection of the table discloses the fact that lymphocytosis is the predominant feature in the majority of cases. In this connection it might be said that a few observations made on non-pellagrins in regions where pellagra was endemic revealed a moderate relative lymphocytosis, incidental, in all probability, to a poor state of general health, or to some mild gastro-intestinal disturbance.

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* Reprinted from The Archives of Internal Medicine, January, 1915, Vol. xv, 147.

1. Hillman: Am. Jour. Med. Sc., 1913, cxiv, 507.

Table Giving Data Concerning Blood-Count of Pellagrins

Name	Case No.	Sex	Age	Polynu-clears	Lympho-cytes	Large Monos.	Transi-tionals	Eosino-phils	Baso-phils	Total Leuko-cytes	Nature and Duration of Attack
Q. J. F.	629	M	51	58.00	38.40	1.20	0.00	2.00	0.40	6,500	First attack, mild; six months.
D. W.	...	M	32	68.86	18.86	3.70	2.86	5.43	0.29	4,500	Recurrent attack, chronic; six months.
M. M.	628	F	30	72.80	18.60	1.60	1.40	5.40	0.20	10,000	First attack, severe; six weeks.
H. W.	518	F	40	49.75	46.25	2.50	1.00	0.50	0.00	6.050	First attack, severe, chronic; three months.
E. H.	...	F	38	64.20	29.40	1.40	0.80	4.20	0.00	7,200	Recurrent attack, chronic.
C. C. C.	582	M	43	78.75	16.25	2.25	2.50	0.25	0.00	6,000	Recurrent attack, chronic; two months.
S. J. H.	511	M	62	70.80	22.00	2.60	1.60	3.00	0.00	.....	Recurrent attack, chronic; four months, recovery.
S. M.	584	F	10	64.20	33.40	1.00	0.80	0.60	0.00	.....	Recurrent attack, chronic; three months, recovery.
E. S.	293	F	54	51.60	45.00	1.60	0.40	1.40	0.00	.....	Recurrent attack, chronic; six weeks recovery.
S. R. M.	510	M	19	68.00	25.75	3.50	1.00	1.75	0.00	6,650	First attack, chronic; two months, recovery.
M. W. M.	688	M	52	53.40	38.40	3.20	0.60	4.40	0.00	8,800	First attack, chronic; two months.
B. S. A.	53	F	44	55.80	35.00	0.80	0.80	7.60	0.00	.....	Recurrent attack, chronic, mild, recovery.
E. S.	570	F	28	43.00	54.85	0.85	0.00	1.30	0.00	6,000	First attack, subacute; one month, recovery.
S.	509	M	48	63.75	32.50	0.50	0.25	3.00	0.00	8,200	Recurrent attack, chronic; one month, died.
S.	509	M	48	67.50	25.75	4.00	0.00	2.50	0.25	.....	Recurrent attack, chronic; died.
S. W. H.	553	M	23	68.25	25.00	1.00	0.00	5.50	0.25	.....	Recurrent attack, chronic; two months.
S. L.	76	F	35	58.80	38.00	0.80	0.40	2.00	0.00	7,500	Recurrent attack, chronic; recovery.
A. V.	506	M	13	65.00	30.25	1.50	1.00	2.00	0.25	.....	First attack, mild; recovery.
W. C. C.	701	M	32	59.25	31.25	3.75	2.00	2.75	1.00	.....	First attack, subacute; recovery.
C. D. E.	255	M	25	56.67	32.67	3.33	0.67	6.66	0.00	8,250	Recurrent attack, acute; two weeks.
F. L. T.	523	M	35	54.20	31.80	7.20	1.40	4.80	0.60	8,800	Recurrent attack, chronic.
T. M. P.	129	M	58	48.40	46.80	0.80	2.00	1.60	0.40	.....	First attack, chronic; mild, recovery.
C. M.	387	F	25	67.00	29.30	1.00	1.50	1.20	0.00	.....	Recurrent attack, acute; three weeks, died.
W. C. J.	526	M	49	73.80	22.00	1.00	2.00	1.20	0.00	7,150	First attack, acute; two weeks.
W. C. J.	526	M	49	38.00	59.30	1.10	0.60	1.00	0.00	6,700	First attack, subacute.
M. E. C.	516	M	48	52.50	39.00	2.50	0.00	4.50	1.50	6,000	Recurrent attack, acute; five weeks, died.
W. M.	528	F	12	53.60	34.20	1.80	1.40	8.80	0.20	8,800	First attack, chronic; five weeks, recovery.
R. W. C.	502	M	56	73.00	18.90	4.50	2.00	1.10	0.50	8,750	Recurrent attack, chronic.
S.	508	F	20	70.00	24.00	2.00	1.00	2.60	0.40	.....	Recurrent attack, acute; died.
S. S. H.	144	F	35	51.20	37.80	2.60	3.00	5.00	0.40	.....	Recurrent attack, acute.
M. C. F.	...	F	17	59.00	33.40	2.20	2.20	2.80	0.40	10,150	First attack, acute; one week.
S.	634	M	35	55.00	43.00	1.33	0.67	0.00	0.00	9,800	First attack, acute; four weeks.
A. J. A.	505	M	35	45.70	49.30	2.40	0.30	2.30	0.00	7,550	Recurrent attack, acute.
S. E.	732	M	14	42.00	47.00	4.50	1.50	3.50	1.50	9,800	First attack, acute; four weeks.
B. J.	16	F	25	54.75	34.50	2.00	1.75	5.75	1.25	6,650	Recurrent attack, chronic; one month.
H. E.	...	F	35	61.25	33.50	2.75	1.00	1.00	0.50	.....	First attack, subacute; two months.
E. S.	293	F	54	45.50	49.00	0.50	1.50	3.00	0.50	.....	Recurrent attack, chronic.
W. R. G.	658	F	22	67.50	26.00	3.00	2.50	0.50	0.50	.....	Recurrent attack, subacute.
E. W.	569	M	10	50.50	43.50	2.00	0.25	3.50	0.25	9,800	First attack, acute; two weeks.
H. M.	703	F	45	69.75	22.50	3.00	1.00	3.75	0.00	8,000	Recurrent attack, chronic; mild.
R. L. L.	...	M	30	64.25	31.50	2.25	0.50	1.50	0.00	.....	First attack, acute; two weeks.
D. A.	552	F	24	61.50	32.75	3.25	1.25	1.25	0.00	.....	First attack, subacute; two months.
H. D.	572	F	32	42.00	57.00	0.50	0.00	0.25	0.25	8,000	Recurrent attack, chronic.
D.	575	F	53	51.00	40.50	5.50	1.00	1.25	0.75	6,500	First attack, chronic; mild.
G. E.	501	F	34	58.00	35.00	1.00	0.50	5.00	0.50	.....	First attack, chronic; two months.
E.	108	F	54	61.75	32.50	1.00	2.25	2.25	0.25	7,100	Recurrent, chronic; six weeks, severe.
Averages.....	...	..	35.5	58 87	34.57	2.23	1.13	2.86	0.25		

In cases showing a decided lymphocytosis, the total number of leukocytes was practically normal or only slightly below normal in a few instances. Marked and persistent leukopenia does not seem to be a feature of this disease. As far as we were able to determine from the cases studied, there appears to be no definite relation between the degree of lymphocytosis and the severity or chronicity of the attack. The small lymphocyte with relatively little cytoplasm is the most common type of lymphocyte in pellagrous blood.

In the few patients examined during the first stages of an acute attack, a tendency was noted toward a slight rise in the leukocytes to maximum normal or a trifle beyond, but in no instance was a pronounced leukocytosis found. The differential count on these cases did not exhibit a polynucleosis, and in only one case of acute severe pellagra were the polynuclears over 70 per cent. A rise in polynuclears was recorded in a few recurrent chronic cases, due most likely to complicating factors.

It has been mentioned by some workers on pellagra that the so-called large mononuclear leukocyte is relatively increased. Our observations would not tend to substantiate this finding as a constant feature, although in a few cases a slight rise in this type of cell was noted.

The eosinophils varied considerably, as may be seen from the table. A very moderate eosinophilia was found in occasional cases, but to state that eosinophilia is characteristic of pellagra would not be justified from a study of this analysis. The prevalence in the South of hookworm infection and other forms of intestinal parasitism capable of causing an eosinophilia, is a factor to be considered in interpreting slight fluctuations in the number of eosinophilic leukocytes.

With regard to the changes in the amount of hemoglobin and in the number of red corpuscles, it might be said that nothing further was detected other than a mild degree of secondary anemia which has been already noted in the first report. This anemia is not at all constant or characteristic of the disease. Cases of decided anemia occurred for the most part in patients afflicted with some associated condition to which the anemia was probably referable rather than to the pellagra *per se.*

VI

STATISTICS OF PELLAGRA IN SPARTANBURG COUNTY, S. C., INCLUDING GEOGRAPHICAL DISTRIBUTION OF THE DISEASE AND ITS RELATION TO RACE, AGE, SEX AND OCCUPATION *

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GEOGRAPHICAL DISTRIBUTION AND RACIAL DISTRIBUTION OF PELLAGRA IN SPARTANBURG COUNTY

The geographical distribution of pellagra in Spartanburg County was considered in detail in the First Progress Report.[1] In general, it was found that morbidity tended to vary directly with congestion of population, although this relationship was markedly disturbed by other factors. The villages of the cotton mills showed the highest morbidity and, when their population was excluded from the figures, the morbidity rate for the city dwellers was about the same as in the neighboring rural population, although somewhat above the morbidity of the rural population of the county as a whole.

The cases of pellagra in Spartanburg County on our records at the end of 1912 included 257 white persons and twenty-five colored (negro and mixed blood), representing a morbidity of 45 per 10,000 whites and 9.5 per 10,000 colored population. This difference was not regarded necessarily as evidence of racial resistance to pellagra on the part of the negro population, but it was thought that industrial conditions might account for it to a large extent.[2]

The field work of 1913 has added to our records of the number of cases in Spartanburg County, bringing the total number of recorded pellagrins up to 847. In 780 of the cases we know the race of the patient and the place in which he lived at the time the disease was recognized. Of these, 680 were white and 100 colored. We have obtained from the Census Bureau of the United States Department of Commerce and Labor, racial statistics of the population of the minor civil divisions of Spartanburg County. Our data enable us, therefore, to inquire into the total morbidity and the racial morbidity from pellagra, not only in the county as a whole, but also in each of these various minor civil divisions, which present differences in industrial and living conditions. The data are presented in Table 1.

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* From the Division of Tropical Medicine, Department of the Laboratories, New York Post-Graduate Medical School and Hospital.

* Reprinted from The Archives of Internal Medicine, January, 1915, Vol. xv, 98.

1. Siler, J. F., and Garrison, P. E.: Am. Jour. Med. Sc., 1913, cxlvi, 46; First Progress Report, p. 21.

2. Siler, J. F., and Garrison, P. E.: Am. Jour. Med. Sc., 1913, cxlvi, 51; First Progress Report, p. 26.

The general geographical distribution of the total 780 cases of Table 1 is not significantly different from that shown by the work of the previous year. The highest morbidity was found in the township of Spartanburg and it was somewhat higher (182 per 10,000) in the population of this township outside the city of Spartanburg proper than within the city limits (153 per 10,000). The only other township with a morbidity approaching these figures was Township E, 127 per 10,000, in which a large portion of the population lived in one mill-village. The townships devoted more especially to agriculture showed relatively much lower morbidity rates. It is probable that we have obtained somewhat less complete records of the actual cases existing in the rural districts, but we do not believe that this can account for the marked difference shown. Pellagra in the farming sections showed a distinct tendency to occur in definite foci of limited extent, in which a considerable proportion of the population was affected. In some of these foci the pellagra morbidity approached the figures observed in villages, but on the whole the rural pellagra morbidity was relatively low. We are compelled to believe that the population of the city and of the villages was, in the aggregate, much more subject to pellagra than the population of the country districts. In other words, higher pellagra morbidity was correlated with congestion of the population.

Within the city of Spartanburg, one small ward was practically free from pellagra, namely, Ward 3. The disease was most prevalent in the unsewered wards, 5 and 6, inhabited largely by the families of mill workers. The population of Spartanburg township outside of the city limits also showed a relatively high pellagra morbidity, 182 per 10,000. This population included the inhabitants of several mill-villages, together with a considerable agricultural population.

In all the townships the pellagra morbidity in the white population was considerably greater than in the colored. This was probably due in part to the fact that negroes were not employed in the cotton-mills and relatively few of this race lived in the mill-villages where the disease was most prevalent. It is also probable that our records of negro pellagrins are somewhat less complete than for pellagrins of the white race, although we do not believe that the discrepancy is very great. In general, it may be said that the negro population was more widely scattered than the white, being less than half as numerous in the first place and living for the most part on farms, except the 6,873 in Spartanburg city. In the principal negro section of the city, in Ward 1, the negro population was nearly equal in numbers to the white and in this ward the pellagra morbidity of the two races was approximately equal, 123 and 121 per 10,000. The financial status and general sanitary surroundings of the white people in this ward were on the average much better than for the negroes. The latter race lived in

TABLE 1.—Pellagra Morbidity of Whites and Negroes in the Townships of Spartanburg County

Township	White			Negro			Total		
	Population	Pellagrin	Morbidity per 10,000	Population	Pellagrin	Morbidity per 10,000	Population	Pellagrin	Morbidity per 10,000
Campobello	6,587	23	35	2,092	4	19	8,679	27	31
Cherokee	4,147	29	70	1,103	1	9	5,250	30	57
Beech Springs	8,359	64	77	3,714	3	8	12,073	67	55
Spartanburg	21,143	448	212	10,208	72	71	31,354	520	166
Pacolet	3,576	62	173	1,921	8	42	5,501	70	127
Reidville	4,562	31	68	2,312	10	43	6,874	41	60
Walnut Grove	1,128	2	18	1,315	1	8	2,443	3	12
Glenn Springs	1,768	2	11	1,176	0	0	2,944	2	7
Woodruff	2,982	6	20	1,398	0	0	4,380	6	14
Cross Anchor	2,796	13	46	1,171	1	9	3,967	14	35
Total	57,048	680	119	26,410	100	38	83,465	780	93

TABLE 2.—Pellagra Morbidity of Whites and Negroes in the Minor Divisions of Spartanburg Township

Locality	White			Negro			Total		
	Population	Pellagrin	Morbidity per 10,000	Population	Pellagrin	Morbidity per 10,000	Population	Pellagrin	Morbidity per 10,000
Ward 1	2,476	30	121	2,366	29	123	4,843	59	122
Ward 2	1,380	20	145	451	4	89	1,831	24	131
Ward 3	445	1	22	64	0	0	509	1	20
Ward 4	2,450	34	139	1,972	13	66	4,424	47	106
Ward 5	973	33	339	540	4	74	1,513	37	245
Ward 6	2,917	86	295	1,480	14	95	4,397	100	227
Total for city of Spartanburg	10,641	204	192	6,873	64	93	17,517	268	153
Township, excluding the city	10,502	244	232	3,335	8	24	13,837	252	182
Township, total	21,143	448	212	10,208	72	71	31,354	520	166

a wholly unsewered section in poorly constructed dwellings, while many of the white residents of this ward were of the well-to-do class living in well appointed homes. It would appear that the negroes in Spartanburg County have, as a race, been somewhat less subject to the disease than the white population. The difference is not sharp enough to warrant the belief in a distinct racial immunity of negroes, and it doubtless depends to a considerable extent on living conditions.

The smaller number of negroes present and the fairly complete social segregation of the races rendered association of negroes with pellagrins comparatively much less common. The negroes associated hardly at all with the white mill-village population and their closest social relation with the white race was doubtless in the capacity of household servants in the more well-to-do white families.

So many undetermined factors enter into the relationship that it seems unwise at this time to draw any very definite conclusions in regard to racial resistance to pellagra. We are inclined to believe that negroes as a race are only slightly, if at all, less susceptible to pellagra than the white population, and that the racial difference shown in our statistics for Spartanburg County is dependent to a large extent on the influence of other factors.

Synopsis.—The geographical distribution of pellagra in Spartanburg County has been very uneven, the morbidity being much higher in those townships in which the larger centers of population were situated and especially in the industrial communities surrounding the cotton-mills.

The disease was about three times more prevalent in the white population as a whole than in the negroes, but this ratio is not considered to be a true measure of the relative racial resistance to pellagra, but rather as the end-result of the influence of several factors, in part undetermined.

THE DISTRIBUTION OF PELLAGRA ACCORDING TO AGE AND SEX

The distribution of pellagra in respect to age and sex was discussed in the First Progress Report,[3] in which 282 cases then on our records were studied from this standpoint and compared with similar compilations of other published data. At the end of our field work in 1913, we have been able to compile data in regard to the age and sex of 740 cases in Spartanburg County, out of the total 847 cases of which we were able to obtain records, and it seems probable that these 740 cases represent a much larger proportion of all the cases which have actually occurred in this county than has been previously obtained in a unit population of comparable size. Further than this, we possess approximately complete data concerning the age and sex of 257 pellagrins

3. Siler, J. F., and Garrison, P. E.: Am. Jour. Med. Sc., 1913, cxlvi, 44; First Progress Report, p. 31.

Synopsis.—Persons engaged in many different occupations were found to be pellagrins, but the greatest number of cases was observed among persons engaged in house-work or remaining at home without

TABLE 14.—Comparative Pellagra Morbidity of Mill Operatives and of the Remaining Population in Villages I., W., P., Sa., A. and Sp., Based on Total Recorded Cases and the Population Statistics of Census of 1913

Age	Mill Workers			Other Persons			Total Population		
	Individuals	Pellagrins	Morbidity per 10,000*	Individuals	Pellagrins	Morbidity per 10,000*	Individuals	Pellagrins	Morbidity per 10,000*
FEMALES									
0-11..........	0	0	...	870	37	425	870	37	425
12-19..........	481	11	229	94	4	426	575	15	261
20-29..........	245	39	1,592	302	17	563	547	56	1,024
30-39..........	81	18	2,222	265	45	1,698	346	63	1,821
40-49..........	26	6	2,308	176	22	1,250	202	28	1,386
50-59..........	6	1	1,667	116	13	1,121	122	14	1,148
60-69..........	1	0	0	49	4	816	50	4	800
70-79..........	0	0	...	26	0	0	26	0	0
80-89..........	0	0	...	0	0	...	0	0	...
Total......	840	75	893	1,898	142	748	2,738	217	790
MALES									
0-11..........	0	0	...	960	38	396	960	38	396
12-19..........	532	8	150	64	3	469	596	11	185
20-29..........	478	4	84	20	0	0	498	4	80
30-39..........	296	5	169	36	0	0	332	5	151
40-49..........	141	6	426	45	2	444	186	8	430
50-59..........	77	11	1,429	46	0	0	123	11	894
60-69..........	35	5	1,429	23	4	1,739	58	9	1,552
70-79..........	6	0	0	11	0	0	17	0	0
80-89..........	1	0	0	4	0	0	5	0	0
Total.......	1,566	39	250	1,209	47	390	2,775	86	310

* The figures in the morbidity column of this table indicate the ratio of the number of recorded pellagrins to the number in the respective group of the present population. A considerable number of these pellagrins had died or moved away before the time of our census.

occupation, namely, the adult females and the children under 12 years of age. Occupation in house-work would appear, however, to bear only an accidental relation to this morbidity, because in those villages concerning which accurate and complete data are available, the morbidity among female mill-workers was practically the same as among the housekeepers. It would appear that our studies have so far failed to discover reliable evidence that occupation has had any definite relation to pellagra morbidity. The excessively high pellagra morbidity in mill-villages would seem to depend on other circumstances affecting the various members of the village community, regardless of whether their days were spent at work in the mill or in other occupations or locations.

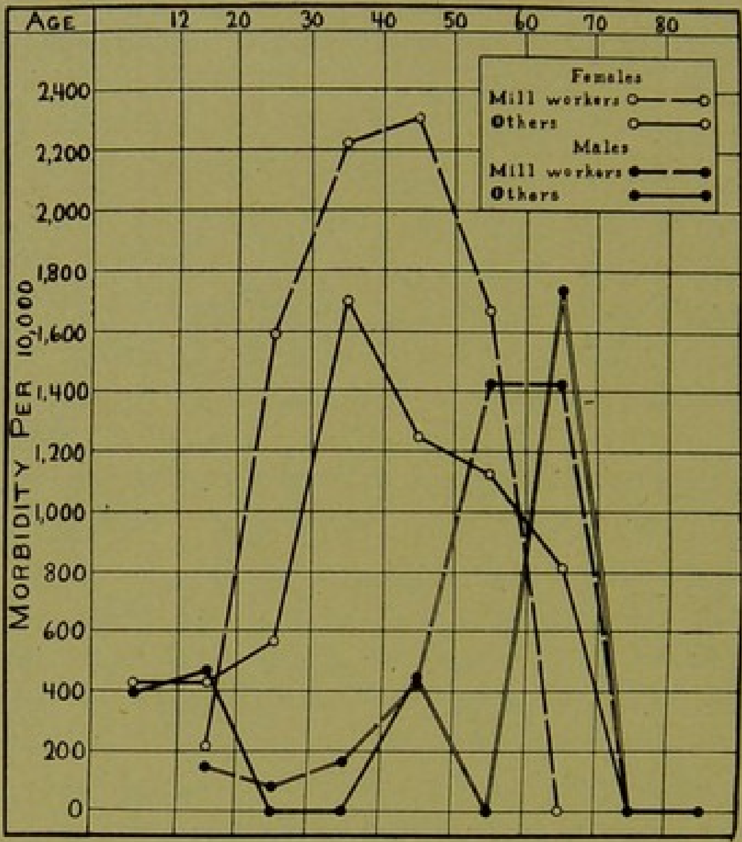

Chart 12.—Comparative pellagra morbidity in the six villages, I., W., P., Sa., A. and Sp., according to age, sex and occupation, based on the total cases of pellagra on record and the population statistics of the census of 1913.

SUMMARY

1. The geographical distribution of pellagra in Spartanburg County, South Carolina, has been uneven, the morbidity being much higher in and near the large centers of population and especially in the cotton-mill villages.

2. Pellagra was found to be about three times more prevalent in the white race than in the negro population of this county. This ratio is not regarded as a true measure of the relative racial resistance to the disease, but rather as the end result of the influence of several factors.

3. Women between 20 and 44 years of age have been most subject to pellagra. Children from 2 to 10 years of age, of both sexes, and

old people of both sexes have also been frequently attacked. Children under 2 years have been rarely affected; adolescents of both sexes and adult males under 50 years of age were relatively free from the disease. Pellagra in children has been relatively benign.

4. The peculiarities of the age and sex distribution are believed to be due in part to differences in physiological resistance to the disease and in part to differences in degree and frequency of exposure to the causative factors, among which proximity to or association with pellagrins seems to be important.

5. No direct relation of occupation to pellagra morbidity was discovered. Indirectly, by determining economic status and environment, occupation was found to have an important bearing on the prevalence of the disease.

VII

MENTAL AND NERVOUS DISORDERS ASSOCIATED WITH PELLAGRA *

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The investigations here published were rendered possible by an invitation to undertake the study of this phase of pellagra extended to the author by the Thompson-McFadden Pellagra Commission. Permission to accept this invitation was readily granted by the Illinois State Board of Administration, to whom my respectful thanks are due. Most valuable assistance was rendered by the physicians of Spartanburg County, by Dr. J. W. Babcock, superintendent, and the medical staff of the South Carolina State Hospital, to one of whom, Dr. E. B. Saunders, I am especially indebted for information and assistance, and finally by the medical officers of the Georgia State Sanitarium. Dr. E. M. Green, clinical director, and Dr. J. W. Mobley, first assistant physician, especially gave of their time and wide experience with ungrudging courtesy. The whole medical staff vied with one another in assisting with the patients and records and contributed materially to such small measure of success as may have been achieved.

The extent of this subject is wide, and the time available was small. Many of the patients were seen but once and there was no possibility of continuous observation over a long period. With these facts in mind, it was thought best to try and observe the conditions at various stages by seeing as large a number of different patients as possible.

The material used comprises that obtained by visits to the homes of known pellagrins in and around Spartanburg, the examination of patients coming, or sent, to the offices of the Pellagra Commission for diagnosis and treatment, a closer study of cases cared for in the Good Samaritan Hospital at Spartanburg, and the investigation of patients and records at the South Carolina and Georgia State hospitals at Columbia and Milledgeville, respectively. To these have been added the results of experience with cases in Illinois.

So widespread is the belief in pellagrous districts, even among physicians, that pellagra is a potent factor in the etiology of insanity, and so greatly is the horror of this disease thereby enhanced in the

* From the Illinois State Psychopathic Institute. This paper forms a part of the Second Progress Report of the Thompson-McFadden Pellagra Commission of the New York Post-Graduate Medical School and Hospital.

* Reprinted from The Archives of Internal Medicine, January, 1915, Vol. xv, p. 121.

minds of the people that the question is one of the greatest importance. Yet the actual state of our knowledge concerning the facts is extremely limited. Published statistics vary widely and most text-books, while very vague as to the details, seem to regard insanity as inevitable. Thus Wood says:[1] "It is true that the probable outcome of the ordinary types of pellagra will be insanity, and it is this phase which makes of the disease a great sociological problem."

FREQUENCY OF MENTAL SYMPTOMS

Most of the statistics concerning the frequency of mental disturbance in pellagra are of but small value for various reasons. First, they have been largely collected in hospitals for the insane, and it should be remembered that failure to commit a person to such a hospital is no criterion of the absence of mental disorder. It might also

TABLE 1.—INCIDENCE OF MENTAL SYMPTOMS IN RELATION TO THE NUMBER OF ATTACKS OF PELLAGRA FROM WHICH THE PATIENT HAS SUFFERED

	First Attack	Second Attack	Third Attack	Fourth Attack	Fifth Attack	Sixth Attack	Later Attack	Total No. of Cases
With mental symptoms	12*	17*	9	7	0	2	0	47
Committed as "Insane"	2	2	1	0	0	0	0	5
Without mental symptoms	35	25	10	5	1	0	2	78

* One of these committed suicide.

be said that many persons so strongly believe that pellagra is constantly associated with insanity that commitment may follow the placing of such a diagnosis without further consideration of the actual situation.

Secondly, it is not yet settled whether the recurrent outbreak of the symptoms of pellagra in succeeding years represents new disease each time or merely recrudescence following a period of latency. If the latter is true it would be obviously necessary to wait until the death of an individual before deciding whether he will ever become insane as the result of pellagra.

Thirdly, the statistics are based in the main on superficial estimates of the total incidence of pellagra in any given community, so that the case incidence of mental disorder becomes largely guess-work.

1. Wood, E. J.: A Treatise on Pellagra, D. Appleton & Company, New York, 1912, chap. vi, p. 224.

TABLE 2.—Cases Showing Mental Symptoms in Different Attacks Expressed in Percentages

	No. of Cases	With Mental Symptoms, Per Cent.	Committed as "Insane," Per Cent.	Without Mental Symptoms, Per Cent.
First attack	49	24.5	4.1	71.4
Second attack	44	38.7	4.5	56.8
Third attack	20	45.0	5.0	50.0
Fourth attack	12	58.3	0.0	41.7
Later attacks	5	40.0	0.0	60.0
Total	130	36.2	3.8	60.0

TABLE 3.—Age, Sex and Race Relations to the Incidence of Mental Symptoms

Age	1-10	11-20	21-30	31-40	41-50	51-60	61-70	Over 70
TOTAL CASES CONSIDERED								
	20	11	33	35	10	11	8	2
PATIENTS WITH MENTAL SYMPTOMS								
White males	0	1	2	2	4	3	0	0
White females	0	1	10	13	3	2	2	0
Col. males	0	0	1	1	0	0	0	0
Col. females	0	1	4	1	0	0	1	0
Total	0	3	17	17	7	5	3	0
Proportion of total cases, per cent.	0.0	27.3	51.5	48.6	70.0	45.5	37.5	0.0
PATIENTS WITHOUT MENTAL SYMPTOMS								
White males	9	2	0	1	0	6	2	2
White females	10	6	14	17	3	0	1	0
Col. males	1	0	0	0	0	0	1	0
Col. females	0	0	2	0	0	0	1	0
Total	20	8	16	18	3	6	5	2
Proportion of total cases, per cent.	100.0	72.7	48.5	51.4	30.0	54.5	62.5	100.0

TABLE 4.—AGE AND SEX RELATIONS EXPRESSED IN PERCENTAGES

	1-10	11-20	21-40	41-60	Over 61	Total
PERCENTAGE OF PATIENTS WITH MENTAL SYMPTOMS						
Males	0.0	33.3	85.7	53.8	0.0	36.8
Females	0.0	25.0	46.0	62.5	60.0	41.3
Total	0.0	27.3	50.0	57.1	30.0	40.0
PERCENTAGE OF PATIENTS WITHOUT MENTAL SYMPTOMS						
Males	100.0	66.6	14.3	46.2	100.0	63.2
Females	100.0	75.0	54.0	37.5	40.0	58.7
Total	100.0	72.7	50.0	42.9	70.0	60.0

The last source of error is a very important one. The experience of the Thompson-McFadden Pellagra Commission has demonstrated that, when an intensive study of a given pellagrous district is undertaken, far more cases are discovered than would be estimated from the most careful questioning of the physicians of that district.

In order to arrive at some data on this question the case records of 130 pellagrins, collected without any kind of selection except a positive diagnosis, have been analyzed and the results are presented in Tables 1 to 4. In preparing these tables no attempt has been made to subdivide the mental picture into different types, a point which will be considered later. It may be stated, however, that the great majority of cases included as "with mental symptoms," but not committed as "insane," were examples of a type which will be described as symptomatic depression. Such mental disturbances as well as milder forms of delirium occur in connection with many different diseases, especially the acute and chronic infections, and it may be objected that they do not constitute "insanity." In reply to this it is only necessary to point out that this latter term is not a medical one at all, and that no distinction can scientifically be made.

In this series of one hundred and thirty unselected cases, mental symptoms were present in fifty-two (40 per cent.), and of these, five (3.8 per cent.) were adjudged insane, while two others committed suicide. Certain other features also deserve mention. It will be noted that mental symptoms appear to be progressively more frequent the greater the number of the attacks. (This does not hold true in the above tables for cases having more than four attacks, but this may possibly be due to the small number of such examples.) In Tables 3 and 4, it is well shown that children with pellagra do not as a rule show any mental disorder, and one may add from personal observation that they are generally not very ill with the disease. From the figures given it would appear that males between the ages of 20 and 40 suffer with mental symptoms far more than do females.

This is probably not without significance, although it must be admitted that the number of cases is very small (seven). When it is remembered that men of this age but rarely contract pellagra, it suggests that those who do are in all probability below the average in general make-up and hence especially liable to suffer from mental disorder.

The greatest case incidence of mental disorder in females, on the other hand, occurs between the ages of 41 and 60; that is to say, during the climacterium, a period during which, as is well known, women are especially prone to mental disturbance.

To supplement these figures, a similar analysis of a series of thirty-four consecutive cases studied by me and forming part of the material on which the later description of types is based, showed results entirely in keeping, except that the numbers are too small for subdivision into age groups. The percentage showing mental symptoms was 38.2. There were ten children of 10 years or under, none of whom showed any mental disturbance. The average age of those with mental symptoms was 41.5 years and of those without mental symptoms, 18.5 years.

As might be expected, there is also a correlation between the appearance of mental symptoms and the severity of the pellagra attack, as illustrated by the mortality given in Table 5.

TABLE 5.—Case Mortality in Relation to Mental Symptoms

	No. of Cases	Deaths	Percentage Mortality
With mental symptoms................	52	10	19.2
Without mental symptoms............	78	2	2.6
Total	130	12	9.2

As a further illustration of this same point, it was found that in a series of eighteen patients, cared for and examined in the hospital provided for the Commission, who were admitted mainly because of the severity of the pellagra attack and the need for special attention, sixteen with an average age of 44 (23 to 95), showed mental symptoms, the exceptions being aged 10 and 15 years, respectively.

With the object of studying the question as to whether pellagra gives rise to a chronic "insanity" a list of all cases committed to the Columbia State Hospital from Spartanburg County from Jan. 1, 1912, to July 1, 1913, was secured, and these cases were investigated to determine how many were suffering from pellagra. These investigations were made possible by the courtesy of Dr. J. W. Babcock, superintendent, and the medical staff of the South Carolina State Hospital, the excellent records in the office of the Pellagra Commission and the physicians of Spartanburg County.

In 1912 sixty-five persons were adjudged insane in Spartanburg County, of whom eleven were stated to be pellagrous at the time of commitment. This diagnosis was confirmed at the State Hospital in all but one who had recovered from his attack at the time of admission. Besides these, nine others are reported as having pellagra at the time of admission to the hospital. In the first six months of 1913, twenty-four persons were adjudged insane, although only twenty-two were admitted to the State Hospital. Four were stated to be pellagrous on the commitment papers and to these must be added three found to have this disease when received at the hospital.

The population of Spartanburg County at this period was stated to be 83,465. The proportion of pellagrous persons living in the county, according to the figures of the Thompson-McFadden Commission in 1912, was 44, and in the first six months of 1913, 55 per 10,000.

These facts may be expressed in the accompanying table (Table 6).

TABLE 6.—Certifiable Insanity in Pellagrous and Non-Pellagrous Persons in Spartanburg County *

	Total Number of Persons Committed	Number of Pellagrins Committed	Certified Insane per 10,000 Population	Certified Insane per 10,000 Pellagrins
1st. 6 mos., 1912...	28	9	3.3	245.2
2d. 6 mos., 1912...	35	14	4.2	381.5
1st. 6 mos., 1913...	24	7	2.9	152.2

* It should be noted that the population has been considered as remaining constant throughout, and also that the number of living pellagrins in the first and second halves of 1912 has been regarded as equal. While not accurate, this will suffice for the present purpose. The figures for the whole of 1912 would be correctly given as the sum of those for the two halves of that year.

These figures as to the case incidence of insanity are somewhat smaller than those given by Grimm,[2] who found 7.5 per cent. insane of 1,436 cases. Presumably this refers to those who were certified as insane, and it is probable that the percentage is somewhat high for the reason that many of the milder cases of pellagra would not come under observation unless they were sought. Especially is this true, in the experience of the Thompson-McFadden Commission, for pellagrous

2. Pub. Health Rep., U. S. Pub. Health Service, March 7, 1913.

children in whom, as the figures already given amply demonstrate, mental symptoms are exceptional.

One other feature of the relation between insanity and pellagra, which has already been briefly mentioned, requires further consideration. That is the extraordinary frequency of pellagra arising in hospitals for the care of the insane. This fact of almost universal experience is well illustrated by the situation at Milledgeville, Ga. In Tables 7 and 8 are given, respectively, the numbers of cases of pellagra arising within and without the walls of the hospital in which there was an association with certifiable insanity.

TABLE 7.—Patients Admitted with Pellagra Already Developed *

	White						Colored						Total		
	Male			Female			Male			Female					
	Admissions	Pellagrous	Per Cent.	Admissions	Pellagrous	Per Cent.	Admissions	Pellagrous	Per Cent.	Admissions	Pellagrous	Per Cent.	Admissions	Pellagrous	Per Cent.
1910	338	..	...	264	..	...	207	..	...	187	..	...	996	56	5.6
1911	365	14	3.8	281	31	11.1	212	5	2.4	206	20	9.7	1,064	70	6.5
1912	375	21	5.6	311	18	5.8	226	11	4.9	196	33	16.8	1,108	83	7.4
Total ...	1,078	35	3.2	856	49	5.7	645	16	2.5	589	53	9.0	3,168	209	6.6

TABLE 8.—Cases Probably Arising Within the Hospital *

	Average Daily Population	White		Colored		Total No. of Cases	Per-centage
		Male	Female	Male	Female		
1910	3,276	..	..	..	..	114	3.5
1011	3,383	12	16	10	61	99	2.9
1912	3,424	35	27	21	97	180	5.3

* These figures are taken from the annual reports of the Georgia State Sanitarium.

The population of the state of Georgia, according to the 1910 census was 2,609,121. If we accept the proportion of certifiable insanity for Spartanburg County as approximately correct for the state of Georgia, this would mean that in 1910 there were approximately 900 pellagrins (this figure is probably far too small, H. D. S.), or 3.4 per 10,000 of the population. On the other hand, the average daily population of the hospital was 3,276 with 114 cases of pellagra, or 348 per 10,000, practically one hundred times as many as in the population outside. Experience in Illinois would tend to bear this out.

No satisfactory explanation of these facts has yet been offered. There are, however, several possibilities. First, if, as I fully believe, pellagra is an infectious disease, these hospitals may be endemic foci in which the opportunities for transmission are especially favorable. Secondly, it may be that the conditions of life are such as to cause pellagra, either by deficiencies in dietary, or positive intoxication by spoiled food or other means. Thirdly, and this is a possibility which has been too little considered, the conditions of life in such a hospital or the constitution of the persons therein confined may be such as especially to favor the onset of pellagra whether the actual cause be a living virus, a dietary deficiency or an intoxication. In discussing these possibilities it must be conceded that the only explanation for a special focus of infection in such a hospital would be the collection together of a large number of infected individuals sent to the hospital because of the occurrence of "insanity." This would not explain the sequence of events at the Peoria State Hospital and other institutions of like character in Illinois where the outbreaks appeared to start in these widely separated localities, while the number of cases in the state generally was certainly small. Some explanation is also needed for the rarity with which doctors or attendants in these institutions become affected. I know of no instance in Illinois. In Georgia but one was reported (J. E. H., white, male, attendant, on June 19, 1913) in the years 1910 to July, 1913.

The relation to dietary has already been discussed in the Report of the Illinois Pellagra Commission, 1913, so that there is no need to enter on that question here.

From the above consideration it therefore seems justifiable at present to state that evidence points to the conclusion that there is something in the make-up of those persons who suffer from faulty nervous organization, and especially of those who show character traits leading to what is called "insanity," which renders them more prone to affection with pellagra. This would be entirely in keeping with the statistics concerning the frequency of association between pellagra and insanity given above and elsewhere. It is too often forgotten that statistics merely establish correlations and do not indicate causal relationships. The importance of this view on the relation between pellagra and insanity will become more obvious from a consideration of the types of mental disorder which will be next considered.

TYPES OF MENTAL PICTURE

The literature dealing with the forms of mental picture occurring in association with pellagra is not extensive and has been reviewed in an excellent article by Gregor[4] who also gives the results of his own investigations on this subject. He emphasizes the importance of distinguishing between the mental disorders which may be directly attributed to pellagra; i. e., are due to cerebral changes brought about by the pellagra toxin, and those which have only a secondary relation to it. As will be seen from the report which follows, my results agree in the main with those of Gregor, and there is but little need to discuss his findings separately.

The type of mental picture has also been studied in some detail at the Georgia State Sanitarium, where there is a large mass of material available for the purpose. At this hospital a system of classification has been adopted, under the advice of Dr. Adolf Meyer, which is free from objection, but which makes no attempt to particularize as to the relation between the pellagra attack and the psychosis. Such a method is unquestionably wise where the data are as yet scanty and the material undigested. Under this system all cases in which pellagra seems to have some relation to the onset of the psychosis are grouped together under the general title of "Psychoses Accompanying Pellagra." This group is then subdivided according to the condition-picture presented into subheads corresponding with the Kraepelin classification in general use. Thus there appear: Infective-exhaustive, manic-depressive, dementia praecox, involutional melancholia, general paralytic, paranoic and senile types.

At present, however, it seems justifiable to speak a little more definitely concerning the meaning of these types and their relation to pellagra. The situation, indeed, is much the same as that concerning the relation of many other general diseases to mental disturbance. As is well known, similar varieties of picture are met with in typhoid fever, yet they are not grouped separately because of this association. We recognize, it is true, that the toxins of this disease, like many others, directly injure brain, as well as other body cells; and that, in consequence of this damage, certain disorders in function, such as delirium, appear, which may be regarded as the direct result of the infection. On the other hand, there may appear a dementia praecox picture or a manic-depressive reaction and these cases run a similar course to that of other examples of these types in which there has been no such infection. It may be said that there are but few to-day who regard typhoid fever as more than a precipitating cause. Personally, I regard such

4. Jahrb. f. Psychiat. u. Neurol., 1907, xxviii, 215. Trans. by A. Alleman in Alienist and Neurologist, 1911, xxxii, No. 4.

reactions as this, whether following a specific fever or other somatic disease, or whether appearing in connection with some psychological difficulty, as the way of meeting difficulties of all kinds which are peculiar to this particular individual as the result of inheritance and experience.

Viewed in this light a dementia praecox type of picture and course is not a particular kind of disease, but merely the natural outcome of the particular kind of make-up with which the individual is endowed when placed face to face with difficulties which call for special adjustment. Thus, pellagra would not be the cause of the dementia praecox syndrome, but merely the last straw which brings the individual's modes of adjustment into prominence and demonstrates the odd and inadequate manner of doing things which have always been present, but which have not been specially obvious hitherto.

Indeed, there is another view of the relation between pellagra and insanity which deserves serious consideration and which has hitherto been but little discussed.

It is quite within the bounds of possibility that the actual relation between the functional psychoses (including dementia praecox) and pellagra is somewhat the reverse of that more usually accepted. That the defective construction, whatever it be, which is responsible for the poor adaptability and peculiarity of make-up indicated by the particular stamp of these disorders, predisposes to the development of pellagra. It is certainly a fact that the disease is extremely frequent among the chronic insane, most of whom represent late stages of the dementia praecox personality. This possibility should not be forgotten when considering the epidemiology of pellagra.

The relation of pellagra to psychoses due to more definite brain disease or degeneration, such as the presenile, senile and arteriosclerotic dementias, is a somewhat different question. That pellagra occurs in combination with them is unquestionably true, and it may be that such involutional changes and diseases as involve not only the brain but also the organs of the whole body, predispose to affection with pellagra. It is also conceivable that an intoxicative disease such as pellagra might favor the early onset of involutional change, or even actually provoke arterial degeneration in the course of time. But the relation of pellagra to the dementia thus arising would even then be secondary rather than direct.

The so-called general paralytic type has given rise to much discussion and deserves some special consideration, although I have so far been unable to see cases in which this description seemed justified. That pellagra occurs in individuals suffering from dementia paralytica is a fact of observation, as in a case recently seen with Dr. O. S.

Ormsby in Chicago. But this is not what is implied by this description. The cases here grouped have all been rapidly fatal and the picture presented is that of the final stage of dementia paralytica. It is not claimed that they run the whole course of that disease. To quote from the report by Green of Milledgeville, Ga., the features which lead to such a grouping are: "Exaggeration or loss of knee-jerk, speech disturbance [possibly a dysarthria due to stomatitis, H. D. S.], tremors, muscular incoördination, pupillary inequality or irregularity, convulsions and sensory disturbance." The case records of examples which I was able to study at the Milledgeville hospital speak of extreme disorientation with confusion and a muttering incoherence, so that but little information can be obtained from the patient who leads a more or less vegetative existence, does nothing for himself and voids urine and feces in the bed. The picture thus described suggests an extreme degree of general intoxication with central and possibly at times peripheral neuritis. It resembles in many respects the severe toxic forms of infective fevers, such as typhoid, and there seems but little justification for regarding it as especially comparable to dementia paralytica. It is not the extreme nervous disorganization which is characteristic of general paralysis, and it is unfortunate that a name with a specific significance should be used to describe a condition which may result from many different causes.

For purposes of description the types of mental disorder associated with pellagra may be grouped as follows:

Group I. Disorders directly due to the pellagra toxin (or toxins).

1. Symptomatic depressions.
2. Delirious pictures.

Group II. Disorders based on peculiarities in personal make-up, the "attack of insanity" being precipitated by pellagra.

1. Manic-depressive disorders.
2. Hysteria.
3. Psychasthenia.
4. Dementia praecox.
5. Paranoic developments.

Group III. Disorders due to definite brain changes with pellagra merely as a complication.

1. Arteriosclerotic dementia.
2. Senile dementia.
3. Presenile psychoses.
4. General paralysis of the insane.

The disorders in Group I may be considered in some detail, whereas the others will be passed over more briefly.

I. *Symptomatic Depressions.*—This type of disturbance is by far the most frequent, if one includes the cases outside a hospital for the insane. They are but seldom committed. They have been described by Gregor under the title of neurasthenic type, but the name here used seems preferable for the reason that while neurasthenic features are present, yet there is a decided attitude of depression, sometimes without any very definite objective signs of fatigue. The main characteristic of them is that the attitude of depression runs parallel with the other manifestations of pellagra, improving as they improve and becoming worse as these other symptoms become more severe.

The picture presented is that of a more or less hopeless sadness with all that this implies in regard to the activities of the body as a whole. There is a general lowering of tone, energy and attention are more or less difficult, thinking is difficult and activities are diminished. Obviously the exact mode of expression will vary with the personality of the patient, just as the words he uses to express his feelings depend on his personal experiences and habits of adjustment. As illustrations of the type most commonly met, the following quotations from cases observed in Spartanburg may be given: In expressing the color of the mood, "so blue I couldn't stand it hardly . . . seemed like I couldn't stand it if I couldn't sit down and cry"; "afraid I'll not get better"; "depressed and down-hearted"; "can't get cheerful"; "can't ever look forward to being any better." At times this is amplified by similes such as: "feel like I was lost . . . my soul was going to be lost and going to torment . . . didn't feel like I could get forgiveness for my sins." The lack of energy and feeling of inefficiency are shown in "energy and ambition all gone"; "can't do nothing, can't work or hold out"; "lost interest . . . it's hard to work"; "so tired all the time, no ambition"; "I just feel helpless"; "I used to be one of the best housekeepers and now look at my house." The difficulty in thought is shown in: "can't get my mind on anything"; "it's difficult to think"; "my recollection is mighty short"; "I'll get up from the porch to do something and forget what it is before I get into the house."

Sometimes there is more or less well-marked apprehension without any definite fear, e. g., "I feel as if something is going to turn up"; "so nervous I scream when anything happens." etc. At times this becomes definitely an anxiety expressed not only in words, but also by restless agitation. This has seemed to be true especially in persons during the involutional period of life and hence probably connected with the somatic changes which are then in progress, but it does also occur in younger individuals. Well-marked examples of this kind would naturally be included with the presenile psychoses or involutional melancholia. In such case the pellagra is not the direct cause, but rather an exciting or perhaps purely complicating disease. Thus, for instance, I recently had under care in Illinois a woman in comfortable circumstances in life, who at the age of 58 developed an anxious agitated depression for which she was sent to a sanatorium. In the course of a few months she improved, although still depressed, and was returned to her home where she developed pellagra and became more worried and depressed, with finally the necessity of commitment at least three months after the onset of pellagra, but with active manifestations in the skin and gastro-intestinal tract. The condition ended fatally in a few weeks. Here unquestionably the sequence of events suggests that pellagra was merely a complicating disease and that the general bodily state expressed in the psychosis was a predisposing factor to, rather than the result of, its development. No other cases of pellagra had been known in the town in which this patient lived, although I am informed, one had occurred a year earlier in the sanatorium to which she was first sent.

Delirious Pictures.—By the term delirium is implied a state characterized clinically by clouding of consciousness together with sense-falsifications, especially of illusory character, the reactions of the patient in word and act being conditioned by this dream-like state. The vast majority of such condition-pictures are the result of intoxication of the brain with consequent general lowering of functional activity which involves first and most the highest cerebral levels. All degrees are met with in pellagra as in other intoxications. In the milder forms the periods of clouding may be quite brief and episodic In such cases, in the intervals when consciousness is practically clear, the general attitude is one of symptomatic depression similar to those described above. Indeed, it is not uncommon to find that the more severe forms of depression give a history of occasional and transient sense-falsification with apprehensive content and more or less fear-reaction. Such, for instance, is true for Case 1, recorded below, while Case 2 represents a more severe and permanent clouding with practically complete amnesia for the period on recovery.

CASE 1.—*Symptomatic depression with episodic clouding, sense-falsification and apprehension. Central neuritic syndrome and fatal outcome.*

B. S., white woman, aged 35, observed first at home and later in the Good Samaritan hospital. The family history as far as obtained was negative for mental and nervous disease. The patient was stated to have been healthy except for malaria in childhood. The first attack of pellagra appeared in April, 1910, and subsided in the following month, but was accompanied by some depression. The second attack was very similar and appeared in April, 1911.

The third attack of pellagra was more severe and began in April, 1912. This was accompanied by severe gastro-intestinal symptoms and was still present in July when she was examined by the commission, who state that she then was very weak, much depressed and did not seem at all times to be quite clear in her mind. This outbreak gradually subsided, but the erythema recurred again in December, 1912, with an exacerbation in January or February, 1913.

Mental picture: July 16, 1913. The patient appeared very dull and apathetic, intensely depressed, "life is not worth living," spoke in a low, rather monotonous voice, slowly and only with frequent urging. She seemed to be entiely clear and perfectly oriented as to her surroundings and the situation. When left to herself she lay in bed almost without movement, paying but little attention to what was taking place around her.

In answer to questions she expressed a feeling of fear, at times severe, as if "something going to get me." She mentioned the occurrence of "bad dreams" in which she would see horrible things, animal forms which she could not describe. She would also hear voices, even when awake, some of which were recognized, others were strange. They frightened her but she could not give the content more than to say that they were "just calling me." There was at the time of examination a full realization that they were imaginary but "they just come by spells" and at such times seemed real. In answer to a leading question she stated that at such times she did not feel clear in her mind.

Such periods as this came irregularly and lasted perhaps a day but she could not give any details as to frequency. The picture of hopeless apathy continued during the week that she was under observation, without the appearance of any objective evidences of clouding or apprehension. There was, however, a rapid development of signs of a "central neuritis" reaction, gross exaggeration of deep reflexes, bilateral extensor plantar reflex, slight jactatoid movements, nausea and vomiting. In spite of a temporary improvement in the last few days of July, the patient died August 9, 1913.

Case 2.—*Delirious type. Severe clouding of consciousness with sense-falsifications of dream-like character and of depressive and more or less horrible content. After about four weeks a brief period of apathetic stupor and recovery with amnesia; subsequent exacerbation with fatal outcome.*

S. M. P., white woman, aged 23, housewife. Admitted July 11, 1913. The friends and relatives were very ignorant and the history is consequently not full. As far as could be determined, the family history showed nothing of importance for two generations. The patient was always healthy and had no serious illness. She had some attacks of "fever," but was at no time out of her head. The family were in poor circumstances and she had no schooling. She was described as of quiet, retiring disposition, high-tempered and "some selfish." She was, however, contented and cheerful, "would sing right smart" and worked steadily. Always scrupulously neat and clean, "an excellent housekeeper," "nothing ever out of order." She was married about two years ago; has been happy and has one child about 1 year old.

Pellagra: The first attack occurred in the summer of 1912, five months before the birth of her child. She then had a characteristic erythema of the hands with stomatitis and diarrhea. She was not very ill and is said to have had no mental disorder except "some loss of memory" and a general malaise. These symptoms all cleared up during the summer, although there is said to have been some scaling of the hands more or less until the present attack. Towards the end of May, 1913, the hands again became sore and soon after there appeared sore mouth and diarrhea.

Mental disturbance: About the beginning of the last week of June, 1913, the patient became "queer in her head." She seemed "to be hearing voices and talking to them." At first more or less intermittent this condition has become worse and practically continuous with increasing restlessness and fearful excitement. Many of her utterances were quite unintelligible even to her relatives, but the general trend is illustrated by such remarks as she had "seen her mother dead," her "head cut off," etc. At times she would suddenly "jump up like she was going to run away," and the restlessness had become so extreme as to make it difficult to care for her. During this period she had been growing steadily weaker and had emaciated badly.

When admitted to the hospital she was extremely ill, with severe and characteristic erythema, stomatitis and diarrhea. When seen by me, July 14, 1913, no very complete examination was possible owing to the extreme illness of the patient, but no evidence of other somatic disease was discovered. Neurologically there was marked exaggeration of the deep reflexes but without clonus, and the plantar reflexes were of flexor type. Constant restless movements were present, tossing about in bed, pulling at the bed clothes and even trying to get out of bed. All these movements were feeble and tremulous but showed no incoordination and there were no convulsive jerkings or twitchings.

All the time the patient was muttering, with occasional crying or apprehensive screaming. Much of what she said could not be understood, partly because of the low muttering, and partly because of the dysarthria due to severe ulcerative stomatitis. Samples of spontaneous utterances are: "Give it here . . . give it here . . . Oh! get up . . . get loose from there . . . I can't do nothing . . . (pulling at the bedclothes and looking around apprehensively) . . . I wouldn't use you that way . . . Oh! . . . Oh! . . . you're on my dress . . . I want my dress . . . (cries and moans fretfully and becomes unintelligible)." "I go up and go all over the place . . . go from here to the mill . . . and never know what is the matter . . ." "Annie . . . Annie . . . Annie . . . Oh! . . . Oh! dear (screams) . . ."

During this time she was apparently taking no notice of her surroundings, paid no attention to the examiner or her sister when they entered the room nor to the fact that someone was sitting close beside her. By speaking loudly and persistently it was possible to gain some degree of attention and even some degree of relevancy in response. When asked her name she did not give it but when asked to spell it said somewhat slowly and monotonously, "R - i - n - e - e - n - h - e - a - e - a - h - e - a - t - a - t - a - t" (her maiden name was Rhinehart). She gave the name of her home town correctly, but when asked her father's name gave that of her husband. When asked if she was sick she replied, "Of course I am . . . Go away from here . . . I don't want to talk to you . . . I want to go home . . . Annie . . . Annie . . . Oh! . . . Oh! . . . dear." Questioned as to her baby she said that "she (the baby) is dead." This is not true but is an illustration of the depressive content of the ideas. No answer indicating any grasp of where she was could be obtained and she apparently failed altogether to recognize her sister or brother-in-law.

She virtually did not sleep the following night, but screamed and yelled as if in fear or in pain. The next morning, however, she was a little brighter when roused, recognized her sister and called her by name, but immediately again became more clouded and presented a picture much as before.

July 17 she was obviously clearer and more easily roused but fretted and moaned much of the time. She then stated that she "felt terribly bad" and spoke spontaneously of a visit from her sister and mother (the latter had not been there) and added that she had not seen her husband. With regard to herself she said "seems like I have just given way and haven't got any use to myself . . . I can't get up . . . couldn't do nothing." When questioned about her baby she replied that she was "doing nicely, thank you." She very speedily became tired and more fretful and denied any knowledge as to her whereabouts.

From that time she became gradually brighter when roused but at the same time more heavy and apathetic when left to herself. It was not until July 22 that she was able to recall the name of the hospital or the examiner, although these had been told to her repeatedly. At this time she said she was "feeling good" but very tired. She stated "I've got my mind now . . . have for a long time . . . I used to didn't have none, didn't know nothing." In answer to question she professed to be entirely ignorant as to what had happened for two or three weeks but came to herself "last week." She spoke of the period as being "all like a dream," but was apparently unable to remember any of the dream.

Coincident with the improvement in the mental state the pellagrous symptoms had been improving. The skin eruption was almost gone on July 20 and the diarrhea, after becoming gradually less, ceased altogether about July 22. She remained weak but clear mentally until September 1, when she became stuporous and died September 7.

Occasionally, periods of delirium recur several times in relation with exacerbations in the general manifestations of pellagra. One such example was seen at Milledgeville in the case of T. S., a colored man, who had four such brief periods of apprehensive excitement in which he vaguely remembered horrible "dreams" of being pursued by wild animals and tortured by persons in his environment with whom he fought. These "dreams" explain his conduct as observed during the attacks and each occurred in association with an exacerbation of diarrhea.

The relation of pellagra as the cause of such attacks is fully intelligible, but it should be remembered that different individuals show different relations to intoxication. Some very easily become delirious from alcohol or mild infectious fever; others seem able to resist much larger doses and more severe infections. It is thus generally recognized that the persons who readily develop delirium are poorly constructed in some way. The fact that delirium occurs so frequently in pellagra is capable of two explanations. Either the toxin is extremely virulent, or the individuals who suffer from pellagra are especially those of poor nervous organization. This latter possibility is in keeping with the suggestions already made in this direction.

II. *Disorders in which the Character of the Picture is due to the Personality of the Individual Affected.*—It would be entirely out of place here to attempt to describe these pictures. They differ in no way from other examples of such types not associated with pellagra. It is true that the pellagrous intoxication may give rise to a delirious stamp which may render the recognition of the type more difficult, but such features, as in the deliriums already described, will run a course parallel to the other pellagrous manifestations, whereas the elements in the disorder belonging to the personality of the patient will remain more or less independent of them.[5] This is also the case with examples of such psychoses arising in connection with specific fevers. Dementia praecox precipitated by a puerperal infection may be recognizable at first only as a delirium, which disappears with the subsidence of the infection, while the peculiar traits of conduct which make up the dementia praecox picture become thereby more and more obvious.

It may be said, then, that disorders of this kind run a similar course with a similar outcome (except that the pellagra brings with it a far

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5. See Case 2 "Pellagra in Illinois," The Archives Int. Med., 1912, x, 162.

greater menace to life) to that of cases arising with some other factor as a precipitating agent. The dementia praecox types result in what is called deterioration or dementia, the manic-depressive modes of reaction subside after a shorter or longer time without dementia, and so on.

In cases of this kind which have been investigated by me, evidences of the type of personality which results in such developments have been demonstrable before the onset of pellagra. An excellent illustration is afforded by a typical outbreak of manic excitement coincident with the appearance of pellagra which led to the first commitment of the patient.[6] The anamnesis revealed evidence of a manic-depressive type of make-up for several years before.

An excellent example of a dementia praecox picture, with apparent recovery, was seen at Milledgeville. A very full katamnesis was obtained in which it was learned that the fancies and imaginations with peculiar forced reactions had been present, although unknown to relatives, for at least nine months before the outbreak of pellagra, which did not become quite definite until after admission, although suspected at the time when she was received. Another patient was seen at Columbia with considerable deterioration, of the dementia praecox type, who had been admitted to the hospital on several occasions with attacks of pellagra, but in whom the mental disorder, as stated by Dr. Saunders, had been present at least one year and a half before the first attack of pellagra.

Below is published in detail another case (Case 3), probably belonging to the dementia praecox group, but with certain other features of nervous disease which seemed worthy of record. The absence of any parallelism between the pellagra and other nervous manifestations is here obvious.

These illustrations might be multiplied without advantage, sufficient having been said to illustrate the point under consideration. It may be that cases occur in which the sequence here claimed cannot be demonstrated, but where it has been possible to obtain sufficient information, no case has yet been presented to controvert this claim. Both at Milledgeville and Columbia an effort was made to see every pellagrous patient who had been detained as an example of chronic insanity.

With regard to Group III, there will be but little objection to the views expressed, that the pellagra and nervous disease are separate disorders, although it is possible that some degree of correlation may exist, in that one may predispose to the other. The question of a general paralytic type has already been discussed and need not detain us here.

6. See Case 3, "Pellagra in Illinois," The Archives Int. Med., 1912, x, 166.

FREQUENCY OF THE DIFFERENT TYPES OF MENTAL PICTURE

This subject may be considered under two headings. First, the frequency in a series of cases of pellagra, and second, the frequency in a series of cases committed to a hospital as "insane." The material at hand is not entirely satisfactory for this purpose owing to the short time available. For the first part of the question, use will be made of the cases in which the patients were seen and examined by me, and of the 130 observed by the Pellagra Commission. The information in these latter cases is not always sufficient to justify a positive conclusion, but the errors will be small.

TABLE 9.—Types of Mental Disorder in a Series of Pellagrins

	Thirty-four Unselected Cases Seen by the Author		One Hundred and Thirty Unselected Cases Seen by Commission		Total Unselected Cases		Eighteen Hospital CasesSelected for Severity	
	No. of Cases	Per cent.	No. of Cases	Per cent.	No. of Cases	Per cent.	No. of Cases	Per cent.
Group I—								
Symptomatic depression	9	26.5	41	31.5	50	30.5	10	55.5
Delirious pictures.........	2	5.9	10	7.7	12	7.3	2	11.1
Group II—								
Manic-depressive disorders	0	0.0	0	0.0	0	0.0	1	5.5
Hysterical disorders......	1	3.0	0	0.0	1	0.6	0	0.0
Dementia praecox disorders	0	0.0	1	0.8	1	0.6	1(?)	5.5
Group III—								
Arteriosclerotic dementia	0	0.0	0	0.0	0	0.0	1	5.5
Presenile phychoses.......	1	3.0	0	0.0	1	0.6	0	0.0
Senile dementia...........	0	0.0	0	0.0	0	0.0	1	5.5
Total	13	38.2	52	40.0	65	39.6	16	88.8

For the second part, use has been made of the thirty pellagrins committed to the Columbia State Hospital from Spartanburg County. To these are added the figures obtained from the annual reports of the Georgia State Sanitarium. Many of the records of these cases and some of the patients were investigated by me, so that some discussion is permissible.

From Table 9 it will be seen that in a series of 164 unselected cases of pellagra, mental symptoms directly attributable to this disease occurred in 62 or 37.8 per cent.; that 2 (1.1 per cent.) presented a psychosis depending on peculiarities in personal make-up, and that 1 (0.6 per cent.) showed the mental picture of an involutional psychosis.

From the above Table it will also be noted that in the 164 unselected cases of pellagra the disorders included in Group I constitute 95 per cent. (62 out of 65 cases) of the mental pictures observed in the series.

One is probably not justified in attempting to correct the groupings here given of the Georgia cases, because in many instances the patients were no longer in the hospital and the time available for a study of those remaining was very short. Nevertheless, it may be pointed out that the cases included under the head of "general paralytic type" seemed to be severe examples of delirium (none of these patients were seen) and that some of the manic-depressive depressions appeared to belong rather to our group of symptomatic depression. Of all the fifteen cases of dementia praecox type only four were still present in

TABLE 10.—Types of Mental Disorder Associated with Pellagra Admitted to the Georgia State Hospital in 1911 and 1912, Taken from the Annual Reports of That Institution, and of Those Admitted to the South Carolina State Hospital from Spartanburg County in 1912 and the First Half of 1913

	Georgia Cases				Columbia Cases				Per Cent. of Grand Total
	1911	1912	Total	Per Cent. of Total	1912	1913	Total	Per Cent. of Total	
Group I—									
Symptomatic depression..	0	0	0	0.0	2	1	3	10.3	1.6
Delirious pictures*........	38	46	84	54.9	16	4	20	69.0	57.2
General paralytic type†...	6	2	8	5.2	0	0	0	0.0	4.4
Group II—									
Manic-depressive disorders	8	10	18	11.8	2	0	2	6.9	11.0
Dementia praecox disorders	9	6	15	9.8	2	1	3	10.3	9.9
Paranoic disorders........	0	1	1	0.7	0	0	0	0.0	0.6
Group III—									
Involutional psychoses....	2	1	3	1.9	0	0	0	0.0	1.6
Senile dementia...........	2	0	2	1.3	1	0	1	3.5	1.6
Undetermined types.........	5	17	22	14.4	0	0	0	0.0	12.1
Total	70	83	153	100.0	23	6	29	100.0	100.0

*In the hospital reports these cases are grouped under the title of infective-exhaustive types.

† These in all probability belong with the delirious pictures.

July, 1913. In them the grouping seemed justifiable. Of the others, some were dead and the records at times suggested rather a delirious picture, while others had been discharged. A study of the records of the cases in which no type had been determined naturally permitted no conclusions, but it may be said that death followed speedily in many of the cases and this suggests that many of these patients belong in the delirious type.

Leaving the figures as given in the hospital reports it is obvious that delirium is by far the most frequent form of mental picture which leads to commitment. The effect of reclassification would be only to augment this group at the expense of the others. It would be a matter of great value and interest if the subsequent history as regards outcome of the psychosis could be followed in detail for all cases in these various groups.

If one compares the proportion of the different groups in Table 10 with that in Table 9, it will be obvious that a very erroneous impression of the relative frequency of the different types of mental disorder associated with pellagra would be gained if the data were limited to the cases admitted to a hospital for the insane. Group I constitutes 95 per cent. of all forms in Table 9 and but 63 per cent. (as a minimum) in Table 10.

One other comparison may be made at this point which tends to emphasize the correlation between faulty nervous organization and liability to pellagra. According to the annual report of the Georgia State Sanitarium for 1912, there were admitted to that hospital 132 cases of dementia praecox and 150 cases of manic-depressive insanity. Among the pellagrins it will be seen from Table 10 that there were six examples of a dementia praecox type of personality, and ten of manic-depressive constitution. The ratio between pellagrous and non-pellagrous individuals in the two groups is 1 : 22 and 1 : 15, respectively, proportions which are unquestionably far greater than that of pellagrous to non-pellagrous sane inhabitants of the state of Georgia.

OUTCOME

From a practical point of view, this is probably the most important question of all. The facts recorded above afford ample justification for the general recognition of the frequent association between insanity and pellagra. But they do not support the gloomy prognostications which are so prevalent and so distressing in pellagrous regions.

It will be noted that of all the examples of mental disorder occurring in a series of 164 unselected cases, 95 per cent. are included under the heading of symptomatic depression or delirium. Furthermore, that of the cases committed as "insane" at least 63 per cent. come under this same category. All of these cases will recover provided they live through the attack of pellagra. The mental symptoms bear exactly the same relation to pellagra that the similar disturbances occurring in connection with other infective or intoxicative diseases, such as typhoid and tuberculosis, do to these diseases. They do not lead to any permanent mental disorganization.

This at once brings up the question as to whether there is any form of chronic insanity which can be considered as being directly due to pellagra. This question is necessarily closely bound up with the view which is taken as to the rôle which is played by pellagra in the etiology of dementia praecox. This has already been discussed and the view expressed that such a development is the result of the personality of the individual rather than the consequence of the disease process which constitutes pellagra. Many of the examples of these types have shown definite mental disturbance prior to the outbreak of pellagra. It would be impossible to say definitely that all others would have developed the psychosis if they had not contracted pellagra, but there is no doubt in my mind that the probabilities are strongly in favor of such an occurrence. For, difficulties to be faced must occur in even the most protected existence and it becomes a question of the degree of ability possessed by the individual to adjust in a manner which more or less satisfactorily meets the difficulties. The answer to this question is the determining factor in the evolution of a psychosis. In other words, such a personality must be considered as always standing on the edge of a precipice over which he may slide as the result of any difficulty whatsoever, provided it cause him sufficiently to stumble. The man with average capacity for walking amid the irregularities of the pathway of life will successfully maintain his poise, while he with poorly balanced mechanisms of coordination or adaptation is liable to fall.

Besides this form of dementia, it is also possible that, like alcohol, pellagra might produce a degenerative condition in the nervous system with resulting chronic dementia. While this possibility cannot be denied, I can state definitely that in spite of a close search for examples of such end-result I have as yet failed to find one. At Milledgeville, an attempt was made to interview all still present patients with "psychoses accompanying pellagra," with this question in view, but without result. It may be that I am including some examples of this kind with the terminal stages of dementia praecox, but the number is certainly small and in my opinion entirely negligible.

It thus seems justifiable to conclude that pellagra is especially frequent in individuals of faulty nervous organization, and that in consequence there occur, in association with it, a greater percentage of such disorders as dementia praecox, manic-depressive insanity, hysteria, etc., than prevails among more healthy persons, yet the vast majority of the mental disturbances occurring in connection with pellagra are of no more significance *quâ* "insanity" than are the deliriums of typhoid fever. It is, however, probably true that, just as in that disease, the appearance of delirium or severe depression is a sign of the severity of intoxication and greater danger to life.

NERVOUS MANIFESTATIONS

This subject will be dealt with extremely briefly, for the reason that there is but little to add to what has already been said by me in the report of the Illinois Pellagra Commission. One cannot but be impressed with the strong conviction which prevails that pellagra is especially a disease of the nervous system. Thus we find Wood[7] stating, "It is a daily problem with me and my colleagues to differentiate between myelitis of specific origin and similar pathologic conditions produced by pellagra."

Among the cases seen in the South, apart from the results of arteriosclerotic changes such as cerebral thromboses, it has been my experience to observe only one case in which there were evidences of chronic structural change in the nervous system. (This is entirely in keeping with the findings in regard to chronic dementia.) It is true that many of the severe and fatal cases present the syndrome of central neuritis, which is a reaction of the central nervous system to severe intoxication. This subject has already been amply discussed in the Illinois report and the anatomical findings in a series of cases published by L. J. Pollock and myself.[8] Dr. E. B. Saunders kindly furnished me with information as to the mode of death among pellagrins in the Columbia State Hospital. According to her observations, in a series of 88 fatal cases, sixty-four patients (74.7 per cent.) died with central neuritic symptoms, nineteen (21.6 per cent.) with appearances of simple exhaustion and five (5.6 per cent.) terminated suddenly from some unknown cause. In all severe cases there are evidences of irritable weakness in the nervous system, such as tremors, exaggeration of tendon-jerks, increased myotatic irritability, etc., entirely comparable to those met with in other severe intoxicative conditions, such as tuberculosis. Occasionally loss of knee-jerk is reported, the exact meaning of which is not always clear. The only example in the series here reported in which such a loss existed was that of an old man with severe arteriosclerosis who had suffered from a cerebral insult before the onset of the pellagra. The right knee-jerk (on the side of the hemiplegia) was present, but faint, while the left was absent. In the light of other experience, it seemed more probable that the lost knee-jerk was associated with some cerebral lesion rather than with the pellagra.

The single instance of chronic nervous disease which has come under my observation is deemed worthy of record in detail.

CASE 3.—*"Shut-in" type of personality. Loss of interest following first attack of pellagra. More definite psychosis of dementia praecox type of about nine months' duration ending in apparent recovery after a second attack of pellagra. Occasional sudden brief attacks of loss of power in the lower extremities since the first attack of pellagra. Atrophy of small muscles of hands and spastic paraplegia of gradual evolution following the second attack of pellagra.*

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7. Wood, E. J.: Treatise on Pellagra, D. Appleton & Company, 1912, p. 228.

8. Singer, H. D., and Pollock, L. J.: The Histopathology of the Nervous System in Pellagra, THE ARCHIVES INT. MED., 1913, xi, 565.

F. B. M., white, male, aged 21, no occupation. Anamnesis obtained from the father, stepmother, sister and the patient. The mother died in all probability of pellagra seventeen years ago, although the diagnosis was not made at the time. Her illness is described as resembling in all particulars that of the patient as regards eruption on the hands, stomatitis and dysentery, except that it was more severe. The mother was nervous but there is no other history of importance.

The patient was always healthy and thought to be of average brightness. He had never been very enthusiastic about games and always preferred to play with children younger than himself. He was well liked, but had no confidants and kept much to himself; never cared to go out to parties, stayed much around home, and did not mix with members of the opposite sex. He was never a leader; did not read much and although he took pleasure in driving an automobile and caring for it, he seems to have spent much of his spare time loafing around the house. He has formed no definite plans or ambitions and seems to have taken it for granted that he will enter his father's business of lumber merchant. He has never caused any anxiety by getting into mischief and has been thought above the average in regard to morality. Thus the striking features of his make-up are chiefly negative and there is a lack of the push, activity and mischief of the average healthy boy.

In the summer of 1910 he suffered with an attack of malaria which was not very severe and from which he made a good recovery.

In March, 1911, there developed an erythema of the backs of the hands with some malaise which was recognized as *pellagra.* This attack was mild and disappeared in two or three weeks, but on his return to school it was noticed that he did not take as much interest as before. He wished to leave and fell behind so that his younger sister caught up and eventually passed him. He seemed to be unable to get his lessons, loafed around more and was even more retiring than formerly.

In the summer of 1911 he delivered papers for a newsdealer for a few days but then gave it up. While on his rounds he had a peculiar "spell" and had some ten or twelve of these between that time and October, 1912. As these attacks are said to be all alike it will suffice to describe one.

Spells: The onset is more or less abrupt and apparently most often during walking. The first manifestation is a sense of "drawing of the left side of the body," which seems to pull him over backwards and to the left. On some occasions he has been able to reach some support but generally he has fallen. His legs rapidly become stiff, weak and numb and for a while he cannot move them at all. There is no pain, dizziness or loss of consciousness according to the patient. The sister, however, stated that he had once been brought home unconscious in one of these spells. The patient recalls the incident and has apparently a clear recollection of it, so that it is at least doubtful whether he has ever lost consciousness. In an attack seen by the father he remained clear throughout. The paralysis gradually passes off and he is quite all right again in about fifteen to twenty minutes after the onset. In the attack observed by the father in June, 1912, while out in the woods he was able to walk back to camp at the end of twenty minutes, a distance of one and one-half miles.

There has never been any convulsive movement nor loss of sphincter control and he has seemed to recover fully afterwards.

In March, 1912, there was a second and more severe attack of *pellagra.* Following this he became listless, wanted to leave school and said that he could not keep his mind on his books. He did not seem depressed, but merely loafed on the porch or about the house. About the end of June he showed more definite evidence of insanity and began to express such notions as that everyone was watching them, the house was to be burned and they were to be shot. He did not react much to these thoughts and showed no sign of fear, but he did ask for his gun, which had been removed by his relatives, and once spoke to a policeman asking him to be on the watch for these people. He wandered aimlessly about the house peering into corners and rummaging in drawers and had to be watched to prevent him from going away from the house. For a long time he carried a woolly rug around with him, offering no explanation for so doing. He seemed to take little notice of anything and was often very "obstinate." For a time he was entirely mute and refused food and medicine. He would object to getting into a bath and, once in, would refuse to come out, although he was never violent. Sense-falsifications were probably present. He would stop as if listening and mutter to himself and spoke of electricity and automobiles in his back.

He seems to have slowly become worse until October, 1912, when he was committed to the Columbia State Hospital. At this time it was noticed that he was weak in his legs and hands and required supporting to walk at all. This was, however, attributed to disuse and was not considered seriously.

It was impossible to determine the exact relation between the pellagra and the mental disturbance. The listlessness and loss of interest appeared in marked form soon after the appearance of the eruption on the hands, but this was entirely gone when he went to Columbia. It seemed probable that the diarrhea and stomatitis, which were present in March, had disappeared before July.

At Columbia the patient remained in bed with apparent indifference to his surroundings, but without active symptoms of any kind. Slowly he began to improve, both as regards interest in his environment and home, in his walking and the use of his hands, which were at first practically in abeyance. He was discharged as recovered July 17, 1913.

When examined the day after his return home the following facts were noted: A tall, muscular lad with an apparent age of not more than 17, although he was actually 21. There was little hair on the face, although it was normally present elsewhere on the body. The ears were large, irregular and asymmetrical. Genitalia well developed.

The gait was markedly spastic and he used a cane in walking. The feet showed a high arch. The knee- and ankle-jerks were markedly and equally exaggerated and a few clonic jerks, not sustained, were obtained at both ankles. Both plantar reflexes were of extensor type. The small muscles of the hands were much atrophied, with a characteristic *main en griffe*. The forearm muscles were small and power was much diminished, the wrists showing definite extension when an attempt was made to grip firmly. The grips were both feeble. No atrophy was detected elsewhere. Electrical examination was impossible owing to the lack of apparatus. The abdominal muscles were of good power and the epigastric and abdominal skin reflexes were present.

The only sensory disturbance discovered was a hypalgesia, not by any means complete, in the region of the first dorsal root distribution on the left forearm. No incoordination was detected.

A fine lateral nystagmus was present on extreme deviation of the eyes, especially when they were rotated to the left. No other ocular disturbances. Fundi healthy. The tongue deviated slightly towards the left when protruded, but there was no obvious loss of power in any movement and no defect in speech or swallowing. The facial movements were normal.

Bladder disturbance was at first entirely denied, but in reply to a leading question it was learned that there had developed some hesitation in starting the flow of urine.

The picture is thus not very clear or characteristic, but it was thought that the condition was probably one of syringomyelia and that the transient "attacks" of paraplegia might be due to minute hemorrhages or other vascular disturbance in the growth. Although it is said that he recovered perfectly from these attacks, it should be noted that the onset of the spasticity and atrophy of muscle were not noticed until they were severe and that the onset was quite possibly very insidious.

Katamnesis: With regard to the evidences of mental disorder, the patient simply denied most of them although he claimed to have been entirely clear throughout. He admitted that he had been "out of his head" for the first period of his residence at Columbia, but attributed this to drugs and hypodermics. (The only drugs used were simple tonics.) He denied sense-falsifications except that he had had shocks "like electricity" in his back; denied that he had ever thought the house was to be burned or that people were watching the house. He would not meet or talk to people because he was afraid he might have one of his "attacks," of which he was ashamed. His memory for the events of the period of psychosis is apparently good and he gave a good account of his trip to Columbia.

He talked freely and answered questions without apparent evasion, but volunteered little and was not deeply concerned. His father considered him entirely recovered and attributed the somewhat listless attitude and poor interest to the weakness and disability resulting from the nervous lesion.

In spite of the close relation in point of time between the onset of the nervous symptoms and the attack of pellagra, one can hardly doubt that here the latter acted merely as a precipitating factor, both with regard to the psychosis and the nervous disease. As is well known, syringomyelic conditions are occasionally discovered at autopsy which have apparently caused no symptoms during life; also, it is not uncommon for the clinical manifestations to appear following some infectious fever in individuals who have previously been considered normal. The same is also true for other diseases belonging to this group of congenital anomaly, so that even if the suggestion that this is a case of syringomyelia is not correct the argument will still hold. The same explanation in all probability applies to the case published in England by Box[9] with a histological study by Mott.[10]

The occurrence of such cases as this is a further argument in favor of the suggestions which have been made in discussing the mental disorders, that faulty nervous organization seems for some reason to be associated with a predisposition to pellagra.

In closing this chapter reference may be made to the frequency with which manifestations appeared to point to especial involvement of the vestibular apparatus. This has been recorded before, but seemed to be especially prominent in the more severe forms of the disease observed in Spartanburg. Vertigo, often extremely annoying, at times constituted the main complaint of the patient. It was often sudden in onset and would result in falling, sometimes with vomiting. In most cases this dizziness would appear only when the patient was up and walking about, but in some it was present at times even when lying down. It was usually associated with more or less severe tinnitus and less frequently with a sense of pressure on the head. None of these attacks was actually observed. Among the eighteen severe cases in

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9. Box, Charles R., and Mott, F. W.: Trans. Soc. Trop. Med. and Hyg., 1913, vi, 149; Brit. Med. Jour., July 5, 1913, p. 2.

10. Mott, F. W.: Trans. Soc. Trop. Med. and Hyg., 1913, vi, 157; Brit. Med. Jour., July 5, 1913, p. 4.

the Good Samaritan Hospital, this syndrome was more or less prominent in six.

SUMMARY AND CONCLUSIONS

1. Mental disturbance occurs in about 40 per cent. of all cases of pellagra. Such disturbances are more frequent with repeated attacks. Children are practically exempt. They are most common in men between 21 and 40, and women about 41 to 60.

2. About 95 per cent. of the mental disorders are the direct result of the pellagrous intoxication, and although the mortality in such cases is much higher than in cases without such disorder, yet the mental disturbance will fully recover if the patient survives. They correspond to similar disturbances in other somatic diseases and in such case are often described as not "insanity." The remaining 5 per cent. are examples of mental disorder primarily dependent on the individual's make-up, or else are merely concomitant.

3. Faulty nervous organization, including inadequate mental adaptability, seems to be associated with a predisposition to pellagra. This seems to afford the most satisfactory, even if only partial, explanation of the extraordinary frequency of pellagra arising among the insane, the increased frequency of functional psychoses and psychoneuroses and of nervous disease of the congenital anomaly type among pellagrins as compared with more normal individuals.

4. Chronic "insanity" due strictly to pellagrous intoxication, if it occurs, is rare.

5. Chronic nervous disease as the result of pellagra, if it occurs, is exceptional.